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(54) Title: PICK-AND-PLACE METHOD AND CORRESPONDING PICK-AND-PLACE APPARATUS FOR MOUNTING COMPONENTS ON A SUBSTRATE

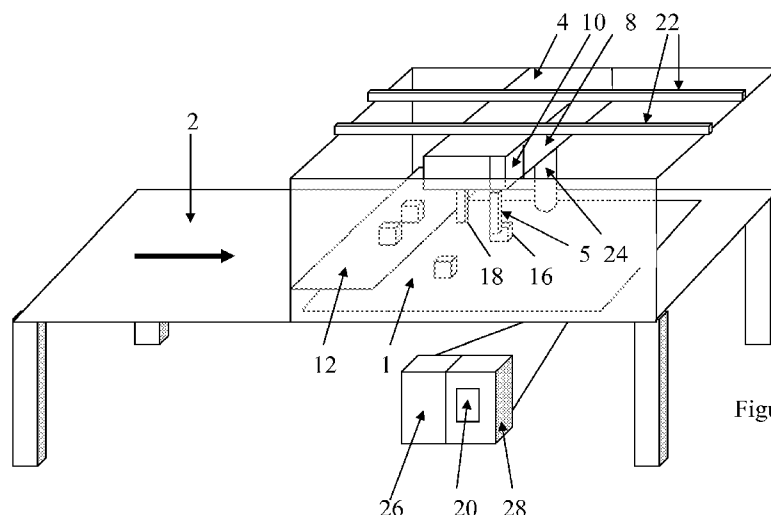


Figure 1

(57) Abstract: The present invention relates to a pick-and-place method and a corresponding pick-and-place apparatus for mounting electronic components, for example surface mounted device (SMD) components, on a substrate, in particular on a large-surface/large-area substrate. According to the invention, the pick-and-place apparatus comprises a material transport and support device (2), an x-y-positioning device (4) with one or several mounted electronic component mounting heads (5), wherein in at least one electronic component mounting head (5) comprises a visual system (8) for identifying form and/or position parameters of the head, substrate and/or component/s, a head rotation or translation system (10), one or several electronic component feeders (12), an electronic component mounting device (16). The apparatus also preferably has an electronic component testing device (18) for directly testing the component after mounting, and a control interface (20) for adjusting the parameters of the apparatus, in particular the form and/or position parameters of the head, substrate and/or component/s.

Pick-and-place method and corresponding pick-and-place apparatus for mounting components on a substrate

The present invention relates to a method for placing electronic and/or electrical components on a substrate (or pick-and-place method) and a corresponding apparatus for placing (or mounting) components such as electronic or electronic components, for example surface mounted device (SMD) components, on a substrate, in particular on a large-surface/large-area substrate.

Technical Background

The pick-and-place method is well known in electronic industry and is typically used for assembling different electronic components on a substrate that is at least locally conductive, for example a printed circuit board, and has a surface generally smaller than some hundred of square centimeters. In general, the common pick-and-place method is realized by an apparatus with a swivel head and comprises the following sequence of steps:

15

1. referencing the board on which the components should be mounted in order obtain absolute positions. This is typically realised by locating visible reference marks, for example marks printed on the board or holes perforated in the board, or the edges of the board, and positioning the board with respect to the visible reference marks or the edges of the board;
2. placing adhesive spots on the board by the head;
3. placing components on the adhesive spots on the board by the head whereby the head see-saws between the component storage (immobile feeder) and the position where the components should be placed on the board;
4. finally, at the end of the pick-and-place when all components are mounted on the board, logically controlling the board by an electronic test of the function of the components. This is usually realised by applying different electrical signals to the board and verifying if the

30

real output signals correspond with the desired output signals.

At present, substrates having a size of 650 mm x 850 mm are the largest substrates that can be equipped by means of common pick-and-place methods
5 and apparatuses, for example by using an "Assembleon" system. However, there is no pick-and-place method and apparatus for large-surface substrates, for example larger than one meter square.

The preceding common pick-and-place method cannot be simply converted for large-surface substrates of one or several square meters or for
10 transparent substrates, due to the following technical problems:

- the referencing and positioning step on the basis of exclusively absolute positions cannot be applied to large-surface substrates since the accuracy is no longer sufficient for substrates larger than one meter
15 square;
- the time that is needed by the head to cover the distance between a stationary feeder and the position where these components should be placed becomes relevant in the case of large-surface substrates;
- as the time is more relevant in the case of large-surface substrates,
20 problems need to be detected as soon as possible in order to eliminate defective boards at the beginning or during the processing and not to waste time by detecting at the end of the process that the product is defective.

