

Description

Method for providing substrates with inserted components

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The invention relates to a method for providing substrates with inserted components according to the precharacterizing clause of patent claim 1 or 2.

10 When providing substrates with inserted components, in particular printed-circuit boards, the components are removed from feeding units with the aid of insertion heads and positioned by the insertion head into a predetermined position on the substrate. For a high
15 insertion rate (number of substrates provided with inserted components per unit of time), as many components per unit of time as possible are to be positioned in this way on the substrates.

20 WO 98/37744 discloses a device for producing electrical components which has in a central area two parallel, linear longitudinal guides situated closely next to each other, in which carts can be moved accordingly. These carts have in each case a cross bar for
25 respectively suspending an insertion head. This creates two separate processing areas, which can be operated independently of each other. As a result, a high insertion rate of the device is made possible.

30 For a still higher insertion rate, automatic insertion machines are combined in a line. In this case, the various insertion machines have different stores of component types, and can be specially designed for the respective component types. The automatic insertion
35 machines arranged in a line consequently form processing areas arranged in a line, a single processing area respectively comprising an insertion head and feeding units assigned to the insertion head being assigned to specific component types. All the

components to be inserted for a single substrate are then divided between the two processing areas, that is to say the feeding units are also divided between the individual processing areas.

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In order not to allow downtimes, such as the moving of the substrate into the processing area, to affect the insertion rate, two transporting devices are used. However, in the case of substrates with a small number
10 of components to be inserted (< around 100 components), it must be taken into account that the downtimes account for a very high proportion in percentage terms. For example, renewed measurement of the reference marks on the substrate is required after transport into the
15 next processing area. A further effect which leads to reductions in the rate when there are small numbers of components to be inserted is the quantization on the basis of the suction pipettes located on the head (for example 12 or 18). An only partly filled insertion
20 head must nevertheless complete almost the entire number of head cycles in the same way as a fully filled insertion head.

It is therefore the object of the invention to specify
25 a method for inserting components onto substrates which achieves a high insertion rate when there are few components to be inserted and a number of processing areas.

30 The object is achieved according to the invention by a method of the type stated at the beginning with the characterizing features of claim 1 or 2.

The method according to the invention has the effect
35 that, in the case of a number of components to be inserted which is less than or equal to the number of feeding units in the processing area, the complete substrate is already provided with inserted components

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on the first processing area. As a result, no unnecessary downtimes occur, such as a renewed measurement of markings of the substrate in the second processing area, or there are reduced

downtimes, for reasons such as the smaller number of insertion head cycles to be completed.

According to claim 2, it is additionally provided in
5 this case that, when there are few component types to
be inserted, it is additionally determined
theoretically on the basis of the assumed time behavior
of the insertion head whether a time saving is obtained
by insertion in one operating area and, only if there
10 is a time saving, is insertion also carried out in one
processing area. The time saving is generally obtained
in particular when there is a small number of
components to be inserted.

15 In the advantageous refinement of the method as claimed
in claim 3, it is ensured by the use of what is known
as dual transport, with two transporting devices
arranged essentially parallel, that, when there are
small numbers of components to be inserted, two
20 insertion lines operating essentially in isolation from
each other are used. Thus, in this case, a first
substrate is provided with inserted components in the
first processing area in such a way that no further
insertion of components is required in the second
25 processing area, whereas a second substrate is provided
with inserted components on the second transporting
device in the second processing area.

If the number of component types to be inserted is less
30 than the number of feeding units which can be arranged
on one side of a transporting device, it is
advantageous according to claim 4 to arrange all the
component types in the feeding units on the side of the
transporting devices which lies closer to the
35 transporting device on which the substrate to be
provided with inserted components is located.

If on both transporting devices there are substrates

with a small number of components to be inserted, it is advantageous, according to claim 5, that the component types to be kept in store for the two insertion processes are in each case arranged on the side of the
5 transporting

devices which lies closer to the transporting device on which the substrate respectively to be provided with inserted components is located.

