

The invention relates to an apparatus in accordance with the preamble of claim 1.

5 It is known to mount components automatically on printed circuit boards by means of gripping members, whereby the gripping members pick up the components under computer control from a pick-up position, move over the circuit board and set the component down at the mounting position on the circuit board. This technique is
10 relatively complicated and also expensive, particularly when components of different sizes and shapes have to be handled by the same gripping members. Such automatic mounting apparatuses are also little suited for mounting so-called SMD (small mounted device) components, for
15 functional reasons, since reliable gripping of the small components is very difficult.

It is also known to use mounting tables, the circuit board to be mounted being arranged over the table top and the components being transported by a manually displaceable mounting head with a mounting tool between a magazine and the respective mounting point on the circuit board. Particularly when SMD components are to be set down on the circuit board a suction grip or a suction needle that is
20 displaceable in the plane of the circuit board and also transverse thereto is used to transport the components between the magazine, for example a gripping dish, and the mounting point on the circuit board. This makes it possible to remove a component from the gripping dish with the suction needle, move it to the mounting point and set it down there. The mounting head carrying the suction
25 needle is freely displaceable by hand in two horizontal guides and a vertical guide, so that every point on the circuit board can be reached. Such an arrangement is described and illustrated in German Utility Model 88 00
30 058.

To facilitate finding the correct mounting point it is already known, in the case of other known mounting tables, to indicate the correct mounting point optically, e.g. by
40 means of a beam of light produced by an optical pointer system which forms a spot of light on the circuit board. The optical pointer system can be controlled by an electronic control circuit so that in the mounting
45 procedure successive mounting points are automatically indicated.

Thus in the case of manual mounting the operator has to meet two requirements, namely first the localisation of the mounting point on the circuit board and second the
50 centering of the component at the mounting point. This demands a high level of attention from the operator, resulting in substantial working stress for the operator. Even when close attention is paid there is always the danger of incorrect mounting, particularly when mounting
55 SMD components, with which the mounting points lie close

together as a consequence of the compact design.

5 An apparatus of the above-mentioned type is described
in FR-A-2 519 833. With this known apparatus there is
provided a positioning device associated with the second
carrier for the component, which device makes it possible
to position the second carrier exactly over the desired
10 mounting point on the circuit board. In this known
configuration, the positioning device has many positioning
parts which are fixedly located in a pattern corresponding
to the desired mounting points. The second carrier for the
component is connected with a positioning element that can
be brought into operative connection with a desired one of
15 the positioning parts present, whereby the second carrier
is automatically moved therewith to the desired mounting
point because of its connection with the positioning
element. With this known configuration, the mounting
points which can be reached are restricted to the positions
of the positioning parts present.

20 It is an object of the invention to design an
apparatus of the above-indicated type so that selected
mounting points on the circuit board can easily be found.

25 This object is achieved by the features of claim 1.

In the arrangement according to the invention the
second carrier for the component to be mounted has
associated with it two positioning members, one of them,
30 namely the positioning element, forming part of the carrier
or being held by it and the other, namely the positioning
part, being displaceable relative to the second carrier and
to the circuit board and parallel to the plane of the
circuit board, and being displaceable and fixable in each
35 case such that the positioning part is in the or is in a
specific relationship to the mounting point. It is thus
only necessary to bring the positioning element of the
second carrier into operative contact with the positioning
part, whereby the second carrier reaches the mounting point
40 at which the component can be set down on the circuit
board. Hence with the arrangement according to the
invention not only can the mounting point be reliably and
easily found but also, as a result of the operative
connection between the positioning members, the second
45 carrier for the component is centered at the positioning
point, so that accidental displacement of the second
carrier, and thus mounting errors, are avoided.

50 Further advantageous developments of the invention,
which are advantageous by reason of simple and economically
manufacturable construction, functional reliability and
user-friendliness, are described in the sub-claims.

55 The arrangement according to claim 18, which relates
to an advantageous means of centering a component that has
been picked up by the second carrier relative to the

component, deserves particular emphasis. By this means the component can, at an intermediate station, be centered in a simple manner relative to the second carrier, whereby the mounting can be performed more simply, clearly and precisely. A centering of the component relative to its carrier is also of advantage if the respective mounting point is indicated by a separate pointer, e.g. by means of a spot of light as described above.

The invention will now be explained in more detail with reference to preferred exemplary embodiments illustrated in the accompanying drawings, in which:

Fig. 1 shows an apparatus according to the invention for mounting and/or soldering or cementing electronic components, in particular SMD components, on printed circuit boards, in a perspective view from the front;

Fig. 2 shows a positioning device for the carrier for the components, in plan view;

Fig. 3 shows a modified positioning device; and

Fig. 4 shows the section IV-IV in Fig. 3.

