SPECIFICATION

Apparatus for mounting a chip-type electronic component on a substrate

The invention relates to an apparatus for mounting a chip-type electronic component on a substrate, comprising a table, a mounting head and means for positioning a substrate on the table.

The increasing emphasis on miniaturization in the electronics industry has resulted in the development of plate-shaped block-shaped and cylinder-shaped chip-type components devoid of connection wires, that is to say, components which do not have the conventional comparatively long radial or axial connection wires.

These components without connection wires comprise contact portions which are provided on opposite faces or sides of the component in the case of a capacitor, resistor or coil, for example, or short connection studs in the case of diodes and transistors. The components are arranged on a substrate provided with printed wiring, a layer of adhesive or tracks of solder paste being provided on the side of the substrate on which the components are to be mounted. The components have dimensions in the order of from 0.5 to several millimetres. In view of the small dimensions of the components and considering the possibly dense pattern of tracks, the components must be accurately positioned with respect to the tracks on the substrate.

U.K. Patent Specification 1,477,087 discloses an apparatus of the above kind in which the components are fed *via* tubes and apertures and are positioned on a slidable plate, situated over the substrate, in a position which corresponds to the desired position of the components on the substrate. Subsequently, the plate is displaced while the components are retained, so that the components ultimately drop onto the substrate. Due to the uncontrolled dropping motion, there is a risk that the components will tilt, rotate and/or land in an incorrect position on the substrate.

According to the invention there is provided an apparatus for mounting a chip-type electronic component on a substrate, comprising a table, a mounting head, and means for positioning a substrate on the table, wherein the mounting head comprises a slide which is displaceable in a guide between a loading position and an unloading position and which comprises a recess for receiving a component to carry the component from the loading position to the unloading position, said mounting head also comprising a suction device which is displaceable in the vertical direction and which is operable to pick up a component from the slide when the latter is in the unloading position, and the guide comprising a passage through a component picked up by the suction device can be moved downwards by this device onto the substrate positioned beneath the guide.

The slide transports the component linearly and at a comparatively high speed, and in the unloading position of the slide the component is situated in the desired X—Y position over the positioned substrate, just beneath the suction device. The component is then picked up and held by the suction device, after which the slide is returned to the loading position and the suction device is displaced downwards through the passage in the slide with the component to deposit the component on the substrate. After removal of the vacuum, the suction device is returned to the starting position. As a result of the controlled displacement of the component in only two directions the component is accurately positioned on the substrate.

Components may be fed to the recess in the slide by hand or, for example, by mechanical pick-up means or by a suction device from a vibrating feeder or from a tape-like carrier, a cartridge or a magazine, and are transported one at a time by the slide to the unloading position. However, the apparatus offers special advantages in combination with a strip-shaped or tape-shaped carrier having openings in which the components are located. In one embodiment of the invention the mounting head comprises a punch which is situated at the area of the recess in the slide when the slide is in the loading position, the apparatus further comprising means for transporting the guiding between the punch and the guide a strip-shaped or tape-shaped carrier carrying a succession of said components.

Due to the simple transfer of a component from the carrier to the slide by means of the punch, a comparatively high mounting frequency is obtained. This is important for the successive mounting of a large number of components on one and the same substrate.

In view of their shape, chip-type electronic components are particularly suitable for stacking in elongate magazines. Components which are supplied in stacked form in a magazine can be handled simply and efficiently by an embodiment of the invention wherein the mounting head comprises a holder for a magazine containing a stack of said components, the holder being arranged to support the magazine at the area of the recess in the slide when the slide is in the loading position so that the components can be transferred one component at a time from the stack to the recess in the slide.

The suction device preferably comprises a suction tube which is displaceable axially in the vertical direction to pick up a component from the slide and move this component down onto the substrate, and which is also rotatable about its longitudinal axis so that the component can be positioned on the substrate not only in the X—Y directions but also with any desired orientation about an axis perpendicular to the substrate.

Embodiments of the invention will now be described in detail with reference to the accompanying diagrammatic drawings, in which

Figures 1 and 2 are perspective views of one embodiment of the apparatus in accordance with the invention showing in the slide in the loading and unloading positions respectively,

Figures 3 and 4 are sectional views taken along the lines III—III in Figure 1 and IV—IV in Figure 2 respectively,

Figure 5 is a perspective view of a further embodiment of the apparatus according to the invention,

Figure 6 is a sectional view taken along the line VI—VI in Figure 5,

Figure 7 is a perspective view of a magazine containing a stack of components, for use on the apparatus shown in Figures 1 to 4, and

Figure 8 is a sectional view taken along the line VIII—VIII in Figure 7.

