

Description

Method for operating a pick-and-place machine, pick-and-place machine, exchangeable component for a pick-and-place machine and system comprising a pick-and-place machine and an exchangeable component

The invention relates to a method for operating a pick-and-place machine, a pick-and-place machine, an exchangeable component for a pick-and-place machine and also a system comprising a pick-and-place machine and an exchangeable component of the pick-and-place machine.

15 In pick-and-place machines, components are removed from feeding units by means of a pick-and-place head and are placed in predetermined positions onto substrates. In order that the components are placed onto the substrate in the correct position, the position of the components on the pick-and-place head is determined with the aid of sensors. Then, in dependence on the determined position of the components, a control device of the pick-and-place machine controls the pick-and-place head parallel to the plane of the substrate in such a way that the placement takes place in the correct position. For the greatest possible flexibility in the picking and placing of different components onto the widest variety of substrates, some of the components of a pick-and-place machine are of an exchangeable design. There are for example pick-and-place heads which can receive a plurality of components, and then deposit the received components one after the other onto the predetermined positions on the substrate, without in the meantime first having to travel back to the feeding units. This results in a high placement rate, i.e. the highest possible number of picked-and-placed components per unit of time. In addition, pick-and-place heads which receive only one component, but deposit it onto the substrate with high accuracy are known.

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Furthermore, pick-and-place heads of different sizes are provided for components of different sizes, so that different pick-and-place heads are used, according to the picking-and-placing process.

Depending on the type of components to be picked and placed, different feeding units are also used, and, for example, different sensors are used for the positional detection of the substrates.

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After an exchange of the components, the different positional assignment of the components and the pick-and-place machine in relation to one another is no longer ensured. Therefore, after mounting exchangeable components, the pick-and-place machine is re-calibrated. Known for this purpose, for example from US 5 537 204, is a method in which a glass substrate with markings is used instead of the substrate which is to have components placed on it, and glass slides are positioned on the glass substrate instead of the components. The position of the glass substrates on the glass substrate is subsequently measured optically. The measured deviations of the positions of the glass substrates in comparison with the desired positions are then entered into the control device of the pick-and-place machine, in order that the control device takes these deviations into account in the subsequent picking-and-placing process. However, such a calibration is very time-consuming; it takes about 1 to 2 hours.

It is the object of the invention to specify a method for operating a pick-and-place machine, a pick-and-place machine, an exchangeable component for a pick-and-place machine and a system comprising a pick-and-place machine and an exchangeable component of the pick-and-place machine, which make it easier for the exchangeable components to be exchanged more quickly and easily.

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The object is achieved according to the invention by a method with the features of claim 1, by a pick-and-place machine with the features of claim 8, by an

exchangeable component for a pick-and-place machine with the features of claim 9 and by a system comprising a pick-and-place machine and an exchangeable component of the pick-and-place machine according to claim 14.

In this arrangement, a memory device in the exchangeable component and a control device, reading out the memory device, of the pick-and-place machine are provided. Stored in the memory device of the exchangeable component are characteristic data of the exchangeable component, which are read out by the control device after the mounting of this component. The data read out are then used by the control device in the subsequent picking-and-placing process.

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In an advantageous way, according to claim 2, the geometrical data of the exchangeable component are measured before it is mounted and are stored as characteristic data. Measuring the component before it is mounted dispenses with the laborious calibration process after mounting. This is because, by having knowledge of the geometrical data in consideration of a fixed reference point, the control device is already given all the data of significance for the subsequent position correction of the components on the pick-and-place head.

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For subsequent tracing ("retraceability"), it is provided according to claim 3 in an advantageous way that different exchangeable components are assigned different identification codes and these are stored as characteristic data and read out by the control device. As a result, if there are a series of placement errors on substrates, possibly a defective pick-and-place head or some other exchangeable component which is no longer functioning properly can be detected.

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In a preferred refinement of the method according to claim 4, it is provided that the individual components are combined to form what are known as component classes, the complete functional scope of which in a function list together with the activations belonging to the respective individual functions have already

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been stored in the control device of the pick-and-place machine.