The main parts of the apparatus, indicated generally by 1 and having the form of a manipulator, are a support frame 3 for printed circuit boards 4, which is arranged at the front relative to the operator side 5 of the apparatus 1, a bridge-shaped guide part 6 offset towards the rear relative to the support frame 3 and extending parallel to the operator side 5 and having on the underside of its horizontal cross-beam 7 an arm 8 mounted to be displaceable substantially at right angles to the operator side 5 and parallel to the operator side 5, in a cross guide indicated diagrammatically in Fig. 2 and in the form of a sliding or roller guide 9, 11, a so-called mounting head 12 which is arranged on the end of the arm 8 pointing to the operator side 5 and having a handle 13 which the operator grips in order to displace the arm 8 as desired parallel to the plane of the circuit board 4, and a magazine 14 for electronic components, which in the present exemplary embodiment is round, which is arranged below the guide part 6 and is preferably rotatably mounted.

On the front of the cross-beam 7 the control elements determining the functioning of the device are arranged.

The mounting head 12, guided to be vertically displaceable (double arrow) on the arm 8, carries a downwardly projecting mounting or holding tool, indicated generally by 16, having a suction needle 17 and having a suction tip 18 arranged at its lower end that can be pushed inwards into the suction needle 17 or the mounting head 12 when it meets an obstacle. Pushing it in actuates a proximity switch 19 situated in the mounting head 12 and indicated only diagrammatically, which normally serves to

connect or disconnect a vacuum source (not shown) to or from the suction tip 18.

5 The support frame 3 consists of the two supporting
ribs 21, 22 extending transverse to the operator side 5, of
which the left-hand rib 21 is fixed and the right-hand rib
22 can be displaced with a guide piece on a guide rail
extending parallel to the operator side 5 and can be fixed
as desired by means of a fixing screw (not shown). The
10 upper edges of the supporting ribs 21, 22 are stepped as
mirror images of one another, so as to form supports for
the circuit board 4 and boundary ribs laterally overlapping
it.

15 The mounting head 12 has associated with it a
positioning device indicated generally by 28, having a
positioning element 29 that is fixed to the mounting head
12 and a positioning part 31 that can be displaced parallel
to the plane of the circuit board 4 and to a positioning
20 location corresponding to the position of the associated
mounting point, and can be fixed in the respective
positioning location. In the present exemplary embodiment
the positioning element 29 of the mounting head 12 is a
guide pin 32 extending from the underside of the head 12
25 parallel to the suction needle 17. The positioning part 31
of the positioning device 28 is formed by a strip 33 having
a vertical hole 34 in the region of its free end that is
large enough for the fitting end of the guide pin 32 to be
introduced into the hole 34 with only a small amount of
30 play. The strip 33 is arranged higher than the circuit
board 4 and the supporting ribs 21, 22 so that it can pass
over the latter, particularly when large circuit boards 4
are present.

35 The strip 33 is fixed to the underside of a slide 36
that can be displaced on a guide rail 37 running parallel
to the operator side 5 and is connected underneath to the
strip 33. The guide rail 37 is fixed near its end (on the
right in the drawing) to a guide carriage 41 that can be
40 displaced horizontally transverse to the operator side 5 on
a further guide rail 42 that extends between a front and a
rear side wall 43, 44 and is fixed to these side walls 43,
44. The side walls 43, 44 can be fixed to a supporting
plate that is also common to the supporting ribs 21 22, so
45 as to form a common mounting structure for the circuit
board 4 and the positioning device 28. The positioning
part 31 can thus be displaced as desired in two directions
A, B (Fig. 2) at right angles to one another, so that it
can be adjusted to any desired point on the circuit board
50 4. Each direction of movement A, B has its own associated
drive with an electric motor 45, 46 that drives the
associated guide slide 36 or carriage 41 by means of a
toothed belt 49, 50 running round guide pulleys 47, 48.
The electric motor 45 driving the guide carriage 41 in
55 direction A is arranged on and fixed to the inner side of
the guide rail 42. The electric motor 46 driving the slide

36 in direction B is fixed to the underside of the guide rail 37. The associated toothed belt drive here runs inside the guide rail 37 which is in the form of a hollow rail and has an elongated rounded cross-section.

