

Method and device for spacing apart electronic components arranged in a matrix structure

The present invention relates to a method and device for spacing apart electronic components arranged in a matrix structure. In the method a part of a group of electronic components arranged in an initial matrix structure are picked up; and the picked-up electronic components are set down on a carrier. The device is provided with a feed for electronic components arranged in an initial matrix structure; a carrier on which picked-up electronic components are set down, and at least one manipulator for picking up a subgroup of the electronic components supplied in an initial matrix structure.

The regrouping of electronic components supplied in a matrix structure, such as for instance in the production of semiconductors, is known. During production semiconductors for instance thus undergo different successive processes which are performed in different processing stations. The semiconductors are transported between these processing stations. Standardized carriers are usually used for this purpose within a production location. Most processing stations deliver electronic components in a matrix structure, though certainly not always in an immediately usable configuration. It is thus possible that the mutual spacing, the relative orientation and/or - if batchwise production steps are involved - the group size in an initial matrix structure does not correspond to the orientation of the electronic components in which a specific subsequent process is performed. An example of a method and device for modifying the relative orientation of electronic components supplied in a matrix form is described in, among others, the international patent application WO 07011218 of the present applicant. The method and device described in this publication function adequately, although the flexibility in efficient regrouping of electronic components has limitations.

The object of the present invention is to provide a method and a device with greater flexibility than the prior art in respect of modifying the relative orientation of the matrix structure in which electronic components are supplied. It is also a particular object to enable more efficient regrouping of very small electronic components placed in a matrix structure.

The present invention provides for this purpose a method for spacing apart electronic components arranged in a matrix structure, comprising the processing steps of: A) picking up a part of a group of electronic components arranged in an initial matrix structure; and B) setting down the picked-up electronic components on a carrier, wherein the electronic components are set down in successive subgroups on the carrier in a modified matrix structure such that the number of rows of the modified matrix structure is smaller than the number of rows of the initial matrix structure of electronic components. A matrix structure of electronic components is formed here by rows and columns of electronic components, wherein the direction of the rows of the matrix structure substantially corresponds to a (primary) transport direction of the electronic components. The direction of the columns generally lies substantially perpendicularly of the direction of the rows of the matrix structure. The carrier is formed usually, though not necessarily, by a flat carrier, for instance a carrier in the form of one or more carrier plates optionally provided with individual product holders, a carrier with a plurality of parallel guide channels for electronic components, a conveyor belt or other type of carrier accessible from the top side. The advantage of applying this method is the increased flexibility in the processing of electronic components supplied in matrix format; not only can the pitch between the supplied components thus be modified, but also the number of rows in which the electronic components are supplied. Particularly in the case of smaller electronic components (envisage here for instance electronic components with an upper surface area of only several mm²) it may be desirable to reduce the number of rows of the matrix arrangement in which the electronic components are supplied, for instance shortly after separation of the electronic components, so as to thus make possible spacing apart of the rows of electronic components without this resulting in a very considerable increase in the width of the matrix arrangement of electronic components to be discharged.

It is desirable that the electronic components are engaged by a manipulator provided with engaging positions, the relative orientation of which corresponds to the orientation of the subgroups of electronic components to be engaged. Depending on the conditions, it is possible here to opt to use a more complex manipulator with which the relative orientation of the engaging positions of the manipulator changes between processing steps A) and B), or a structurally simple manipulator with which the relative orientation

of the engaging positions of the manipulator does not change between processing steps A) and B).

When the picked-up electronic components are set down with the manipulator during processing step B), they can be set down on the carrier simultaneously or they can be set down on the carrier in successive sub-steps. When setting-down takes place in sub-steps it is possible to influence the mutual spacing of the electronic components by displacing the carrier and the manipulator relative to each other between two successive set-down steps.

In situations where the electronic components must be rotated it is attractive to do this during at least one of the component transport operations. The manipulator can for instance be adapted for this purpose to rotate the electronic components engaged by the manipulator during a transfer operation.

The subgroups of electronic components can be engaged in a manner as desired by the manipulator. It is thus possible to engage the electronic components by means of underpressure or in a mechanical manner.

In yet another variant of the method according to the invention the electronic components are set down in successive subgroups on the carrier in a modified matrix structure such that the number of rows of the modified matrix structure is halved compared to the number of rows of the initial matrix structure of electronic components. It is then also further possible in this variant to engage every other individual component of the supplied group of electronic components in a first subgroup of electronic components and to set them down on the carrier in a modified matrix structure, and to then subsequently engage the remaining components of the supplied group of electronic components in a second subgroup and to place them on the carrier such that the electronic components of the second subgroup are then located between the electronic components of the first subgroup on the carrier. Odd and even processing of the electronic components can thus take place wherein two rows of electronic components are merged into each other. The number of rows of electronic components to be discharged will thus be halved compared to the number of supplied rows of electronic components.