- 5 The invention is explained in more detail on the basis of an exemplary embodiment in the figures of the drawing, in which:

10 figure 1 shows a schematic plan view of a line for the insertion of components, with two processing areas for when there is a large number of components to be inserted,

15 figure 2 shows a schematic plan view of a line of processing areas for when there is a small number of components to be inserted,

20 figure 3 shows a flow diagram of a first exemplary embodiment of the method according to the invention and

25 figure 4 shows a flow diagram of a second exemplary embodiment of the method according to the invention.

Represented in figure 1 is a schematic plan view of a line of processing areas 6, 11. In the first processing area 6, a first substrate 1 is provided with inserted components 2, which are made available in
30 feeding units 3. An insertion head 4 picks up the components 2 from the feeding units 3 by holding devices 5, for example suction pipettes, transports them by a movement essentially parallel to the surface of the substrate 1 into a predetermined position above
35 the substrate 1 and places them there onto the substrate 1. The insertion head 4 is in this case movable within the processing area 6. The first substrate 1 is moved by means of a first transporting

device 7 into the first processing area 6, provided with a first group 8 of inserted components and, after the component-insertion process, is transported into a second processing area 11. The two

processing areas 6, 11 are therefore arranged in a line. In the second processing area 11, the substrate 1 is analogously provided with a second group 9 of inserted components 2 from feeding units 3 with the aid of a second insertion head 10. Additionally represented in figure 1 is a second substrate 13, which moves on a second transporting device 12, likewise through the two processing areas 6, 11, and is provided with inserted components 2 in a first group 8 and a second group 9 in the respective processing areas 6, 11 with the aid of the first insertion head 4 and the second insertion head 10. To insert further components, further processing areas may be provided in the line. Components 2 of a specific component type, for example specific resistors, specific integrated circuits or other specific electronic components, are stored here in each feeding unit 3. The division of all the components to be inserted into two processing areas makes it disadvantageous, in particular when there are few components to be inserted, that in each processing area it is necessary for example for the position of the individual substrate 1 to be determined before the actual component-insertion process can begin. When there are few components 2 to be inserted, it is also frequently the case that the insertion head 4, which in this example has a total of 12 suction pipettes 5, often has to cover the distance from the feeding units 3 to the substrate 1 in a not completely filled state. However, this time from the feeding unit 3 to the substrate 1 decisively affects the level of the insertion rate, that is to say the number of components inserted per unit of time.

In figure 2 it is shown that, when there are few components to be inserted, all the components to be inserted, that is to say both the first group 8 and the second group 9, are inserted only in one of the two processing areas. Not shown, but possible, is the use

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of the respectively empty places on the transporting
devices 7, 12 in the respective

processing areas as buffers for further substrates, to keep changing times as small as possible.

As schematically represented in figure 3 on the basis
5 of the flow diagram, in a first exemplary embodiment it is determined before the component-insertion process whether the total number of component types to be inserted onto a substrate is greater than the number of feeding units in a processing area. Only if this
10 number is greater is the component insertion divided between two processing areas, otherwise the component insertion of all the components to be inserted takes place in one processing area.

15 A further exemplary embodiment is represented in figure 4 in the form of a further flow diagram. In this case, it must be taken into account that the time advantage from inserting components in only one processing area is particularly great whenever the number of components
20 to be inserted is small, since in this case the downtimes are reduced particularly effectively. Before the component insertion, it is therefore determined as part of what is known as setup optimization, taking into account the theoretical moving times of the
25 insertion head, whether or not a time saving is achieved when there are few component types by dividing the components to be inserted between two processing areas. Dependent on this result, the component insertion then takes place in one or two processing
30 areas.

If a first transporting device 7 and a second transporting device 12 are used, the two transporting devices and the two processing areas 6, 11 are
35 essentially isolated by this method. Therefore, the method advantageously allows both substrates with a high number of components to be inserted, which are then divided between a number of processing areas, and

substrates with a low number of components to be inserted, in which case the component insertion takes place only in one processing area, to be produced in one component-insertion line with a high insertion rate.