25 Furthermore, these problems can not be solved by dividing the total surface of the substrate into sub surface sections and to apply the preceding common pick-and-place method to each sub surface section as this is associated with the following problems:

- 30 - increased costs due to
 - the multiplication of the number of sub-systems,
 - the more complex process management and
 - the increased error margin;
- communication/synchronisation problems between the different

elements;

- referencing each sub-method to the substrate is complex and requires supplementary means, in particular for transparent substrates.

5 Summary of the invention

It is the object of the invention to provide a pick-and-place apparatus and method for substrates of large size.

The present invention provides an apparatus such as a pick-and-place apparatus for placing or mounting electronic and/or electrical components, for example surface mounted device (SMD) components, on a substrate, comprising:

- a material transport and support device, and
 - a two dimensional positioning device, for example, an x-y-positioning device with one or several mounted electronic component mounting heads;
- 15 wherein at least one electronic component mounting head comprises
- a visual system for identifying form and/or position parameters of the head, substrate and/or component/s,
 - a head rotation system and/or translation system which takes into account at least one form or position parameter supplied from the visual system,
- 20 - one or several electronic component feeders, and
- an electronic component mounting device which comprises
 - a conductive glue or solder applying device, and
 - a component positioning device,

the electronic mounting device being activatable for each component to be mounted on the substrate. The apparatus may include an electronic component testing device for directly testing the component after mounting. The apparatus may also include a control interface for adjusting the parameters of the apparatus, in particular the form and/or position parameters of the head, substrate and/or component/s.

30

An apparatus according to the invention advantageously allows to rapidly and precisely mount a great number of electronic components on a large-surface substrate, such as substrates having a surface of $\geq 1 \text{ m}^2$, for example $\geq 2 \text{ m}^2$, in particular $\geq 6 \text{ m}^2$. Furthermore, the apparatus according to the invention

advantageously may be used for very large, even/flat and/or transparent or translucent or highly reflective substrates and does not require generally high contrast visible reference marks for precisely mounting electronic components.

The present invention also provides a method such as a pick-and-place
5 method for placing or mounting electrical and/or electronic components, for example surface mounted device (SMD) components, on a substrate, optionally performed by an apparatus according to the invention, comprising the sequence of process steps of:

- 10 1. detecting a first, in particular absolute, reference marks on the substrate by a visual system;
2. calculating the positioning error by comparing the detected position of the first reference marks with their theoretical position;
3. displacing an electronic component mounting head to a placement
15 position of a first component calculated on the basis of the first reference marks;
4. locally detecting the position and the orientation of the first component relative to one or several secondary reference marks on the substrate and adjusting the position (x, y) and the orientation of the first
20 component;
5. mounting the first electronic component;
6. indexing, e.g. increasing or decreasing the position and component counter;
7. repeating the sequence from process step 3 on for another electronic
25 component on the basis of a subsequent position or terminating the method after one or several cycles.

The present invention will now be described with reference to the following drawing in more detail. The dependent claims each define an independent
30 embodiment of the present invention.

Brief Description of the drawings

Figure 1 shows a pick and place apparatus according to an embodiment of the present invention.

Fig. 2 is a flow diagram of a pick-and-place method according to an embodiment of the present invention.

Detailed description of the illustrative embodiments

5 The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting.

 Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for
10 describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

 Moreover, the terms top, bottom, over, under and the like in the description and
15 the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

 It is to be noticed that the term “comprising”, used in the claims, should not be
20 interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression “a device comprising means A and
25 B” should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

 Similarly, it is to be noticed that the term “coupled”, also used in the claims, should not be interpreted as being restricted to direct connections only. Thus, the scope
30 of the expression “a device A coupled to a device B” should not be limited to devices or systems wherein an output of device A is directly connected to an input of device B. It means that there exists a path between an output of A and an input of B which may be a path including other devices or means.

 The present invention provides an apparatus, e.g. a pick-and-place

apparatus for placing and/or mounting electrical and/or electronic components, for example surface mounted device (SMD) components, for example on a substrate (1), e.g. as shown in the figure. It may comprise:

- a material transport and support device (2), and
- 5 - a two dimensional positioning device, for example, an x-y-positioning device (4) with one or several mounted electronic component mounting heads (5);

wherein at least one electronic component mounting head (5) comprises

- a visual system (8) for identifying form and/or position parameters of the head, substrate and/or component/s,
- 10 - a head rotation and/or translation system (10),
- one or several electronic component feeders (12) that are optionally mobile, and
- an electronic component mounting device (16). The head rotation and/or translation system may have a conductive glue or solder applying station as well as a component positioning device. The head rotation and/or translation system may include a conductive glue or solder applying device and a component positioning device.
- 15
- An electronic component testing device (18) for directly testing the component after mounting may be provided.
- 20

A control interface (20) may be provided for adjusting the parameters of the apparatus, in particular the form and/or position parameters of the head, substrate and/or component/s.

