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Description



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Method and device for processing substrates

- 5 The invention relates to a method and a device for processing substrates, in particular for populating the substrates with electrical components.

10 In the automatic population of substrates (for example printed circuit boards or ceramic substrates) with SMD components (SMD=Surface Mounted Device), the individual components are removed from a magazine or a feed device by means of a pick-and-place head and then positioned in a predefined position on the substrate. In this case
15 the substrates are taken from a magazine and transported to a processing position in a first automatic processing machine. In this first automatic processing machine, for example stickers are applied at those points on the substrate at which components are
20 to be placed in a second automatic processing machine. The substrates are transported to this second automatic processing machine by a transport device.

In order to place components in position accurately,
25 the knowledge of the position of the substrate is necessary. For this purpose, position markings (for example crosses) are applied to the substrate, are picked up by a camera in the automatic processing machine and evaluated in terms of their position
30 relative to the automatic processing machine in an image evaluation unit connected downstream of the camera.

On one substrate, a number of circuits may be provided
35 which, in turn, each have circuit markings which are surveyed in order, for example, to reduce the influence of distortions in the substrate on the accuracy of

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population. In addition, unserviceable circuits are marked by functional markings, known as ink dots. As a result, the camera with the downstream image

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evaluation unit detects the faulty circuit, and it is not populated with components.

If, then, complex circuits are populated with many
5 different types of components, then a number of
processing stations are arranged in a line, as is
disclosed for example by US 5,692,292, between which
stations the substrates are transported. In each
processing station, the position markings, the circuit
10 markings and the functional markings are surveyed and
evaluated, which requires a correspondingly high
expenditure of time.

Methods and devices for detecting the markings are
15 disclosed for example by WO 97/38567 or DE 41 36 543.
The use of such devices in processing lines is not
described.

Moreover, in automatic pick-and-place robots from FUJI
20 Machine, it is known to transport the substrates on
workpiece carriers, which are provided with accurate
fixing means. As a result, surveying in the subsequent
pick-and-place robots is dispensed with, but a large
number of expensive workpiece carriers has to be kept
25 ready.

DE 42 33 438 discloses a device having a transport
system between individual processing stations for
workpieces on workpiece carriers, in which, in order to
30 check individual mounting steps, image processing
stations are provided, which can be linked with further
processing stations via a computer that controls the
processing stations. In this case, the image processing
stations have different tasks, depending on their
35 position in the transport system. For example,
provision is firstly made to check the workpieces
located in the workpiece carriers for correct position

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and for completeness, with the aid of the image processing stations, and to output a signal if an error is detected. The error can then be rectified. Direct further processing

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of the workpieces cannot be gathered. Secondly, provision is made for the individual mounting steps to be checked by further image processing stations after the respective mounting. Here, too, a signal is output
5 in the event of an error. The results of the checks are transmitted to the further processing stations via a PC. In this case, there is no disclosure as to the manner in which the following processing stations use these results. There is no description of whether the
10 processing is interrupted in the event of an error or what other measures are taken. At these points in the process sequence, no determination of the position of the workpieces is carried out either, so that the position is defined solely via the position of the
15 workpiece carriers. Such a known device is therefore unsuitable for processing substrates without workpiece carriers and, in addition, pure error detection is not sufficient to permit subsequent further processing.

20 It is an object of the invention to specify a method and a device for processing substrates in which, with little device outlay, the expenditure on time for surveying the geometric data about the substrate and used for processing is minimized.

25

According to the invention, the object is achieved by a method having the features of claim 1 and a device having the features of claim 5.

30 According to claim 1, provision is made for the geometric data about the substrate to be surveyed only in the first of a series of automatic processing machines, and for the geometric data to be transmitted to the further automatic processing machines. As a
35 result, only the position co-ordinates of the substrate have to be surveyed in each automatic processing machine, which approximates the expenditure on time for

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surveying to the expenditure on time when using
workpiece carriers, so that workpiece carriers can be
dispensed with.

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In an advantageous way, the geometric data are determined, according to claim 2, by means of optical surveying of markings applied to the substrate, which leads to an adequately accurate determination of the
5 position.

According to claim 3, the position co-ordinates are likewise simply and sufficiently accurately [lacuna] optical surveying of markings applied to the substrate.
10

In a preferred embodiment according to claim 4, the geometric data are also transmitted to further automatic processing machines through which the substrate passes, which leads to a further reduced
15 expenditure on time.

The device according to the invention has, according to claim 5, a bus system for transferring the measured data between the control devices of the automatic
20 processing machines and, in order to determine the position co-ordinates and the geometric data, uses the same measuring station.