If there is then stored in an exchangeable component, in the associated memory device, which functions of this function list this exchangeable component has, the control device of the pick-and-place machine knows
5 after the reading out operation how this exchangeable component is to be activated without having to perform laborious modifications in the control software.

The data exchange can in this case take place either
10 over electrical lines according to claim 5 or wirelessly according to claim 6. The wireless data exchange has the advantage that no complex additional electrical plug-in connections are required.

15 In the preferred refinement according to claim 7, for pick-and-place heads with a plurality of suction pipettes, the throw, that is the difference between the positions of the suction pipettes in the retracted state and in the extended state, can be calculated.

20 In the preferred refinement of the exchangeable component according to claim 10, the memory device is designed as a contactlessly writable and readable memory ("transponder, TAG"), which does not require an
25 energy supply of its own. Such memory devices can be integrated without any problem into every exchangeable component.

The exchangeable component may in this case be designed
30 either as a pick-and-place head according to claim 11, as a feeding unit according to claim 12 or as a sensor according to claim 13. Depending on the type of component, different data are in this case of course stored in the respectively assigned memory device, in
35 order that the control device of the pick-and-place machine can read out the data relevant for it in each case.

The invention is explained in more detail on the basis of exemplary embodiments in the figures of the drawing, in which:

figure 1 shows a schematic side view of a pick-and-place machine,

figure 2 shows a schematic plan view of a pick-and-place machine,

5 figure 3 shows a schematic side view of a measuring process on a pick-and-place head outside the pick-and-place machine and

figure 4 shows a structogram for the method according to the invention.

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In figure 1, a schematic side view of a pick-and-place machine 7 is represented and in figure 2 a corresponding schematic plan view is represented. In the pick-and-place machine 7, components 2 are picked
15 and placed onto substrates 1, in that the components 2 supplied in feeding units 3 are received by suction pipettes 4 as holding devices of a pick-and-place head 5 and are subsequently mounted onto the substrate 1 in the predetermined position. The pick-and-place head 5
20 is in this case movable substantially parallel to the surface of the substrate 1. Serving for this purpose is a first rail 11, on which a first carriage 12 is movably fastened. Fastened on this first carriage 12, substantially perpendicular to the first rail 11, is a
25 second rail 13, on which a second carriage 14 moves. This second carriage 14 is connected to the pick-and-place head 5. A control device 6 moves the first carriage 12 up to the second carriage 14 in such a way that the pick-and-place head 5 is moved to the feeding
30 units 3 and, after receiving a component 2, is moved substantially parallel to the surface of the substrate 2. Provided in the pick-and-place head 5 is a component camera 21, which records a picture of the component 2 hanging from the suction pipette 4 and
35 transmits it to the control device 6. In the control device 6, the picture is evaluated and, in dependence on the evaluated picture, the pick-and-place head 5 is activated in such a way that the component 2 is placed

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onto the substrate 1 in the correct position. A transporting device 10 serves for transporting the substrates 1 into the pick-and-place machine 7 up to the placement position and out of the pick-and-place machine 7 again. Additionally arranged on the pick-and-place head 5 is a substrate camera 17, with which

the position of the substrates 1 is determined. The position of the substrate 1 is also included in the calculation for the correct positioning of the components 2.

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The pick-and-place head 5 has a memory device 15, which is read out by the control device 6 wirelessly or in a wire-bound manner. The memory device 15 may in this case be integrated into the pick-and-place head 5, for example designed in the form of a contactlessly readable and writable memory (transponder, TAG) or else as a separate memory medium (floppy disk), on which the data of a certain pick-and-place head 5 are stored and which is read out by a floppy disk drive of the control device 6.

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The feeding units 3 also have such a memory device 16, and similarly the substrate camera 17 has a memory device 18. The memory devices 15, 16, 18 in this case respectively contain characteristic data of the pick-and-place head 5, of the feeding unit 3 and of the substrate camera 17, respectively, so that these data are available to the control device 6 after an exchange of these exchangeable components. The control device 6 then uses these data for picking and placing components 2 on the substrates 1.