- 25 An apparatus according to the invention advantageously allows to rapidly and precisely mount a great number of electronic components on a large-surface substrate, such as substrates having a surface of $\geq 1 \text{ m}^2$, for example $\geq 4 \text{ m}^2$, in particular approximately 20 m^2 . Furthermore, the apparatus according to the invention advantageously may be used for very large, even/flat and/or transparent or translucent or highly reflective substrates and does not require generally high contrast visible reference marks for precisely mounting electronic components. At the end of the production process with an apparatus according to the invention, no conductive paths need to be visible on the substrate to the human eye. As a result, the substrates processed with an
- 30

apparatus according to the invention can meet very high aesthetic demands, in particular in view of the level of the product presentation and surface configuration. The apparatus according to the invention offers new processing possibilities for large, even/flat and transparent substrates and can therefore be
5 used in particular in flat screen and solar industry.

Moreover, while the common pick-and-place apparatuses can only work on standardised dimensions, the apparatus according to the invention can advantageously handle and can be adapted to substrates of varying size. As a consequence, the mounting of components, in particular SMD components is
10 made variable but precise by using an apparatus according to the invention.

Within the context of a special embodiment of the present invention, the material transport and support device (2) may be a conveyor, e.g. may be based on a conveyor usually used in glass industry, for example a conveyor provided by distributors as "Grenzebach" or "Bottero". Such material transport
15 and support devices (2) are capable of handling different substrate sizes, for example of ≥ 600 mm x 200 mm to ≤ 2700 mm x 1500 mm, and different substrate thicknesses, for example of ≥ 3 mm to ≤ 10 mm.

Within the scope of the present invention, the x-y-positioning device (4) may be a gantry that is movable to a predetermined but arbitrary x and y
20 position. Within the scope of another special embodiment of the present invention, the x-y-positioning device (4) is provided with at least two separately acting tool-holding cross-beams (22).

The visual system (8) according to the invention can be based on a camera (24) and an image recognition system (26). The visual system (8)
25 according to the invention is preferably able to localise a position, and/or to identify variations between a real and a theoretical position and/or to adjust the electronic component mounting head (5) and an electronic component, respectively, with respect to the substrate (1). Such an adjustment with the concerned surface structure is indispensable in order to detect possible
30 irregularities and to flexibly adapt the positions.

In particular, the visual system (8) according to the invention can be adapted to identify the essential characteristics of the substrate (1) and/or the electronic component, such as form, dimension and shade parameters. The visual system (8) is preferably adapted to carry out a machine vision algorithm

for identifying essential characteristics of the substrate. These essential characteristics may be any of fiducial marks, reference points, colours, shades, shapes, patterns or structures on the surface of the substrate or combinations thereof.

5 Preferably the visual system (8) applies a three-stage geometrical measurement. In order to place an electrical or electronic component such as a LED, the visual system can be adapted to identify a reference mark or a fiducial marker on the glass, e.g. to identify a specific shape, pattern, shade, colour or structure or other type of reference mark on the substrate (e.g. a
10 horizontal laser line). Where the substrate is transparent, the mark or pattern is preferably invisible to the human eye; e.g. does not radiate in the optical spectral region visible to the eye. Then, by comparing the identified specific mark or pattern with an ideal or expected specific mark or pattern which is available in and retrievable from a memory (e.g. in a dedicated library), the
15 visual system associates a matching score with the found mark or pattern. Then, if the score is high (e.g. > 50% or greater than 60% or greater than a higher percentage), it means or it is assumed that what is seen on the substrate, e.g. glass, corresponds to what should be seen, and in that case, the LED can be placed on that identified location at that mark or pattern on the glass. A « 3-
20 stage geometrical measurement » is a mathematical algorithm integrated in the vision system image analysis software and allows for the comparison of the identified pattern with the ideal pattern, the comparison taking into account 3 aspects, e.g. : a) the shape, b) the dimensions, c) the contrast, each control step giving a result which allows finally to obtain the matching score.

25 Subsequently the visual system (8) identifies the spatial relation between the characteristics of a stored model of the substrate and the real image structure, for example by comparison of the parameters.