The number of components transported during successive transfer operations can be the same, although the invention also provides the option that the number of electronic components engaged in a first transfer operation differs from the number of electronic components engaged during a subsequent transfer operation.

The present invention also provides a device for spacing apart electronic components arranged in a matrix structure, comprising: a supply for electronic components arranged in an initial matrix structure; a carrier on which picked-up electronic components are set down, at least one manipulator for picking up a subgroup of the electronic components supplied in the initial matrix structure, wherein the supply is adapted to carry X rows of electronic components and the carrier on which the electronic components are set down is adapted to carry Y rows of electronic components, with $X > Y$. The advantages can thus be realized as already described above with reference to the method according to the present invention. The supply will usually be adapted to carry/supply an even number of rows of electronic components, and this number can be halved during transfer to the discharge (i.e. $X = 2Y$).

Not only does the number of rows X on the supply of the electronic components differ from the number of rows Y on the discharge, the mutual spacing between the X rows on the supply can also differ from the mutual spacing between the Y rows on the discharge. It is thus possible for the mutual spacing between the X rows on the supply to be twice as large as the mutual spacing between the Y rows on the discharge. Using such a device a supplied matrix structure can be modified to a discharged matrix structure with half the number of rows which lie further apart than the rows were spaced apart initially.

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

- figure 1A is a perspective top view of a device according to the invention;
- figure 1B is a perspective bottom view of a manipulator as component of the device as shown in figure 1A;
- figure 1C is a perspective bottom view of an alternative embodiment variant of the manipulator as component of the device according to figure 1A;

figure 2 is a perspective view of an alternative embodiment variant of the device according to the invention;

figures 3A and 3B show two schematic top views of situations representing method steps according to the invention;

5 figure 4 is a schematic top view of four stages of yet another alternative embodiment variant of the method for transferring electronic components according to the present invention; and

figure 5 shows a view of a part of the compact arrangement as shown in figure 4A according to the first stage of the method, but now in more detail.

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Figure 1 shows a device 1 for spacing apart electronic components 2 supplied in a matrix structure. The feed of electronic components 2 consists here of a displaceable carrier plate 3 which is moved using a feed mechanism, not further shown here, into the illustrated position. The feed direction is indicated with arrow P_1 . Electronic
 15 components 2 are supplied (P_1) in a matrix structure consisting of eighteen rows ($X = 18$), the direction of which corresponds to feed direction P_1 .

The supplied electronic components 2 are engaged by a manipulator 4 which can for instance be provided for this purpose with openings 5 - not visible here but shown in
 20 figure 1B - to which underpressure can be applied. Openings 5 are also placed in a matrix configuration, although this is a configuration with nine rows 6. These rows 6 are set out such that the mutual spacing is twice as large as the mutual spacing between the rows in which electronic components 2 are supplied. Using the manipulator 4 one subgroup at a time of the supplied electronic components 2 can be engaged, i.e. every
 25 other row of the matrix configuration presented on the displaceable carrier plate 3. Following displacement of manipulator 4 the electronic components engaged by manipulator 4 are set down on a carrier platform 7 into which nine channels 8 are recessed for the purpose of receiving this many rows ($Y = 9$) of set-down electronic components 9. The direction of the rows of set-down electronic components 9 once
 30 again substantially corresponds to the feed direction P_1 . In order to transfer all electronic components 2 supplied with carrier plate 3 the manipulator 4 will have to have some freedom of movement in lateral direction P_2 (relative to feed direction P_1). During successive processing cycles the manipulator 4 can now alternately engage in two operations (i.e. in two subgroups) electronic components 2 supplied over the full

width of the matrix structure. A condition here however is that delivery capacity is always available on carrier platform 7 for the purpose of setting down a subgroup of electronic components 9. This can for instance be realized, after a subgroup of electronic components 9 has been set down on carrier platform 7, by advancing the set-
 5 down electronic components 9 or discharging them in other manner, or by having manipulator 4 perform a stroke length such that electronic components 9 can be set down in successive subgroups on carrier platform 7.

Alternatively, it is also possible to vary the configuration of the openings 10 arranged in
 10 manipulator 4. An example hereof is shown in figure 1C in which the suction openings are placed in eighteen rows 11 in a matrix configuration which, when compared to the matrix configuration of electronic components 2 supplied on the displaceable carrier plate 3, are only arranged alternately (in a chessboard/odd and even configuration). A subgroup of the supplied electronic components 2 can thus once again be engaged (in
 15 this case in the manner of chessboard squares of the same colour) from the matrix configuration presented on the displaceable carrier plate 3. Following displacement of manipulator 4, the electronic components thus engaged by manipulator 4 are set down in two steps in a position close to carrier platform 7. Nine rows of electronic components 9 set out with double spacing relative to each other are first displaced and,
 20 following displacement of manipulator 4 in lateral direction (P_2) for instance over a distance corresponding to the distance between two adjacent rows of electronic components 2, the components are then placed in accordance with the matrix configuration of supplied electronic components 2 on the displaceable carrier plate 3.

