

Description

Apparatus and method for detecting the position of components and/or for checking the position of connections of components and component-mounting head having an apparatus for detecting the position of components and/or for checking the position of connections of components

10 The invention relates to an apparatus for detecting the position of components and/or for checking the position of connections of components in accordance with the preamble of patent claim 1.

 When components are being mounted automatically on printed circuit boards, the components are removed from feed devices by means of a component-mounting head and are placed at the position assigned to the respective component on the printed circuit board. To ensure that the relative position of the component in relation to the printed circuit board is maintained exactly, the components are illuminated in a position detecting apparatus and an image of the current position of the component on the component-mounting head is recorded by means of a camera and compared with a predetermined position in an image evaluation unit connected downstream of the camera. The component-mounting head subsequently transports the component to the predetermined position on the printed circuit board, taking account of the current position. For mounting components without housings, whose connections are distributed areally over the entire surface of the component (flip-chip mounting), position detection is carried out using the connection positions.

 EP 0 243 680 discloses an apparatus for transmitted-light illumination which, for identifying the position of conductor tracks or alignment structures on printed circuit boards, comprises means

for simultaneously exposing the surface of the printed circuit board to perpendicularly incident beams and obliquely incident beams on all sides. The terms perpendicularly and, subsequently, horizontally

should be understood with reference to the component surface, which, for its part, is essentially perpendicular to the optical axis of the imaging. Principally the connections in the case of flip-chip
5 mounting are only poorly illuminated and cannot be unambiguously identified in the image evaluation unit.

DE 44 26 968 A1 discloses an optical waveguide which can be used for laterally illuminating an object. The optical waveguide has walls at which the light
10 reflected from the side areas of the object is deflected toward an optical inspection system. As a result, the side areas and the top side of the object to be observed can be optically inspected. However, reflective surface structures can be identified only
15 with very great difficulty by virtue of the laterally incident light. Moreover, a separate optical waveguide can be integrated in a component-mounting process only with very great difficulty.

EP 0 725 560 discloses an apparatus for
20 detecting the position of of components in the course of component-mounting in which light sources for perpendicularly incident light and obliquely incident light on all sides are provided, as is a camera with an image evaluation unit connected downstream. A third
25 light source for light which is incident horizontally on the side areas of the component is additionally provided. This third light source serves as a transmitted-light illumination source for a further light sensor. This design is complicated and requires
30 separate evaluations of the camera and the light sensor.

The object of the invention, therefore, is to specify an apparatus for detecting the position and/or for checking the position of the connections of
35 components which illuminates both laterally protruding structures and surface structures of components and their connections so well that the position of the

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connections of the components on a component-mounting head is identified by a camera with an image evaluation unit connected downstream.

According to the invention the object is achieved by means of an illumination device of the type mentioned in the introduction having the characterizing features of patent claim 1 and also by means of a method having
5 the features of claim 14.

In this case, provision is made both of first means for illuminating the component with light which is incident perpendicularly from above, and of second means for illuminating the component with light which
10 is obliquely incident on all sides, and also of third means for illuminating the side areas of the component with horizontally incident light, which are constructed as reflected-light sources and fully illuminate the image field of a camera. This enables both reflective
15 surface structures and laterally protruding connections to be illuminated.

In a preferred configuration according to patent claim 2, the perpendicularly incident light is generated by light sources which couple their light
20 through a partially transmissive mirror into the beam path of the illumination device. Reflection at the partially transmissive mirror results in the components being imaged onto a camera.

According to patent claim 4, the second means
25 for illuminating the component with obliquely incident light on all sides comprise a mirror arrangement. Compared with a configuration with optical lens systems, said mirror arrangement is particularly light and can be integrated in the illumination device in a
30 space-saving manner.

In an advantageous manner, according to claim 6, the third means for illuminating the component with horizontally incident light comprise a light-deflecting body which deflects the light that is radiated into it
35 onto the side areas of the component situated in an opening in the light-deflecting body. As a result, structures that emerge laterally from the component

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can easily be identified from above and utilized for position detection.