For the adjustment, reference marks, for example a lattice of lines, preferably invisible to the human eye, are preliminary applied to the substrate.
30 For example inductive paths on the substrate, preferably having a line breadth of $\leq 100 \mu\text{m}$, may serve as reference marks which are invisible to the human eye. Such invisible reference marks and/or inductive paths can for example be achieved by preliminary applying a laser ablation process to a, in particular, conductive layer/coating on the substrate.

Within the scope of another special embodiment of the present invention, the visual system (8) comprises an infrared emission device coupled with an infrared camera (24) or other form of optical receiver. For this purpose, for example a camera (24) provided by distributors as “Flir system”
5 is suitable. Preferably an annular infra-red light is placed in front of the receiver/camera (not shown). By this measure, the contrast is enhanced and the apparatus according to the invention can advantageously localise thin structures and may be also used for processing transparent substrates.

Within the scope of a further special embodiment of the present
10 invention, the visual system (8) comprises at least two high resolution alignment cameras.

The visual system (8) may comprise a computing device (28) and peripheral devices such as memories, cameras, etc. Furthermore, the visual system preferably comprises a frame grabber, for example of the company
15 “Cognex”, and a vision tool based on an image processing program, in particular a geometric pattern-matching program, for example the Patmax (registered trademark) of the company “Cognex”. The vision tool, in particular PatMax of the company “Cognex”, advantageously creates a clearly structured model from a low-contrast and/or to the human eye totally uniform image. The
20 vision tool may run as a computer program application on the computing device (28), e.g. in the form of executable software.

Preferably, the vision tool is incorporated in a particular application and is started and stopped by a main program of the computing device (28) in the apparatus according to the invention. During the mounting/bonding process,
25 the main program automatically starts the vision tool. When the image processing function of the vision tool is finished, the final values are given back to the main program.

In contrast to conventional tools, the visual system (8) according to the invention preferably uses a compensation technique and need not rely on a
30 pixel matrix. The analysis of the characteristics and the spatial relations furthermore makes it possible to unambiguously define the position of an object. Furthermore, the visual system (8) according to the invention makes it possible to mount electronic components on substrates, in particular on transparent or reflective substrates, without applying visible reference marks.

The human eye therefore advantageously only sees an even and transparent or reflective substrate and no structure, no shade, no colour difference or anything else.

5 The head rotation and/or translation system (10) is adapted to mount of a component in any orientation on the basis of the information received and evaluated by the visual system (8). The head rotation and/or translation system (10) makes use of at least one form and/or position parameter obtained from the visual system. Using the head rotation and/or translation system (10), the electrical or electronic component mounting head (5) may be, for example, oriented in at least
10 three, in particular four perpendicular directions.

In the context of the present invention the feeder systems for components to be mounted may be mobile feeder systems, e.g. as used in the electronic industry, for example by companies like "Assembleon". Such feeder systems may be used as mobile electronic component feeders (12). The
15 electrical or electronic components may be stored therein for example in form of component reels, in particular in the form of component reel tapes. Such component reels are for example provided by distributors as "Nichia".

Advantageously, an electrical or electronic component feeder (12) especially a mobile electronic or electrical component feeder (12) allows to
20 economise the time for the displacement of the electronic component mounting (5) between two positions as the mobile electronic component feeder (12) loads the head at or close to the location where the component is required. For this reason the head need no longer return to an immobile component storage to fetch new components.

25 Preferably, the electronic component mounting device (16) comprises a conductive glue or solder applying device and a component positioning device. Such an electronic component mounting device (16) can place or mount the electronic components by means of jetting and/or dispensing a fixing material such as a glue or solder. Within the scope of the present invention, a glue can be an adhesive, for
30 example a conductive adhesive such as is offered by suppliers like "Epotecnny", and this may at first be applied on the component or on the substrate (target material). If the adhesive is applied to substrate, the component is then mounted on the substrate, positioned with respect to the disposed adhesive spots. However, the bond between the component and the substrate may

equally be realised by soldering, for example by use of ultra sound and/or heat. Preferably, the step of mounting the component on the substrate is realised on the basis of information pre-registered in the apparatus comprising the lead pattern of the component. During the mounting, preferably a force of
5 ≥ 0.1 N to ≤ 0.4 N is applied on the component for fixing the component on the substrate. Preferably, this force is controlled by a force control device.

The electronic component testing device is an optional device and its form will depend upon the nature of the component to be tested. For example it may comprise/consist of a power source which is connected to a photo-diode.