25 Figure 2 is a perspective view of an alternative device 15 for spacing apart electronic components 16 supplied in a matrix structure. Electronic components 16 are supplied here in nineteen rows by means of a conveyor belt 17. The supplied electronic components 16 are engaged by a manipulator 18 which is provided here with engaging elements 19 (which can for instance engage mechanically or on the basis of
 30 underpressure) which this time are not placed in a usual matrix configuration but in a configuration of rows wherein four different columns of the rows are engaged alternately each time. Engagement of the electronic components 16 is combined here with a punching plate 20 provided with punching openings 21. Engaging elements 19

are therefore also punching elements and the electronic components 16 supplied on the conveyor belt have therefore not yet been separated from each other.

After electronic components 16 have been released and engaged by engaging elements 5 19, they are laid alternately per nine or ten rows on a first part of a delivery table 22. This means that only some of the electronic components engaged by manipulator 18 are set down simultaneously. Nine rows of the first part of delivery table 22 are then emptied in that the electronic components 23 present thereon are advanced toward a connecting part 24 of the delivery table on which there is space for only nine rows. 10 Arranged for this purpose in the first part of delivery table 22 are nineteen tracks 26 and in the connecting part 24 of the delivery table nine tracks 25, wherein nine tracks 26 of the first part of delivery table 22 filled with electronic components 23 are aligned during the advancement with the nine tracks 25 of the connecting part 24 of the delivery table. Once nine tracks 26 of the first part of delivery table 22 have thus been emptied, the 15 first part of delivery table 22 can, in the case ten rows have been set down by manipulator 18, be displaced in a lateral direction through a distance corresponding to the pitch between two adjacent tracks 26 (see arrow P_3) such that only empty tracks 26 of the first part of delivery table 22 lie in line with the still filled engaging elements 19 of manipulator 18. The track 26 of the first part of delivery table 22 filled with 20 electronic components 23 is pushed aside as described. Once a first group of electronic components 23 has been set down by engaging elements 19, the still remaining electronic components engaged by manipulator 18 can then be transferred to the first part of delivery table 22. This process is repeated in similar manner until nine tracks 26 of the first part of delivery table 22 have been additionally filled with electronic 25 components 23. The filled tracks 26 of the first part of delivery table 22 are then moved back in lateral direction of movement (see arrow P_3) such that they lie in line with the nine tracks 25 of the connecting part 24 of the delivery table. The additionally filled nine tracks 26 of the first part of delivery table 22 are subsequently emptied and the first step of the cycle (as shown in figure 2) can once again commence. The first part of 30 delivery table 22 in this way functions as a buffer for electronic components 23 when the number of rows to be supplied does not correspond to the number of rows of electronic components 23 to be discharged because for instance the number of rows to be supplied as shown here is odd and has to be transferred in two process steps.

Figure 3A is a top view of a device 30 in which the supply of electronic components 31 has a configuration which closely resembles the previous supply configuration of figure 2 but, now having eighteen rows, differs from the configuration as shown in figure 2. A manipulator 32 engages a subgroup of the electronic components 31 as shown with
 5 eighteen rows (once again highly similar to the configuration as shown in figure 2). At variance with that illustrated above, manipulator segments 33, 34 are then displaced relative to each other as shown in figure 3B (see arrows P₄) such that only nine rows of electronic components 31 still remain. The electronic components engaged by manipulator 21 can then be set down in one operation on a discharge carrier 35.

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Figures 4A-4D show four configurations of electronic components, wherein the schematic representation in figure 4A shows the configuration 36 supplied in accordance with the manner in which the electronic components 41, 42 have been processed in one or more preceding production steps and in which they are presented.

15 This configuration 36 is also referred to as the “lead frame” configuration and is a very compact arrangement of the electronic components 41, 42. The electronic components 41 shown in dark colour form the rows 43 and the electronic components 42 shown in the lighter colour form the rows 44. Despite the colour differences in these figures, electronic components 41 and 42 can consist of identical electronic components, the
 20 colour difference being used solely for the purpose of elucidating this embodiment variant. The reason for supplying electronic components 41 and 42 in offset rows is for instance that it thus becomes possible to increase the density of electronic components 41 and 42 during preceding process steps. The compact arrangement of configuration 36 is shown in more detail in figure 5, which further elucidates why electronic components
 25 41, 42 of adjacent rows 43, 44 are offset relative to each other in each case.