5 Each of the electric motors 45, 46 has associated with it a position measuring device (not shown) by which the respective position of the positioning part 31 can be determined relative to a starting position. Such a
10 starting position can be dependent on the circuit board 4 (first moving to a specific point on the circuit board) or on the second carrier 3 (positioning of the circuit board 4 relative to the carrier 3), e.g. by stop edges. In
15 addition electric motors 45, 46 are connected to the electronic control circuit of a computer or calculator (not shown) that controls the movements A, B of the positioning part 31, and in which the starting position for the movements A, B and the particular mounting points on the
20 circuit board 4 are stored. Another possibility is to connect the electric motors 45, 46 to a manual control device or keyboard so that, having regard to the above-mentioned starting position of the movements A, B, it is possible to steer manually to intended mounting points on the circuit board 4. In each case the positioning part 31
25 is displaced to a positioning location corresponding to a mounting point and is held in this location. A simple way of doing this is by making use of braking motors.

30 In this position control account must be taken of the fact that in the present exemplary embodiment the respective positioning location of the positioning part 31 is not above the associated mounting point, but at a distance therefrom that is taken into account in the position control. Since the distance a between the
35 positioning element 29 and the suction needle 17 corresponds to the above-mentioned distance, at each attained positioning location the suction needle 17 is above an associated mounting point. The arrangement of the positioning element 29 and of the positioning part 31
40 laterally displaced relative to the associated mounting point is advantageous, since the suction tip 18 of the suction needle 17 remains clearly visible. Within the scope of the invention it is however also possible to arrange the positioning location of the positioning element
45 29 above the associated mounting point and to use the suction needle 18 or part thereof as the positioning element.

50 For vertical stabilization of the widely projecting end of the guide rail 37 that overlaps the circuit board 4 an additional guide is associated with it on the carrier 3. This guide is formed by a horizontal groove 20 in the outer side of the wall 21 in which a guide piece 30 on an end
55 piece 40 of the guide rail 34 engages like a claw.

To mount a component (not shown) on the circuit board

4 the suction needle is pushed over a particular compartment of the magazine 14 and brought down by pulling down on the handle 13 until the suction tip 18 meets a component and the source of suction is connected by
5 actuation of the switch 19. The mounting head 12 is then raised again and is introduced into the guide hole 34 by first horizontal and then vertical movement of the guide pin 32. In this position the suction tip 17 with the
10 component thereon is above an associated mounting point. On lowering the mounting head 12 further so that the guide pin 32 dips further into the guide hole 34 the component meets the circuit board 4, thus again actuating the switch 19 and disconnecting the suction. The switch 19 is a
15 reversing switch whose function reverses each time it is actuated, so that the suction is alternately connected and disconnected.

It is also possible, depending on the constructional layout, to position the suction needle 18 by means of the
20 positioning device 28 exactly or approximately at the mounting point. The positioning is exact when the guide pin 32 fits quite closely in the guide hole 34 and the drive as a whole is substantially free from play. A
25 substantial amount of play for the suction needle 17 in the region of the associated mounting point results if the associated drive and/or the fit between the guide pin 32 and the guide hole 34 exhibits any marked freedom of movement. In the latter case pre-centering can be
30 performed with which an individual manual post-centering in the region of the mounting point is possible.

In accordance with Figs. 3 and 4, the device 1 also has associated therewith a centering device 51 for
35 centering a component, here denoted by 52, relative to the mounting or holding tool 16 or the suction tip 18. The centering device 51 can advantageously be arranged between the magazine 14 and the circuit board 4 or near the circuit board 4 or the positioning part 31. In the present
40 exemplary embodiment the centering device 51 includes a plate-shaped centering piece 53 having a positioning hole 54 corresponding to the positioning hole 34 and a centering hole 55, arranged at a distance therefrom, of which the cross-section or the wall of the hole converges downwards and whose largest diameter is larger and whose smallest
45 diameter is smaller than the length l of the component or components 52 present. On lowering the component 52 held on the suction tip 17 by the vacuum into the centering hole 55 the relevant end of an eccentrically held component comes into contact with the inclined wall 56 of the hole,
50 so that the component 52 is automatically displaced into the central position. The arrangement is made such that the lower limit of the movement of the mounting head 12 is reached before both ends of the component 52 touch the wall 56 of the hole so that it could jam or actuate the switch 19. Consequently the component 52 can be lifted out of the
55 centering hole 55 again after this centering stroke,

clinging to the suction tip 17, to an intermediate position and further transported to the circuit board 4. In the present exemplary embodiment the centering piece 53, viewed from the operator side 5, is arranged behind the positioning part 31, and is preferably adjustable in height on the structure supporting the positioning device 28 and the circuit board 4, here the wall 22. Preferably the positioning hole 54 is arranged higher than the centering hole 55 in order on the one hand to be able to form a point for the guide pin 32, and on the other hand so that this point is not lower than the suction tip 18.