10 Preferably, an apparatus according to the invention has access to a database comprising local characteristic images (patterns) of the positions where the electronic components shall be placed on the conductive paths. These images can be obtained in advance, for example during the step of creating the inductive paths / electronic circuit on the substrate.

15 The apparatus according to the invention is feed with substrates on which conductive paths and/or reference marks, for example dots, crosses, lines or a pattern thereof, were provided in advance and electronic components.

The apparatus according to the invention may process opaque, for example conventional printed circuits, transparent, for example glass, semi-transparent
20 or reflective, for example mirrors, substrates having a surface on which conductive paths and/or reference marks were provided in advance. The conductive paths and/or reference marks can for example be provided by subjecting a, in particular conductive, layer/coating to a laser ablation process. For example, the substrate may be a glass sheet on which a transparent
25 conductive layer (for example a conductive metal oxide layer such as a tin oxide layer or an indium tin oxide (ITO) layer or a layer on the basis of SnO_2) is deposited and provided with conductive paths and/or reference marks by means of local laser ablation of the conductive layer.

The apparatus according to the invention may mount a series of electrical or
30 electronic components, for example passive devices such as resistors, capacitors, inductors, or active devices such as electroluminescent diodes, sensors. In particular surface mounted device (SMD) resistors, capacitors, inductors, electroluminescent diodes, sensors, for example light-emitting diodes (LED), more particular surface mounted device (SMD) light-emitting diodes, can be mounted. These may

have shapes and/or connections of different geometry and may be purchased from different companies.

Another aspect of the present invention is a method such as a pick-and-place method for mounting or placing components such as electrical or electronic components, for example surface mounted device (SMD) components, on a substrate, optionally performed by an apparatus according to the invention. The flow diagram for the method (40) is shown schematically in Fig. 2. The method (40) may comprise the following sequence of process steps of:

1. detecting in step 42 a first, in particular absolute, reference marks on the substrate by a visual system;
2. calculating in step 42 a positioning error by comparing the detected position of the first reference marks with their theoretical position;
3. displacing in step 44 an electronic or electrical component mounting head to the placement position of the first component calculated on the basis of the first reference marks;
4. locally detecting the position and the orientation of the first component relative to one or several secondary reference marks on the substrate in step 46 and adjusting the position (x, y) and the orientation of the first component in step 48;
5. mounting the first electric or electronic component in step 50;
6. indexing in step 54, e.g. increasing or decreasing the position and component counter;
7. repeating the sequence from process step 3 (steps 44 to 54 in Fig. 2) on for another electronic component on the basis of a subsequent position or terminating the pick-and-place method after one or several cycles in step 56.

During the first process step the visual system investigates the first reference marks in the vicinities of several reference positions on the substrate. These first reference marks were applied to the substrate before the beginning of the method according to the invention. The secondary reference marks, for example intersecting structures and lines, can also be preliminarily applied to the substrate. For example, conductive paths on the substrate on which the

electronic component will be placed can serve as secondary reference marks. Therefore, it is not necessary to provide other secondary reference marks besides the already existent inductive paths to mount electronic components.

These conductive paths may be realized by applying laser ablation to a
5 conductive layer, i.e. the paths are present where the ablation has not taken place. Preferably, the system is preliminary trained to recognize the form and/or pattern of the conductive paths on the substrate.

Preferably, in process step five (step 50 in Fig. 2), the electronic or electrical components are mounted/bond by adhering or soldering. Process step
10 five, may therefore comprise an adhesive deposition step (step 51 in Fig. 2), wherein an adhesive is deposited on the substrate or a solder application step (step 51), and a component deposition step (step 52 in Fig. 2), wherein at least one component is deposited on the substrate. The step of applying a glue or solder (step 51) can be selected from:

- 15
- a jetting technique;
 - a dispensing technique; or
 - a screen printing technique.

When the first electronic component is fixed on the support, the component and position counter is indexed to the next item, e.g. increased or decreased and the process
20 steps three to seven are repeated for a second electronic component and so on for each component. Component by component is thereby mounted on the substrate. For each mounted electronic or electrical component, optionally except for the last electronic component, the component and position counter is indexed. Simultaneously, the number of remaining components on the component reel/s,
25 in particular on the reel tape/s, is verified.

Within the scope of a special embodiment of the method according to the present invention, the electronic component is taken into a feeder such as a mobile feeder and oriented during process step three.

Within the scope of another special embodiment of the method
30 according to the present invention, a force of ≥ 0.1 N to ≤ 0.4 N is applied on the component during process step five. This advantageously enhances the fixation of the component on the substrate.