The light sources for the illuminations with perpendicularly incident light, with obliquely incident light on all sides, and with horizontally incident light are constructed as light-emitting diodes in a space-saving, light and inexpensive embodiment according to claims 2, 4 and 7.

The light-deflecting body is embodied in a particularly lightweight manner by virtue of being produced from an optically transparent plastic according to claim 8.

According to claim 9, the light sources are arranged in holding apparatuses of the light-deflecting body which are provided for them, which results in the light sources being secured well in conjunction with little loss of optical power.

In a preferred configuration according to claim 10, the light-deflecting body has cutouts through which the components are transported into the opening essentially horizontally and hence without a technically more complicated vertical movement.

A particularly high component-mounting performance is produced, according to the advantageous configuration according to patent claim 11, by the illumination apparatus being fitted on a component-mounting head, which ensures that the component-mounting head does not have to move to a special device for position identification within the automatic component-mounting machine for each position identification operation.

A light-deflecting body according to claims 12 and 13 is preferably used for the apparatus, which light-deflecting body can also be used for solving illumination problems which occur for example during the production of components.

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

Figure 1 shows a schematic cross section through a position detection apparatus according to the invention,

Figure 2 shows a schematic illustration of the
5 types of illumination,

Figure 3 shows a schematic cross section through a light-deflecting body according to the invention along the sectional axis A-A of Figure 4, which illustrates a plan view of the light-deflecting
10 body.

Figure 1 illustrates an apparatus 1 for detecting the position and/or checking the position of the connections 14 of a component 2. In this case, the apparatus 1 is designed in such a way that it is
15 preferably secured on a component-mounting head 3 of an automatic component-mounting machine. In this case, the component-mounting head 3 also comprises a rotatably mounted suction pipette holder 4 (turret head) with suction pipettes 5 for taking up the components 2 from
20 a feed device (not illustrated). In this case, the apparatus has first means for illuminating a component 2 with perpendicular light incidence 25 from above, particularly high reflective surfaces of the component 2 such as, for example, conductor tracks or contacts 14
25 which have a planar surface being identified. A first light source is provided for this type of illumination, said first light source comprising a first group of light-emitting diodes 6, the emitted light from which is directed through a first mirror 7, which is
30 constructed such that it is partially transmissive, and, as a result of reflection at a second mirror 8, perpendicularly onto the surface of the component 2. The illuminated component 2 is likewise imaged via the second mirror 8 and the partially transmissive mirror
35 7, which image the component via an optical imaging device 10, for example an objective lens, onto a camera 11 in the apparatus 1 for the purpose of store

identification. The camera 11 is connected to an image evaluation unit (not illustrated) in which the position of the component 2 on the component-mounting head 3 is determined in relation to a predetermined desired position. Second means for illuminating the component 2 with obliquely incident light 26 on all sides are additionally provided. In this case, these second means

comprise a second light source comprising a second group of light-emitting diodes 15 and a third mirror arrangement 13, which deflects the light emitted by the second light source in such a way that it impinges obliquely on the component 2 on all sides. The imaging is again effected via the second mirror 8 and the partially transmissive mirror 7 onto the camera 11. Furthermore, third means for illuminating the component 2 with light 27 which is incident horizontally on the side areas of the component 2 are provided to ensure that structures protruding laterally from the component 2, such as connections 14 for example, are identified. The three types of illumination are illustrated more clearly once again in Figure 2. These three means comprise a third light source in the form of a third group of light-emitting diodes 16 secured in holding apparatuses 17 of a light-deflecting body 18. The light-deflecting body 18 is composed of a transparent material such as glass or optically transparent plastic (PC, polycarbonate, trade name Makralon or PMMA, polymethacrylate, trade name Plexiglas). The light emitted by the third group of light-emitting diodes 16 is deflected in the light-deflecting body 18 onto the side areas of the component 2, which is situated in an opening 20 in the light-deflecting body 18. The imaging is likewise effected via the second mirror 8 and the partially transmissive mirror 7 onto the camera 11. Instead of the light-deflecting body, it is also possible to use a fourth mirror arrangement (not illustrated) for deflecting the light into the horizontal plane.