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The determination of the data which are stored in the memory device 15 is represented by way of example in figure 3 using the example of the pick-and-place head 5. Represented here in this example is a turret head, as it is known, with a total of eight suction pipettes 4, which are formed along the circumference of the pick-and-place head 5. After final assembly, the pick-and-place head 5 is put onto a test bench. After that, a first suction pipette 4 is moved onto the test bench over a stationary camera 22 and measured there in the extended state (corresponds to the position of the

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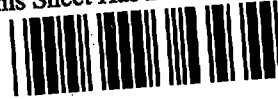
suction pipette during picking-and-placing). Then,
this first suction pipette 4 is moved on in the cycle
to the component camera 21 of the pick-and-place head 5
and measured there in the retracted state (corresponds
5 to the position of the suction pipette during
transporting and during the optical

measurement of the components during the picking-and-placing process). This generally produces a difference (known as the throw) between the stationary camera 22 and the component camera 21 (center offset), which is evaluated in a verifying device 20. This procedure is repeated for all the seven other suction pipettes 4, and the offset with respect to the first suction pipette is determined in the verifying device 20 and subsequently stored in the memory device 15. Each time the pick-and-place head 5 is mounted in the pick-and-place machine 7, only the offset of the first suction pipette 4 has to be determined by conventional means. This offset is either known, since the pick-and-place head 5 itself is connected to the pick-and-place machine 7 via a highly accurate mechanical interface, the reference point of which is known to the pick-and-place machine 7. Or the offset of this first suction pipette 4 is determined in the pick-and-place machine 7 after mounting by means of fixed sensors (for example by placing a glass block on a glass substrate). The data of all the other suction pipettes are transferred from the memory device 15 to the control device 6 and processed there. The pick-and-place machine 7 can then itself calculate the offset of the other seven suction pipettes, on the basis of the first suction pipette 4. Instead of the first suction pipette 4, other fixed reference points, the position of which in the pick-and-place machine 7 is known or can easily be measured, can also be chosen. Before the mounting of the exchangeable components 3, 5, 17, the geometrical data are then determined with respect to this fixed reference point and stored in the memory device 15, 16, 18.

In figure 4, the method sequence is represented once again on the basis of a structogram. In this case, firstly characteristic data of the exchangeable component 3, 5, 17 are determined. These may be, for

example, geometrical data of the components 3, 5, 17, but also identification data or a functional scope assigned to this component. These data are then stored in a memory device 15, 16, 18, which is assigned to the
5 exchangeable component 3, 5, 17.

Once the component 3, 5, 17 has been mounted, the content of the memory device 15, 16, 18 of the component 3, 5, 17 is read out by the control device 6 of the pick-and-place machine 7. The control device 6
5 then uses these characteristic data for the picking-and-placing process of the pick-and-place machine 7.



Patent claims

1. A method for operating a pick-and-place machine (7)
with a control device (6), which controls the
picking and placing of components (2) onto
substrates (1), in which method
- characteristic data of an exchangeable component
(3, 5, 17) of the pick-and-place machine (7) are
determined before it is mounted in the pick-and-
place machine (7) and are stored in a memory
device (15, 16, 18) assigned to the exchangeable
component (3, 5, 17),
- after the exchangeable component (3, 5, 17) has
been mounted in the pick-and-place machine (7),
at least some of the characteristic data are
transferred from the memory device (15, 16, 18)
into a control device (6) of the pick-and-place
machine (7),
- the characteristic data are taken into account by
the control device (6) during the operation of
the pick-and-place machine (7).
2. The method for operating a pick-and-place machine
(7) as claimed in claim 1, characterized in that
geometrical data of the exchangeable component (3,
5, 17) are measured before it is mounted and are
stored as characteristic data.
3. The method for operating a pick-and-place machine
(7) as claimed in one of claims 1 or 2,
characterized in that different exchangeable
components (3, 5, 17) are assigned different
identification codes and in that the identification
codes assigned to the respective exchangeable
component (3, 5, 17) are stored as characteristic
data.
4. The method for operating a pick-and-place machine

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(7) as claimed in one of claims 1, 2 or 3,



characterized in that component classes of exchangeable components (3, 5, 17) which perform similar functions are formed, in that the functions of all the exchangeable components (3, 5, 17) of at least one of the component classes are compiled in a function list, in that the function list is stored, together with the activation to be carried out for the individual functions, in the control device (6) of the pick-and-place machine (7), in that the exchangeable component (3, 5, 17) is assigned the functions characteristic of this component, which this component (3, 5, 17) can perform, in that the characteristic functions are stored as characteristic data in the memory device (15, 16, 18).