Within the scope of another special embodiment of the method according to the present invention, the method comprises a further process step

5a (step 53) of directly testing some or all of the components after being mounted on the substrate.

If required the system may re-check its calibration by returning to step 42 in Fig. 2 and relocating and reference marks and resetting any parameters as required.

5 The method according to the invention advantageously allows to clearly identify smallest structures on heterogeneous substrates by means of visual software. It advantageously allows to mount SMD components straightforwardly on substrates having a surface of up to 6 square meters and more. Furthermore, the heterogeneous surface structure of the production line
10 can advantageously be compensated by the method and apparatus according to the invention.

Claims

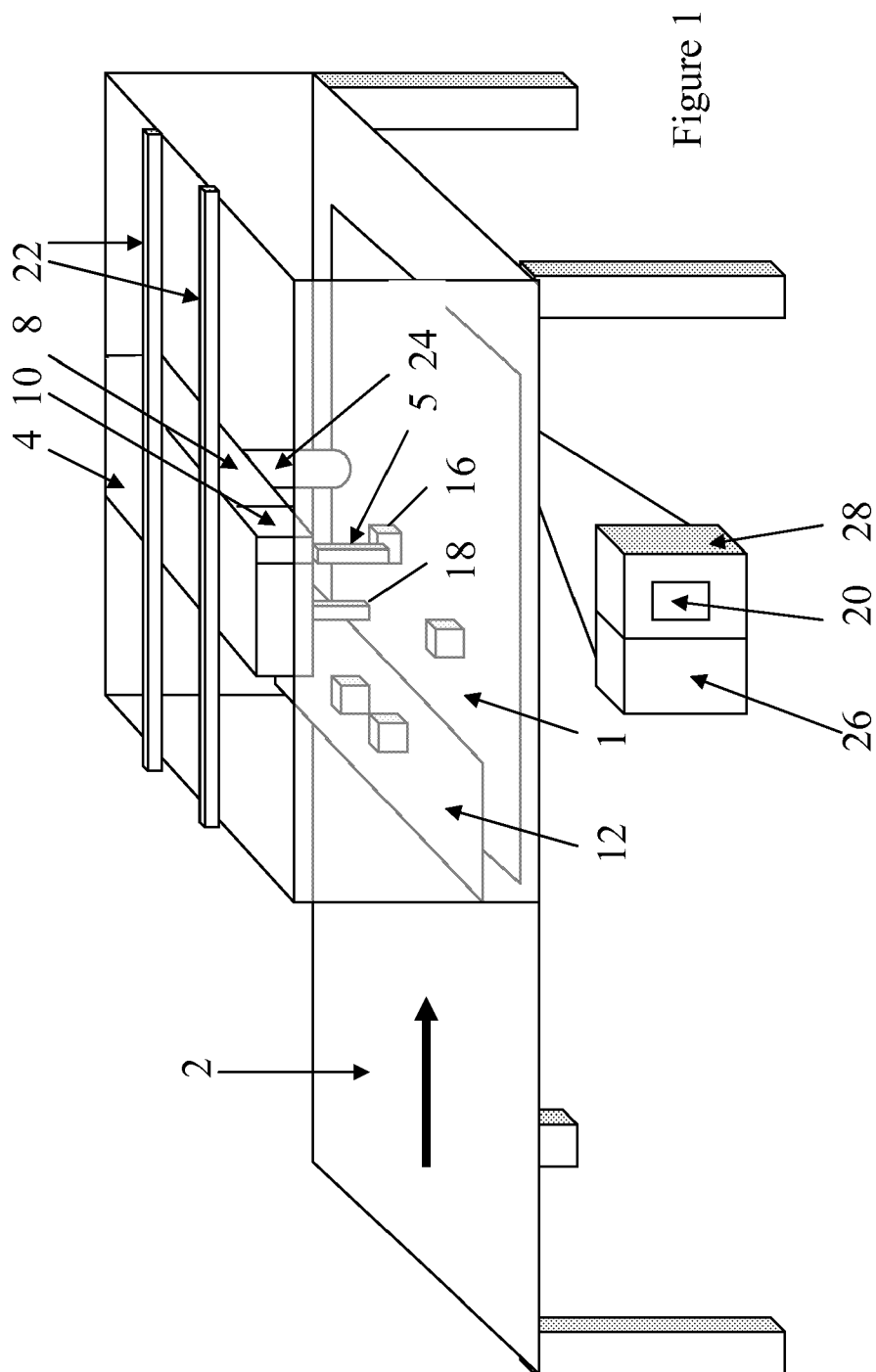
1. Apparatus for placing electronic and/or electrical components on a substrate, the apparatus comprising
 - a material transport and support device (2), and
 - a two-dimensional positioning device (4) with one or several mounted electronic component mounting heads (5),wherein at least one electronic component mounting head (5) comprises:
 - a visual system (8) for identifying form and/or position parameters of the head, substrate and/or component/s,
 - a head rotation and/or translation system (10) which takes into account at least one form and/or position parameters from the visual system,
 - one or several electronic component feeders (12),
 - an electronic component mounting device (16) which comprises :
 - a conductive glue or solder applying device,
 - a component positioning device,the electronic component mounting device (5) being activated for each component to be mounted on the substrate.
-
2. Apparatus according to claim 1, wherein the glue or solder applying device is at least one of the following devices :
 - jetting devices;
 - dispensing devices;
- screen printing devices.
3. Apparatus according to claim 1 or 2, wherein the apparatus comprises an electronic component testing device (18) for directly testing a component after its mounting on the substrate.
4. Apparatus according to any one of the preceding claims, wherein the apparatus comprises a control interface (20) for adjusting the parameters of the apparatus, in particular the form and/or position parameters of the head, substrate and/or component/s.