Figure 4B shows a matrix configuration 40 in which columns of lead frame configurations 36 are alternately picked up and set down again such that spacing is created between the electronic components 41, 42 lying in the rows. The non-engaged
 30 columns can be engaged in a subsequent process run. Figure 4C shows the situation of a configuration 45 in which only the light-coloured electronic components 42 of configuration 40 (according to figure 4B) have been transferred in a second processing step in a manner such that the relative orientation of the light-coloured electronic components 42 is identical to the relative orientation of the light-coloured electronic

components 42 in configuration 40. Figure 4D then shows configuration 50 in which the dark-coloured electronic components 41 have now also been engaged and transferred such that they are placed between the light-coloured electronic components 42, whereby the number of rows of components has been halved compared to orientation 40. In other words, the dark-coloured electronic components 41 have been “merged” with the rows of light-coloured electronic components 42 such that the rows now consist of alternate light-coloured and dark-coloured electronic components 41, 42. In order to make this possible the distances between successive rows, and so between electronic components 41, 42, have increased in a first transfer step, thereby creating sufficient space to enable the merging.

Figure 5 shows a view of a part of the compact arrangement of electronic components 41, 42 as shown in figure 4A wherein the leads 51 (contact parts) of electronic components 41, 42 are mutually engaging, with the result that a highly compact configuration of electronic components 41, 42 is obtained.

Claims

1. Method for spacing apart electronic components arranged in a matrix structure, comprising the processing steps of:
 - 5 A) picking up a part of a group of electronic components arranged in an initial matrix structure; and
 - B) setting down the picked-up electronic components on a carrier,wherein the electronic components are set down in successive subgroups on the carrier in a modified matrix structure such that the number of rows of the modified matrix structure is smaller than the number of rows of the initial matrix structure of electronic components.
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2. Method as claimed in claim 1, **characterized in that** the electronic components are engaged by a manipulator provided with engaging positions, the relative orientation
15 of which corresponds to the orientation of the subgroups of electronic components to be engaged.
3. Method as claimed in claim 1 or 2, **characterized in that** the relative orientation of the engaging positions of the manipulator changes between processing steps A) and
20 B).
4. Method as claimed in claim 1 or 2, **characterized in that** the relative orientation of the engaging positions of the manipulator does not change between processing steps A) and B).
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5. Method as claimed in any of the foregoing claims, **characterized in that** all electronic components picked up by the manipulator are set down simultaneously on the carrier during processing step B).
- 30 6. Method as claimed in any of the claims 1-4, **characterized in that** the electronic components picked up by the manipulator are set down in successive sub-steps on the carrier during processing step B).

7. Method as claimed in claim 6, **characterized in that** between the successive sub-steps with which the electronic components are set down on the carrier the manipulator is displaced in a direction at an angle to the rows of the electronic components.
- 5 8. Method as claimed in any of the foregoing claims, **characterized in that** the electronic components are rotated during at least one of the processing steps.
9. Method as claimed in any of the foregoing claims, **characterized in that** the subgroups of electronic components are engaged by the manipulator by means of
10 underpressure.
10. Method as claimed in any of the foregoing claims, **characterized in that** the electronic components are set down in successive subgroups on the carrier in a modified matrix structure such that the number of rows of the modified matrix structure is halved
15 compared to the number of rows of the initial matrix structure of electronic components.
11. Method as claimed in claim 10, **characterized in that** every other electronic component in a first subgroup of a supplied group of electronic components is engaged and set down on the carrier in a modified matrix structure, and that the remaining
20 components of the supplied group of electronic components are subsequently engaged in a second subgroup and placed on the carrier such that the electronic components of the second subgroup are placed between the electronic components of the first subgroup on the carrier.
- 25 12. Device for spacing apart electronic components arranged in a matrix structure, comprising:
- a supply for electronic components arranged in an initial matrix structure;
- a carrier on which picked-up electronic components are set down,
- at least one manipulator for picking up a subgroup of the electronic components
30 supplied in the initial matrix structure,
wherein the supply is adapted to carry X rows of electronic components and the carrier on which the electronic components are set down is adapted to carry Y rows of electronic components, with $X > Y$.

13. Device as claimed in claim 12, **characterized in that** the supply is adapted to carry an even number of rows of electronic components.

14. Device as claimed in claim 12 or 13, **characterized in that** $X = 2Y$.

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15. Device as claimed in any of the claims 12-14, **characterized in that** the mutual spacing between the X rows of electronic components on the supply differs from the mutual spacing between the Y rows of electronic components on the discharge.

10 16. Device as claimed in claim 15, **characterized in that** the mutual spacing between the X rows of electronic components on the supply is twice as large as the mutual spacing between the Y rows of electronic components on the discharge.