The light-deflecting body 18 is illustrated in more detail in the plan view in Figure 4 and in the section along the edge A-A in Figure 3. The third group of light-emitting diodes 16 is secured in the holding apparatuses 17, which are constructed as holes. Said diodes emit their light into the light-deflecting body

18, where the light is reflected by total reflection from a first (outer) wall 21 and falls through a second (inner) wall 22 into the opening 20 in the light-deflecting

body 18 and hence onto the side areas of the component 2. The light-deflecting body 18 furthermore has fixing apparatuses 23 which enable it to be secured in a releasable manner in the housing 24 of the apparatus 1
5 for the purpose of position identification. Both the light which is incident perpendicularly from above and the light which is obliquely incident on all sides pass through the opening 20 onto the component 2. The imaging onto the camera 11 is likewise effected through
10 the opening 20 in the light-deflecting body 18. The light-deflecting body 18 has cutouts 28 for the essentially horizontal transportation of the component 2 into the opening 20. A technically complicated vertical movement of the components 2 is thus avoided.

15 The arrangement with mirrors (7, 8, 13) and light-emitting diodes (6, 12, 15) is particularly light and space-saving and can therefore be secured on a component-mounting head 3. This results in a great deal of time being saved in the component-mounting process,
20 since there is no need to move to a separate station for the purpose of position identification. As a result, the component-mounting performance of the automatic component-mounting machine increases.



Patent claims

1. An apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), having first means for illuminating the components (2) with light (25) which is incident perpendicularly from above, having second means for illuminating the components (2) with light (26) which is obliquely incident on all sides, having third means for illuminating the components (2) with light (27) which is incident horizontally on the side areas of the components (2), and having a camera (11) with an image evaluation unit connected downstream, characterized in that the three means for illumination are constructed as reflected-light sources and fully illuminate the image field of the single camera (11).
2. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim 1, characterized in that the first means for illuminating the components (2) with light which is incident perpendicularly from above comprise a first light source (6) and also a first partially transmissive mirror (7), through which the light from the first light source (6) falls onto the component (2).
3. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim 2, characterized in that the first light source is constructed from a first group of light-emitting diodes (6)

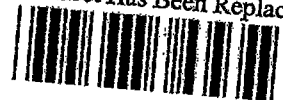




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4. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 1, 2 or 3,

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characterized

in that the second means for illuminating the components (2) with light which is obliquely incident on all sides comprise a second light source (12) and a
5 third mirror arrangement (13), which deflects the light emitted by the second light source (12) in such a way that it falls obliquely onto the component (2) on all sides.

5. The apparatus (1) for detecting the position of
10 components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim 4,

characterized

in that the second light source is constructed from a
15 second group of light-emitting diodes (12).

6. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 1 to 5,

20 characterized

in that the third means for illuminating the components (2) with horizontally incident light comprise a third light source (15) and a light-deflecting body (18),

in that the light-deflecting body (18) comprises a
25 continuous opening (20) for the components (2),

in that the light-deflecting body (18) has a first outer wall (21), which is configured in such a way that the light radiated into the light-deflecting body (18) from the third light source (15) is reflected from the
30 first wall (21) in the direction of the opening (20) and passes through a second inner wall (22), which is assigned to the opening (20), onto the component (2).

7. The apparatus (1) for detecting the position of components (2) and/or for checking the position of
35 connections (14) of components (2) as claimed in claim 6,

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in that the third light source is constructed from a third group of light-emitting diodes (15).

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8. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in either of claims 6 and 7,

5 characterized

in that the light-deflecting body (18) is constructed from an optically transparent plastic.

9. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 6, 7 or 8,

characterized

in that the light-deflecting body (18) comprises a holding apparatus (17) for the third light source (15), the holding apparatuses (17) being configured in such a way that the light emitted by the third light source (15) is radiated into the light-deflecting body (18).

10. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 6 to 9,

characterized

in that cutouts (28) are provided in the light-deflecting body (18) in order that the components (2) can be transported essentially horizontally into the opening (20).

11. A component-mounting head (3) having an apparatus (1), which is arranged on the component-mounting head, for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), in particular as claimed in claim 1, having first means for illuminating the components (2) with light (25) which is incident perpendicularly from above, having second means for illuminating the components (2) with light (26) which is obliquely incident on all sides, having third means





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is incident horizontally on the side areas of the components (2), and having a camera (11) with an image evaluation unit connected downstream, all three means fully illuminating the image field of the single camera

5 (11).

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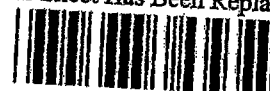
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for illuminating the components (2) with light (27)
which

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12. A light-deflecting body (18), in particular for an apparatus (1) as claimed in one of claims 1 to 10, characterized
- in that the light-deflecting body (18) comprises a holding apparatus (17) for the third light source (15), the holding apparatus (17) being configured in such a way that the light emitted by the third light source (15) is radiated into the light-deflecting body (18), in that the light-deflecting body (18) comprises an opening (20) for the components (2), in that the light-deflecting body has a first outer wall (21), which is configured in such a way that the light radiated into it is deflected in the direction of the opening (20) and passes through an inner second wall (22), which is assigned to the opening, onto the component (2).
13. The light-deflecting body (18) as claimed in claim 12, characterized
- in that the light-deflecting body (18) is constructed from an optically transparent plastic.
14. A method for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), in particular with an apparatus (1) as claimed in claim 1, the component (2) being illuminated with perpendicularly incident light (25) from above, with obliquely incident light (26) on all sides, and with light (27) which is incident horizontally on the side areas of the component (2) and the component (2) being imaged onto a camera (11) with an image evaluation unit arranged downstream, characterized
- in that the image field of the camera (11) is fully illuminated by the perpendicularly incident light (25), the obliquely incident light (26) on all sides, and the horizontally incident light (27).



Abstract

1. Apparatus and method for detecting the position of components and/or for checking the position of connections of components and component-mounting head having an apparatus for detecting the position of components and/or for checking the position of connections of components.

2.1. In the context of flip-chip mounting with an automatic component-mounting machine, the incidence of perpendicularly incident light and obliquely incident light on all sides does not, in some instances, illuminate the connections (14) of components (2) well enough to determine the position thereof, after the components (2) have been imaged onto a camera (11) in an image evaluation unit connected downstream of the camera (11).

2.2. By illuminating the components (2) with perpendicularly incident light, with obliquely incident light on all sides, and with horizontally incident light, the side areas of the components (2) and thus protruding connections (14) as well are illuminated to a sufficient extent. For full horizontal illumination, a light-deflecting body (18) is constructed in such a way that the light from a third light source (15) is radiated into the light-deflecting body (18), reflected from a first outer wall (21) of the light-deflecting body (18) and radiated into an opening (20) in the light-deflecting body (18).

2.3. Component-mounting head for flip-chip mounting.

3. FIG. 1



Patent claims

1. An apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), having first means for illuminating the components (2) with light (25) which is incident perpendicularly from above, having second means for illuminating the components (2) with light (26) which is obliquely incident on all sides, having third means for illuminating the components (2) with light (27) which is incident horizontally on the side areas of the components (2), and having a camera (11) with an image evaluation unit connected downstream, characterized in that the three means for illumination are constructed as reflected-light sources and fully illuminate the image field of the single camera (11), and in that the camera (11) receives the light reflected essentially perpendicularly upward at the connections (14) and/or the components (2).
2. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim 1, characterized in that the first means for illuminating the components (2) with light which is incident perpendicularly from above comprise a first light source (6) and also a first partially transmissive mirror (7), through which the light from the first light source (6) falls onto the component (2).
3. The apparatus (1) for detecting the position of components (2) and/or for checking the position of



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connections (14) of components (2) as claimed in claim
2,
characterized
in that the first light source is constructed from a
5 first group of light-emitting diodes (6).



4. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 1, 2 or 3,
- 5 characterized
- in that the second means for illuminating the components (2) with light which is obliquely incident on all sides comprise a second light source (12) and a mirror arrangement (13), which deflects the light
- 10 emitted by the second light source (12) in such a way that it falls obliquely onto the component (2) on all sides.
5. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim
- 15 4,
- characterized
- in that the second light source is constructed from a second group of light-emitting diodes (12).
- 20 6. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 1 to 5,
- characterized
- 25 in that the third means for illuminating the components (2) with horizontally incident light comprise a third light source (15) and a light-deflecting body (18),
- in that the light-deflecting body (18) comprises a continuous opening (20) for the components (2),
- 30 in that the light-deflecting body (18) has a first outer wall (21), which is configured in such a way that the light radiated into the light-deflecting body (18) from the third light source (15) is reflected from the first wall (21) in the direction of the opening (20)
- 35 and passes through a second inner wall (22), which is assigned to the opening (20), onto the component (2).



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7. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in claim 6,

5 characterized



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in that the third light source is constructed from a third group of light-emitting diodes (15).

8. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in either of claims 6 and 7, characterized

in that the light-deflecting body (18) is constructed from an optically transparent plastic.

9. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 6, 7 or 8, characterized

in that the light-deflecting body (18) comprises a holding apparatus (17) for the third light source (15), the holding apparatuses (17) being configured in such a way that the light emitted by the third light source (15) is radiated into the light-deflecting body (18).

10. The apparatus (1) for detecting the position of components (2) and/or for checking the position of connections (14) of components (2) as claimed in one of claims 6 to 9, characterized

in that cutouts (28) are provided in the light-deflecting body (18) in order that the components (2) can be transported essentially horizontally into the opening (20).

11. A component-mounting head (3) having an apparatus (1), which is arranged on the component-mounting head, for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), as claimed in one of claims 1 to 10.

12. A light-deflecting body (18), in particular for an apparatus as claimed in claim 6,



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having a holding apparatus (17) for a third light source (15), the holding apparatus (17) being configured in such a way



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that the light emitted by the third light source (15) is radiated into the light-deflecting body (18), having an opening (20) for the components (2), having a first outer wall (21), which is configured in such a way that the light radiated into the light-deflecting body (18) is deflected in the direction of the opening (20) and passes through an inner second wall (22), which is assigned to the opening, in the direction of the side areas of the component (2), characterized

in that cutouts (28) are provided in the light-deflecting body (18) in order that the components (2) can be transported essentially horizontally into the opening (20), and

in that fixing apparatuses (23) for releasable fixing on the apparatus (1) are provided.

13. The light-deflecting body (18) as claimed in claim 12, characterized

in that the light-deflecting body (18) is constructed from an optically transparent plastic.

14. A method for detecting the position of components (2) and/or for checking the position of connections (14) of components (2), in particular with an apparatus (1) as claimed in claim 1, the component (2) being illuminated with perpendicularly incident light (25) from above, with obliquely incident light (26) on all sides, and with light (27) which is incident horizontally on the side areas of the component (2) and the component (2) being imaged onto a camera (11) with an image evaluation unit arranged downstream, characterized

in that the image field of the camera (11) is fully illuminated by the perpendicularly incident light (25), the obliquely incident light (26) on all sides, and the



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horizontally incident light (27), the camera (11)
receiving the light reflected essentially
perpendicularly upward from the component (2).