CLAIMS

1. Apparatus (1) for mounting and/or soldering or cementing electronic components, in particular SMD components, on circuit boards (4),
5 having a first carrier (3) for at least one circuit board (4) and a second carrier (12, 18) for the component (52), the second carrier (12, 18) being displaceable relative to the first carrier (3) parallel to the plane of the circuit
10 board (4) and transverse thereto, having a magazine (14) for the components, the second carrier (12) having associated therewith a positioning device (28) with a positioning part (31) which is located in a position corresponding to the mounting
15 point, and having a positioning element (29) on the second carrier (12) that can be brought into operative connection with the positioning part (31) to position the second carrier (12) with respect to its movement parallel to the plane of the
20 circuit board (4), characterised in that, the positioning part (31) is displaceable parallel to the plane of the circuit board (4) into positions corresponding to one or more associated mounting points, and is fixable
25 in each respective displaced position.

2. Apparatus according to claim 1, characterised in that, the positioning element (29) can be brought into operative
30 connection with the positioning part (31) by a movement transverse to the plane of the circuit board (4).

3. Apparatus according to claim 2, characterised in that, during the operative connection between the positioning
35 element (29) and the positioning part (31) the positioning element (29) can be displaced relative to the positioning part (31) transverse to the plane of the circuit board (4).

4. Apparatus according to any of claims 1 to 3, characterised in that, the positioning element (29) and the positioning part (31)
40 are guide parts that can be brought into operative connection with one another.

5. Apparatus according to claim 4, characterised in that, the positioning element (29) is a guide pin (32) and the
45 positioning part (31) is a guide part (31) having a guide hole (34) adapted to the cross-section of the guide pin (32).
50

6. Apparatus according to claim 5, characterised in that, the guide pin (32) is conically tapered or spherically
55 formed at its free end.



7. Apparatus according to claim 5 or 6, characterised in that, the second carrier (17, 18) is arranged on a vertically displaceable mounting head (12), and in that the guide pin (32) is also arranged on the mounting head (12) and extends parallel to the axis of the second carrier (17, 18).
8. Apparatus according to any of claims 5 to 7, characterised in that, the guide pin (32) is arranged spaced at a horizontal distance (a) from the second carrier (17, 18).
9. Apparatus according to claim 7 or 8, characterised in that, the second carrier (17, 18) is a suction needle.
10. Apparatus according to any of claims 5 to 9, characterised in that, the guide part (31) is displaceable in two directions of movement (A, B) directed at right-angles to one another, preferably parallel to the operator side (5) and transverse thereto.
11. Apparatus according to claim 10, characterised in that, the positioning part (31) is attached to a slide (36), which is slidably guided along a guide rail (37) extending parallel to the operator side.
12. Apparatus according to claim 11, characterised in that, the positioning part (31) is an attachment (33) projecting from the slide (36) preferably towards the rear of the apparatus (1).
13. Apparatus according to claim 11 or 12, characterised in that, the guide rail (37) is held on a guide carriage (41) that is slidably guided transverse to the operator side (5) of the apparatus (1) on a further guide rail (42).
14. Apparatus according to claim 13, characterised in that, the further guide rail (42) is held on the first carrier (3) for the circuit board (4).
15. Apparatus according to claim 14, characterised in that, the further guide rail (42) is fastened to two vertical wall parts (43, 44) that extend parallel to one another and are fastened to a base plate of the first carrier (3).
16. Apparatus according to any of claims 11 to 15, characterised in that, the guide rail (37) extends with one end beyond the circuit board (4) and at this end is horizontally guided in an



additional guide.

17. Apparatus according to any of claims 11 to 16, characterised in that,
5 respective electric motors (45, 46) are associated with the slide (36) and the guide carriage (41) which - preferably by means of a toothed belt drive (47, 48) - drive the slide (36) and the guide carriage (41).

18. Apparatus according to any of claims 1 to 17, characterised in that,
10 the second carrier (17, 18) is formed by a suction needle (18), and
15 in that the apparatus has associated with it a centering device (51) with a converging centering hole (54) in a centering part (53), in that the largest cross-section of the centering hole (55) is larger and the smallest cross-section is smaller than the component (52), and in that the suction needle (18) can be centered in a position
20 concentric with the centering hole (55).

19. Apparatus according to claim 18, characterised in that,
25 a pin-shaped positioning element (29, 32) is arranged on the mounting head (12) carrying the suction needle (18), at a spacing (a) from the suction needle (18), and a positioning hole (54) is present in the centering piece (53) at a spacing (a) from the centering hole (55), the cross-section of the positioning hole being adapted to the
30 cross-section of the positioning element.

20. Apparatus according to claim 18 or 19, characterised in that,
35 the centering hole (55) is arranged higher than the circuit board (4).

21. Apparatus according to any preceding claim, characterised in that,
40 at its free end the positioning element (29, 32) converges conically or is rounded and preferably the positioning hole (54) is arranged higher than the centering hole (55).