5. Apparatus according to any one of the preceding claims, wherein at least one of electronic component feeders (12) is mobile independently of the mounting head (5).
6. Apparatus according to any one of the preceding claims, wherein the apparatus processes high-surface substrates having a surface of $\geq 1 \text{ m}^2$, for example $\geq 4 \text{ m}^2$, in particular approximately 20 m^2 .
7. Apparatus according to any one of the preceding claims, wherein the two dimensional positioning device is provided with at least two separately acting tool-holding cross-beams (22).
8. Apparatus according to any one of the preceding claims, wherein the visual system (8) comprises a camera (24) and an image recognition system (26).
9. Apparatus according to any one of the preceding claims, wherein the visual system (8) applies a three-stage geometrical measurement.
10. Apparatus according to any one of the preceding claims, wherein the visual system (8) comprises an infrared emission device coupled with an infrared receiver.
11. Apparatus according to any one of the preceding claims, wherein the visual system (8) comprises at least two high resolution alignment cameras (24), a frame grabber and a vision tool based on an image processing program.
12. Apparatus according to any one of the preceding claims, wherein the components are stored in the electronic component feeder (12) in form of component reels, in particular in form of component reel tapes.
13. Apparatus according to any one of the preceding claims, wherein the

apparatus has access to a data base comprising local characteristic images (patterns) of the position where the electronic components shall be placed on the conductive paths.

14. Apparatus according to any one of the preceding claims, wherein the substrate is transparent or reflective and has a patterned conductive coating.
15. Method for placing electronic and/or electrical components on a substrate, the method comprising the sequence of process steps of:
 1. detecting a first, in particular absolute, reference marks on the substrate by a visual system;
 2. calculating a positioning error by comparing the detected position of the first reference marks with their theoretical position;
 3. displacing an electronic component mounting head to a placement position of a first component calculated on the basis of the first reference marks;
 4. locally detecting the position and the orientation of the first component relative to one or several secondary reference marks on the substrate and adjusting the position (x, y) and the orientation of the first component;
 5. mounting the first electronic component;
 6. indexing a position and component counter; and
 7. repeating the sequence from process step 3 on for another electronic component on the basis of the following position or terminating the pick-and-place method after one or several cycles.
16. Method according to claim 15, wherein step 5 of mounting the first electronic component comprises the following steps :
 - application of a conductive glue or solder on the substrate,
 - positioning the first component on the glue or solder on the substrate.
17. Method according to claim 15 or 16, wherein the application step uses at least one of the following techniques :
 - jetting techniques;
 - dispensing techniques;

- screen printing techniques.
18. Method according to any one of the preceding claims, wherein, for each component mounted on the substrate, it comprises a step for testing the component directly after its mounting on the substrate.
 19. Method according to any one of the claims 15 to 18 , wherein the secondary reference marks are conductive paths on the substrate.
 20. Method according to any one of the claims 15 to 19, wherein the electronic component is taken into the mobile feeder and oriented during process step three.
 21. Method according to any one of the claims 15 to 20, wherein a force of $\geq 0.1 \text{ N}$ to $\leq 0.4 \text{ N}$ is applied on the component during process step five.
 22. Method according to any one of the claims 15 to 21, wherein the method comprises a further process between step 5 and 6 of directly testing the first component after being mounted on the substrate.