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A further increase in the insertion rate can be achieved if the number of component types 2 to be inserted onto the substrate 1, 13 is less than or equal to the number of feeding units 3 arranged in a group 14, 15 on one side of the transporting device 7, 12. If all the component types 2 to be inserted are then set up in feeding units 3 in a first group 14 directly next to the first transporting device 7, the insertion head moves only the short distance between the feeding unit 3 and the substrate 1. In a corresponding way, in the case of the second substrate 13 in the second processing area 11, the component insertion can take place by feeding units 3 exclusively using the components to be inserted of the second group 15.



Patent claims

1. A method for providing substrates (1, 13) with
inserted components (2) at at least two processing
5 areas (6, 11) which are arranged successively in a
line, are connected by at least one transporting
device (7, 12) for the substrates (1, 13) and have
in each case at least one insertion head (4, 10)
and in each case a number of feeding units (3),
10 each feeding unit (3) keeping a store of a number
of components (2) of one component type,
characterized in that the number of different
component types to be inserted onto a substrate (1,
13) is compared with the number of feeding units
15 (3), in that, if there is a smaller or equal number
of component types to be inserted, the substrate
(1, 13) is provided completely with inserted
components in one processing area (6, 11) and in
that, if there is a greater number of component
20 types to be inserted, the substrate (1, 13) is
provided with inserted components at the at least
two successive processing areas (6, 11).
2. A method for providing substrates (1, 13) with
25 inserted components (2) at at least two processing
areas (6, 11) which are arranged successively in a
line, are connected by at least one transporting
device (7, 12) for the substrates (1, 13) and have
in each case at least one insertion head (4, 10)
30 and in each case a number of feeding units (3),
each feeding unit (3) keeping a store of a number
of components (2) of one component type,
characterized in that the number of different
component types to be inserted onto a substrate (1,
35 13) is compared with the number of feeding units
(3), in that, if there is a smaller or equal number
of component types to be inserted, the theoretical
time difference between the execution of a complete

component-insertion process in one of the
processing areas (6, 11) and the execution of a
component-insertion process





at the at least two processing areas (6, 11) is determined with the aid of a theoretical time behavior of the insertion head, in that, in the case of a positive time difference, the substrate (1, 13) is provided completely with inserted components in one processing area (6, 11) and, in the case of a negative time difference, said substrate is provided with inserted components at the at least two processing areas (6, 11) and in that, if there is a greater number of component types to be inserted, the substrate (1, 13) is provided with inserted components at the at least two successive processing areas (6, 11).

3. The method for providing substrates (1, 13) with inserted components (2) as claimed in either of claims 1 and 2, characterized in that a first part of the substrates (for example 1) is transported on a first transporting device (7) through the line of the processing areas (6, 11) and a second part of the substrates (for example 13) is transported on a second transporting device (12), arranged essentially parallel to the first, through the line of the processing areas (6, 11) and, in the case of the smaller or equal number of component types to be inserted, the first part of the substrates (for example 1) is provided completely with inserted components in the first processing area (6) and the second part of the substrates (for example 13) is provided completely with inserted components in the second processing area (6).

4. The method for providing substrates (1, 13) with inserted components (2) as claimed in claim 3, characterized in that a first group (14) of feeding units (3) is arranged in the processing areas (6, 11) on one of the two sides of the two transporting devices (7, 12) and the remainder of the feeding

units (14) are arranged in a second group (15) of feeding units (3) on the opposite side of the transporting devices (7, 12),



in that the number of component types which are to be inserted onto one of the substrates (for example 1) located on the first transporting device (7) is compared with the respective number of feeding units (3) present in the first group (14), in that, if there is a smaller or equal number of component types, the first group (14) comprising the feeding units (3) with the component types to be inserted is combined and arranged on the side closer to the first transporting device (7).

5. The method for providing substrates (1, 13) with inserted components (2) as claimed in claim 4, characterized in that the number of component types which are to be inserted onto one of the substrates (for example 13) located on the second transporting device (12) is compared with the respective number of feeding units (3) present in the second group (15), in that, if there is a smaller or equal number of component types, the second group (15) comprising the feeding units (3) with the component types to be inserted is combined and arranged on the side closer to the second transporting device (12).