The invention will be explained in more detail using an
25 exemplary embodiment and in accordance with the figures of the drawing, in which:

Figure 1 shows a substrate with schematically indicated markings and

Figure 2 shows two automatic processing machines and
30 substrates schematically in plane view.

In Figure 1, a substrate 1, for example a printed circuit board or a ceramic substrate, is applied with two crosses applied in opposite corners as position
35 markings 2. On the substrate 1 there are four circuits 3, which in turn have crosses as circuit markings 4. One circuit additionally has a functional marking 5,

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known as an ink dot, which has been applied in order to document that this circuit is faulty and should not be populated.

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Illustrated schematically in figure 2 are a first automatic processing machine 6 and a second automatic processing machine 8, which are connected by a transport mechanism 7. The substrate, after being
5 processed in the first automatic processing machine 6, is transported into the second automatic processing machine 8 by this transport mechanism 7, for example a belt system. In the automatic processing machines 6, 8, the substrate 1 is fixed, at least temporarily, in
10 order to carry out the processing. The two automatic processing machines can be constructed, for example, as a sticking station and a pick-and-place robot or else as two pick-and-place robots, each of which has a specific supply of component types. Further processing
15 stations can also follow in analogous form.

By means of a measuring station 9, for example a camera with a downstream image evaluation unit, the markings 2, 4, 5 are surveyed in the first automatic processing
20 machine, and the associated position co-ordinates and geometric data about the circuit markings 4 and the functional markings 5 are stored in the first control device 12, which is associated with the first automatic processing machine 6. The measuring station 9 is fixed
25 to a pick-and-place head 10, which can be moved over the substrate in x-y direction via a portal system 11. The position co-ordinates and the geometric data are taken into account in the first automatic processing machine 6 during the subsequent processing of the
30 substrate 1.

The substrate 1 is then transported into the second automatic processing machine 8 by the transport mechanism 7 and is likewise fixed there, at least
35 temporarily, for the processing. In order to determine a relative position between the substrate 1 and the second automatic processing machine 8 which is

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different from the relative position between the
substrate 1 and the first automatic processing machine
6, the position co-ordinates are determined, with the
aid of the measuring station 9 of the second automatic
5 processing machine 8, using the position markings 2.
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geometric data about the circuit markings 4 and the functional markings 5 are transmitted from the first control device 12 to the second control device 14, which is associated with the second automatic processing machine 8. In this case, the transmission can take place directly from the first 12 to the second control device 14, or else via an interposed central unit (not illustrated). As a result, these geometric data do not need to be determined at all in the second automatic processing machine 8, which therefore leads to a lower expenditure on time and therefore to a higher processing speed.

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Patent Claims

1. A method for processing substrates (1) in at least two automatic processing machines (6, 8), in particular
5 for populating the substrates (1) with electric components, in which, in the first automatic processing machine (6)

- the substrate (1) is fixed, at least temporarily,
- position co-ordinates of the substrate (1) in the
10 first automatic processing machine (6), and additional geometric data about the substrate (1), are determined,

- the substrate (1) is processed, taking into account the position co-ordinates and the
15 geometric data,

the substrate (1) is transported to the second automatic processing machine (8) and is fixed there, at least temporarily,

the geometric data are transmitted to the second
20 automatic processing machine (8),

the position co-ordinates of the substrate (1) are determined in the second automatic processing machine (8) and

the substrate (1) is processed, taking into account the
25 position co-ordinates in the second automatic processing machine (8) and the transmitted geometric data.

2. The method for processing substrates (1) as
30 claimed in claim 1, characterized in that the geometric data are determined by means of optical surveying of markings (4, 5) applied to the substrate (1).

3. The method for processing substrates (1) as
35 claimed in either of claims 1 and 2, characterized in that the position co-ordinates are determined by means of optical surveying of position markings (2) applied to the substrate (1).

4. The method for processing substrates (1) as claimed in one of claims 1, 2 or 3, characterized in that when the substrate (1) is processed in more than two automatic processing machines, the geometric data are also transferred to the further automatic processing machines.

5. A device for processing substrates (1) having at least two automatic processing machines (6, 8),
having a transport device (7) for substrates (1) between the automatic processing machines (6, 8),
having a measuring station (9) in the first of the two automatic processing machines (6, 8) for determining measured data from markings (2, 4, 5) on the substrates (1) and for determining position co-ordinates of the substrate (1) in the first of the two automatic processing machines (6, 8),
having a control device (12, 14) in each case for controlling the respective automatic processing machines (6, 8) and for storing the measured data, characterized by
a bus system (13) between the control devices (12, 14) of the automatic processing machines (6, 8), for transferring the measured data about the markings.