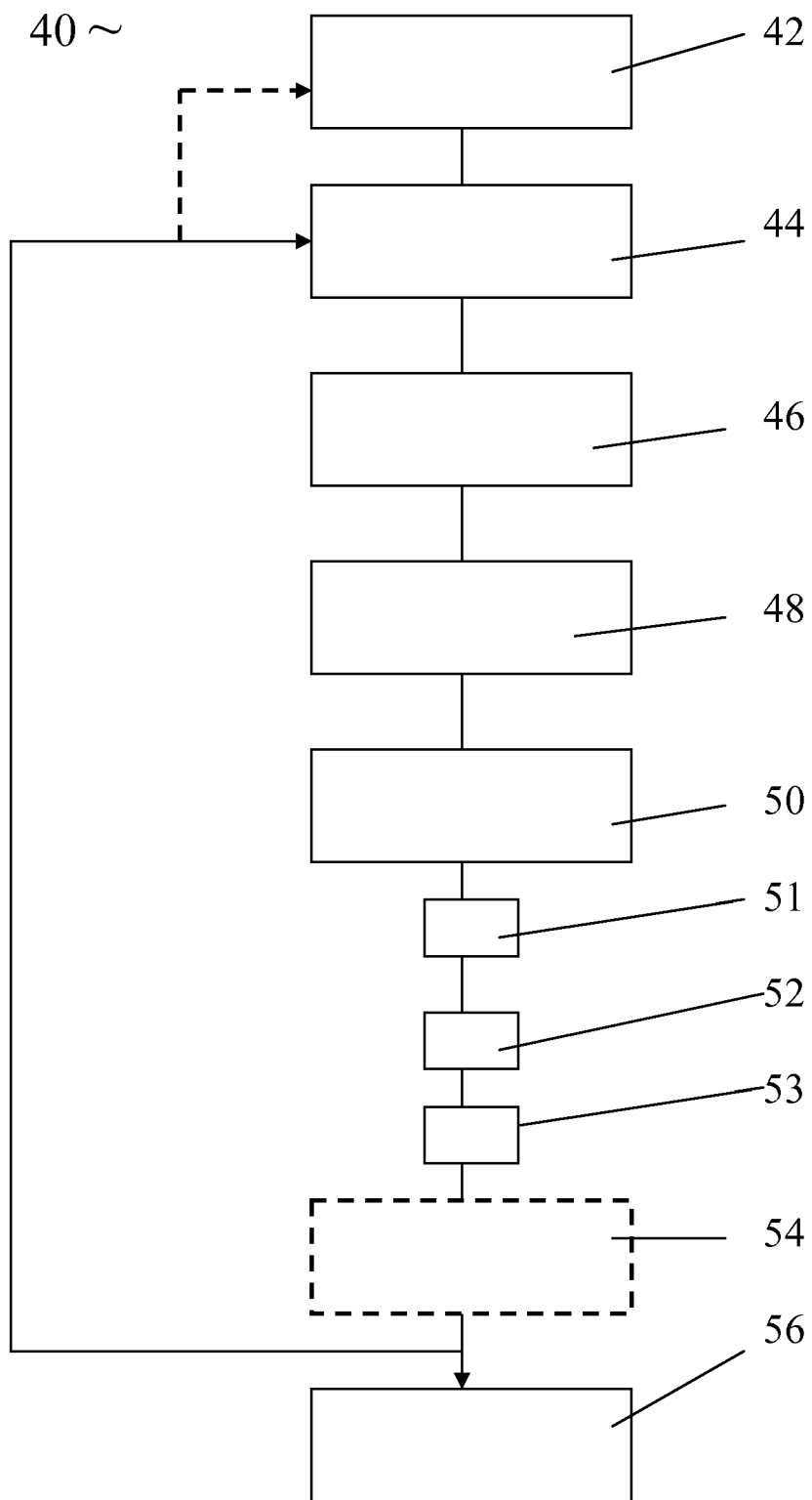


Figure 2

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/052728

A. CLASSIFICATION OF SUBJECT MATTER

INV. H05K13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 213 951 A (MATSUSHITA ELECTRIC IND CO LTD [JP]) 12 June 2002 (2002-06-12)	3-15, 18-22
Y	column 1, paragraph 1 - column 4, paragraph 12; figures 6-8	1,2,16, 17
Y	JP 2007 184497 A (YAMAHA MOTOR CO LTD) 19 July 2007 (2007-07-19) paragraph [0021]; figures 1,2	1,2,16, 17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

14 November 2008

Date of mailing of the international search report

14/01/2009

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/052728

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