5. The method for operating a pick-and-place machine (7) as claimed in one of claims 1 to 4, characterized in that the data exchange between the memory device (15, 16, 18) of the exchangeable component (3, 5, 17) and the control device (6) of the pick-and-place machine (7) takes place over electrical lines.
6. The method for operating a pick-and-place machine (7) as claimed in one of claims 1 to 4, characterized in that the data exchange between the memory device (15, 16, 18) of the exchangeable component (3, 5, 17) and the control device (6) of the pick-and-place machine (7) takes place wirelessly.
7. The method for operating a pick-and-place machine (7) as claimed in claim 2, characterized in that, in the case of a pick-and-place head (5) with a multiplicity of holding devices (4) as an exchangeable component, before it is mounted



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the position of a first holding device (4) is recorded by a stationary camera (22) in a position which corresponds to the position during placement on the substrate (1), in that the position of the first holding device (4) is recorded, in a component camera (21) assigned to the pick-and-place head (5), in a second position, which corresponds to the position of the holding device (4) during transporting and during the optical measuring of the components (2), in that the two recorded positions are compared in a measuring device (20) downstream of the two cameras (21, 22) and this comparison is used to determine an offset, which is stored in the memory device (15), in that the positions of the other holding devices (4) are similarly recorded by the stationary camera (22) and the component camera (21), compared in the measuring device (20) and the predetermined offsets are stored in the memory device (15), in that, in addition, the relative offset of the other holding devices (4) in relation to the first holding device (4) is determined in the measuring device (20) and stored in the memory device (15), in that, after the pick-and-place head (5) has been mounted, the relative position of the first holding device (4) with respect to the pick-and-place machine (7) is determined and the relative offsets of the other holding devices (4) are transferred from the memory device (15) to the control device (6).

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8. A pick-and-place machine (7) with a control device (6) for operating the pick-and-place machine and with a pick-and-place head (5) for receiving components (2) and subsequently depositing the components (2) on a substrate (1), characterized in that the control device (6) has a reading-out device, with which characteristic data of an exchangeable component (3, 5, 17) of the pick-and-

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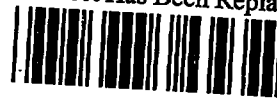
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place machine (7) can be read out from a



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memory device (15, 16, 18) assigned to the exchangeable component (3, 15, 17), and in that the control device (6) is designed in such a way that it stores the read-out characteristic data and uses them for the picking-and-placing process.

9. An exchangeable component (3, 5, 17) for a pick-and-place machine (7) with an assigned memory device (15, 16, 18) for characteristic data of the exchangeable component (3, 5, 17).
10. The exchangeable component (3, 5, 17) for a pick-and-place machine (7) as claimed in claim 9, characterized in that the memory device (15, 16, 18) is designed as a contactlessly writable and readable memory (transponder, TAG), which is connected directly to the exchangeable component (3, 5, 17).
11. The exchangeable component (3, 5, 17) for a pick-and-place machine (7) as claimed in one of claims 9 or 10, characterized in that the exchangeable component is designed as a pick-and-place head (5).
12. The exchangeable component (3, 5, 17) for a pick-and-place machine (7) as claimed in one of claims 9 or 10, characterized in that the exchangeable component is designed as a feeding unit (3).
13. The exchangeable component (3, 5, 17) for a pick-and-place machine (7) as claimed in one of claims 9 or 10, characterized in that the exchangeable component is designed as a sensor (17).

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14. A system comprising a pick-and-place machine (7) and an exchangeable component (3, 5, 17) of the pick-and-place machine (7), in which system

5 - the pick-and-place machine (7) has a control device (6),

- the exchangeable component (3, 5, 17) is assigned a memory device (15, 16, 18) for characteristic data of the component (15, 16, 18) and

10 - the control device (6) is designed in such a way that it reads out the characteristic data from the memory device (15, 16, 18) and uses these data for the picking-and-placing process.



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