

Description

Method and device for supporting substrates in
automatic insertion machines, base plate and support
5 rod

The invention relates to a method of supporting
substrates in automatic insertion machines, a device
for supporting substrates in automatic insertion
10 machines according to the preamble of patent claim 4, a
base plate according to the preamble of claim 8 and a
support rod according to the preamble of claim 9.

When substrates (in particular printed circuit boards)
15 are being fitted with surface-mountable components (SMD
components), automatic insertion machines remove the
SMD components from feed units and place them in a
predefined position on substrates. In the process, the
substrate generally rests firmly clamped on two sides
20 in a transport belt within the automatic insertion
machine. The substrates, in particular the printed
circuit boards, are in practice never ideally flat, but
are either curved downward or upward by up to about
3 mm. Very large and particularly thin printed circuit
25 boards mostly only sag downward, because of their
inherent weight. Since the components are pressed onto
the substrate with a certain placement force, in order
there to remain sticking to an adhesive medium (for
example solder paste, adhesive or flux), the suction
30 pipette presses the substrate downward and, in the
process, bends it downward. Depending on the desired
placement force and stiffness of the substrate, this
sagging may lie in the region of millimeters. As a
result of the ever increasing machine throughputs, in
35 addition the placement speed of the suction pipette is
so high that the substrate is excited, as if by a
hammer blow, into vertical oscillations. These
oscillations, on the one hand, are damaging to the
component which has just been inserted by the

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suction pipette, since, as a result of the substrate
springing back upward, additional shocks

are produced on the component, which cannot be controlled and can destroy sensitive components.

On the other hand, the effects on the placement accuracy in the case of relatively large components with a fine grid of connecting pins are not beneficial. As the substrate springs downward, the component is torn off the pipette if the adhesive force of the adhesive medium on the board is greater than the suction force of the pipette or, in the other case, it is torn up off the adhesive medium again if the pipette suction force exceeds the adhesive force. This is the case in particular with components which are placed in less adhesive media (for example thin flux). If components slip sideways in this way, in the worst case the substrate can become unusable or fail later in operation.

In addition, there is the risk that components which are already seated on the substrate will slip or loosen as a result of the shaking during insertion. This applies again to components on less adhesive media or in the case of particularly narrow, high or heavy components with little adhesive surface.

Hitherto, therefore, fixed substrate supports have been used in automatic insertion machines. In this case, a plurality of support rods of equal length are generally arranged projecting vertically upward on a base plate. Before the insertion operation, these rods move up to the printed circuit board from below, in order to support it. However, this support functions only when the rods bear directly on the printed circuit board. The support rods therefore have to be moved upward with an exactly reproducible and adjustable drive to such an extent that they just touch the substrate. As a result of the addition of the total tolerances of the substrate support height of the lifting drive

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and the evenness of the base plate over the entire area, this is never exactly possible in practice, however.

In order to support a specific substrate, the support rods have to be positioned at those points at which the substrate is free. No components may be inserted there, since the support rods would otherwise strike these and can damage them. If this takes place at the edge in the vicinity of the clamping, the substrate is overpressed upward violently by the component height and may likewise be damaged.

10 The use of fixed substrate supports is therefore a great complication for the user, which requires trained and particularly knowledgeable operating personnel. This is all the more complicated when, for example, three to ten different substrate types are to be
15 produced per day, the arrangement of the supports having to be changed precisely as often in each automatic insertion machine in a line.

JP 9-181496 and JP 4-293300 disclose substrate support
20 with variable-height support rods, in which the individual support rods are located in sprung fashion in depressions in a base plate, and their vertical position is ensured jointly for all support rods by the use of two plates which are provided with holes for the
25 support rods and are arranged such that they can be displaced relative to each other. On account of the depressions in the base plate, in this case only specific arrangements of the support rods can be implemented.

30 JP 2-190000 discloses a substrate support in which the support rods are connected to the base plate by means of magnetic coupling. Vertical adjustment of the support rods is not disclosed.

35 JP 6-209105 discloses support rods for a substrate support which are individually vertically adjustable. In this case, it is not disclosed how the fixing of the

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individual support rods is implemented.

It is therefore the object of the invention to specify a method and a device for supporting substrates in automatic insertion machines which, with more flexible handling, are particularly suitable for curved
5 substrates.

According to the invention, the object is achieved by a method having the features of claim 1 and by a device of the type mentioned at the beginning having the
10 characterizing features of claim 4, by a base plate having the characterizing features of claim 8 and by a support rod having the characterizing features of claim 9.

15 In this case, the support rods are fitted to a base plate. As opposed to the fixed support rods, their tip is sprung. In operation, the lifting table with the base plate and the support rods moves a few millimeters further up than is necessary in order to make contact
20 with the substrate underside. As a result, the rods spring inward individually by a corresponding excess travel, and each individual support rod bears with a low spring force on the substrate underside. The rods, which in this case are placed on a component, in each
25 case spring further in by the component thickness. In the next step, the individually reached vertical position of the support rods is fixed with the aid of a pneumatic brake assigned individually to the respective support rods. Each individual support rod then remains
30 firmly at its own height, so that the substrate is no longer bent and excited into oscillation by the automatic insertion machine when placing the components. As a result of the individual equipment of the support rods with the pneumatic brakes, a flexible
35 arrangement of the support rods on the base plate is also made possible.

By means of the solution according to the invention,

the problems of uncontrolled placement forces as a result of the printed circuit board springing back, the poor placement accuracy as a result of the component being torn off the suction pipette or off the adhesive

medium, and the slipping of components already placed on the printed circuit board are avoided. The solution according to the invention also acts under unfavorable conditions, for example when the substrate is curved
5 arbitrarily upward or downward, when components are already inserted at the point at which the individual support rod bears on the substrate, when the production accuracy of the support or the positioning accuracy of the lifting drive is poor, or when the operator
10 arranges the support rods at unsuitable points. The support rods do not have to be positioned at different points at each product change.

In the advantageous refinement as claimed in patent
15 claim 2, the fixing is canceled again at the end of the insertion operation, in order that the support rods can spring out to their full length again as the table moves downward.

20 According to claim 5, a plurality of support rods fixed to the base plate can advantageously be fixed jointly, since the base plate has compressed-air lines for the compressed-air supply to the respective pneumatic
brakes.

25 In an advantageous refinement according to claim 6, the support rods can be positioned freely on the base plate, as a result of which the position of the support rods is matched optimally to the substrate conditions.

30 According to claim 11, it is advantageously proposed that the upper side of the tip of the support rod, coming into contact with the substrate, is produced from rubber, in order not to damage components possibly
35 already inserted on the underside of the substrate. Simple production of a stable support rod is ensured, according to claim 12, by the foot part and the tip of the support rod being of tubular design.

The invention will be explained in more detail using the exemplary embodiment shown in the drawing, in which:

figure 1 shows a schematic side view of a curved
5 substrate, which is supported by a row of support rods,
figure 2 shows a cross section through a support rod according to the invention in the case of positioning in a fixed pattern on a base plate, and
figure 3 shows a cross section through a support rod
10 according to the invention in the case of free positioning on the base plate.

Figure 1 shows a schematic side view of a substrate 1 which is curved upward and which is held at the
15 substrate edges 2 by lateral fixing devices 3. The transport direction of the substrate 1 in the automatic insertion machine will generally be designed to be perpendicular to the surface of the character. Following the lateral fixing of the substrate 1, a base
20 plate 4, on which a plurality of support rods 5 projecting vertically upward are arranged in a predefined pattern, is moved upward by a lifting table (not illustrated). In this case, the support rods 5 can be vertically individually adjusted, so that the
25 support rods 5 adapt to the contour of the underside of the substrate 1. As a result of the individual vertical adjustment of the support rods 5, in this case components 19 already inserted on the underside of the substrate can be taken into account, as is illustrated
30 by way of example on the second support rod from the right.

Figure 2 shows, in cross section, the functioning of a support rod 5 together with a base plate 4. Here, the
35 support rod 5 comprises a tip 6 and a foot part 7, which can easily be displaced in relation to each other. In this case, the tip 6 is of tubular design and encloses the foot part 7. Provided on the top of the

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tip 6 is a rubber plug 8, in order that when the

support rod 5 makes contact with the substrate 1, no damage occurs to components 19 already inserted on the underside of the substrate 1. The foot part 7 is fixed to the base plate 4 by fastening means 9. The fastening means 9 provided in this case can be, for example, a screw connection or another known possible fastening. The tip 6 is coupled to the foot part 7 via a spring 10, as a result of which the height of the tip 6 is adjustable. As a result of the base plate 4 and therefore the support rod 5 moving upward, the spring 10 is compressed after the tip 6 makes contact with the substrate 1. Once the base plate 4 has been moved up to the extent envisaged by the operator, all the springs 10 of the support rods 5 should be in an individual compressed state. In this position, the vertical position of the tip 6 with respect to the base plate 4 is fixed. For this purpose, a pneumatic brake 11 in the form of an air pad is illustrated in figure 2, being operated by compressed air. For this purpose, a compressed-air line 12 is provided in the foot part 7 and a compressed-air line 13 is provided in the base plate 4, being connected to each other. A compressed-air reservoir 14, not specifically illustrated, supplies the compressed-air lines with compressed air. As a result of the compressed air being switched on, the pneumatic brake 11 is forced outward and locks the position of the tip 6 with respect to the foot part 7. At the same time, the compressed-air line 12 in the foot part 7 is closed by a closure 16. A stop 17 and an associated cutout 18 in the foot part 7 restrict the mobility of the tip 6 with respect to the foot part 7. By means of a plug 15, unused holes in the base plate 4 are closed. During the subsequent insertion operation, the compressed air remains connected, as a result of which all the support rods 5 maintain their vertical position. As a result, the uncontrolled placement forces as a result of the substrate springing back are prevented, and the poor placement accuracy as a result

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of the component being torn off the suction pipette is

avoided. Likewise, the slipping of components already placed on the substrate is reduced.

5 A further exemplary embodiment of the support rods 5 is
illustrated in figure 3. By means of a magnetic foot
20, the support rods 5 are fixed to the base plate 4
made of magnetic material. As a result, the support
rods 5 can be positioned freely on the base plate 4,
which achieves optimal adaptation to the form of the
10 substrate 1. The compressed air is fed from a central
compressed-air supply 23 via a compressed-air
connection 21 on the support rod 5 and a flexible hose
22.

15 After the insertion operation, the compressed air is
switched off, so that the support rods 5 change back
into the sprung-out state again as the lifting table 4
moves back. Subsequently, the substrate 1 is also no
longer fixed laterally and can be transported onward.

Patent claims

1. A method for supporting substrates (1) in automatic insertion machines, in which
- 5 - the substrate (1) is fixed in an insertion position,
- a base plate (4) with support rods (5) projecting upward is provided, the tip (6) of the support rod (5) being spring-mounted with respect to the base plate (4),
- 10 - the base plate (4) with the support rods (5) is pressed against the underside of the substrate (1) from below in a sprung manner,
- the vertical position of the tips (6) of the support rods (5) is fixed with the aid of in each case a pneumatic brake (11) individually assigned to one of the support rods.
- 15
2. The method for supporting substrates (1) in automatic insertion machines as claimed in claim 1, characterized in that following the insertion operation, the fixing of the vertical positions of the tips (6) of the support rods (5) is canceled,
- 20 in that the base plate (4) is moved downward, in that the fixing of the substrate (1) is released.
- 25
3. The method for supporting substrates (1) in automatic insertion machines as claimed in either of claims 1 and 2, characterized in that the support rods (5) are arranged in a fixed pattern on the base plate (4).
- 30
- 35 4. A device for supporting substrates in automatic insertion machines having a base plate (4), having support rods (5) arranged on the base plate

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(4), characterized in that the tip (6) of the support rods (5) is spring-mounted with respect to the base plate (4) and



in that the support rods in each case have a pneumatic brake (11) for fixing the position of the respective tip (6) of the individual support rods (5) with respect to the base plate (4).

5

5. The device for supporting substrates (1) in automatic insertion machines as claimed in claim 4, characterized in that the base plate (4) has compressed-air lines (13) for the compressed-air supply to the pneumatic brake (11).

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6. The device for supporting substrates (1) in automatic insertion machines as claimed in either of claims 4 and 5, characterized in that the support rods (5) are arranged in a fixed pattern.

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7. The device for supporting substrates (1) in automatic fitting machines as claimed in claim 4, characterized in that the support rods (5) are fixed magnetically on the base plate (4) and in that the support rods have a compressed-air connection (21), which is connected to a central compressed-air supply (23) via a hose (22).

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8. A base plate (4) for fixing support rods (5) in a predefined pattern, characterized in that the base plate (4) has compressed-air lines (13), via which support rods (5) to be arranged on the base plate (4) are supplied with compressed air.

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30

9. A support rod (5) for supporting substrates (1) in automatic insertion machines, characterized in that a vertically adjustable tip (6) of the support rod (5) is longitudinally displaceably mounted in a foot part (8) of the support rod (5).

35



and in that the tip (6) can be fixed by means of a switchable clamping device (11) belonging to the foot part (8).

5 10. The support rod (5) for supporting substrates (1)
in automatic insertion machines as claimed in
claim 9, characterized in that the clamping device
(11) is designed as a pneumatic brake (11) and is
10 connected to a switchable compressed-air source
(14).

11. The support rod (5) for supporting substrates (1)
in automatic insertion machines as claimed in
either of claims 9 and 10, characterized in that
15 the upper side of the tip (6), coming into contact
with the substrate (1), is formed of rubber (7).

12. The support rod (5) for supporting substrates (1)
in automatic insertion machines as claimed in one
20 of claims 9 to 11, characterized in that the foot
part (8) is of tubular design,
in that the tip (6) is of tubular design and
laterally encloses the foot part (8).