Corresponding elements are denoted by the same reference numerals in the drawings.

The Figures 1 to 4 show an apparatus 1 for mounting a plate-shaped, block-shaped or cylinder-shaped chip-type electronic component A comprising contact faces F and devoid of connection wires on a substrate S which is provided with printed wiring. The apparatus comprising a table 3, pins 5 for positioning the substrate S on the table 3, and a mounting head 7. By way of a side wall 9, the mounting head 7 is supported on the table 3 in a manner such as to be adjustable in orthogonal horizontal X—Y directions. The mounting head 7 comprises a slide 11 which is slidable in a channel 13 in a horizontal beam 15, the channel serving as a guide for the slide 11. The cross-sectional profile of the channel 13 is shown in the Figures 3 and 4. The slide 11 is displaceable between two extreme positions, namely, a loading position, shown in Figure 1, and an unloading position, shown in Figure 2. The slide 11 is arranged to carry a component A from the loading position to the unloading position and comprises a recess 23 which receives and forms a seat for the component A and which has a bottom wall forming a horizontal surface 22 for supporting the component A and a rear wall forming a vertical abutment face 24. At the area of the recess 23 when the slide 11 is in the unloading position the beam 15 is formed with a vertical passage 25 which communicates with the channel 13. The transverse dimensions of the passage 25 are slightly larger than and are dependent on those of the component A. Directly above the passage 25, the mounting head 7 comprises a suction tube 27 which is displaceable in the vertical direction. The slide 11 and the suction tube 27 are displaced by means of pneumatic cylinders 29 and 31, respectively. The extreme positions of the slide 11 and the suction tube 27 are determined by the extreme positions of the pistons in the cylinders 29 and 31.

The operation of the apparatus shown in Figures 1 to 4 is as follows: a substrate S is positioned on the table 3 by means of the pins 5. The slide 11 is in the loading position shown in Figure 1. By means which will be described later herein a component A is deposited in the recess 23 in the slide 11. Subsequently, the slide 11 is slide forward to the unloading position shown in Figure 2, to bring the component A into the vertical passage 25. In this position the slide 11 closes the passage 25. The suction tube 27 is then in the position shown in Figure 2, with its tip situated in an aperture 28 in the beam 15 above the component A, so that the latter is picked up and slightly lifted by the tube. The slide 11 is subsequently returned to the loading position. As soon as the slide 11 has been withdrawn from the passage 25 the suction tube 27 is displaced downwards, together with the component A, through the passage 25 in the direction of the substrate S, until the component A contacts a layer of glue adhesive or a track of solder paste previously deposited on the substrate, on which layer or track the component is lightly pressed by the suction tube. Subsequently, the vacuum is removed from the suction tube and the tube is returned upwards to its starting position.

As is shown in Figues 1 and 2, the suction tube 27 is connected to a cylindrical rod 33. This rod is formed with a helical groove 35 which extends around the cylindrical surface of the rod through an angle of 90° and which can engage a pin 37 mounted on a lever 39. By means of the lever 39 the pin 37 can be engaged in or disengaged from the groove 35. When the pin 37 is engaged in the groove 35, the suction tube 27 also performs a rotary movement around its longitudinal axis H through an angle of 90° during its vertical displacement, so that, if desired, the component A can be rotated through an angle of 90° as it is moved down onto the substrate S by the suction tube. When the pin 37 is not engaged in the groove 35, the suction tube is not rotated.

The apparatus shown in the Figures 5 and 6 is similar to that shown in Figures 1 to 4 but has a mounting head 51 with means for supplying components A in succession to the recess 23 in the slide 11, which means include a punch 53 which is displaceable in the vertical direction and which is arranged above the beam 15 at the area of the recess 23 in the slide 11 when the latter is in the loading position. The punch 53 is slidably supported in a bridge 55 which extends over the beam and which comprises a slot 57 for guiding the slide 11 and also guide ribs 59 for guiding and partially supporting a component A in the loading position. The components A are accommodated in openings C in a tape-shaped carrier B. The carrier B is moved in a stepwise manner in the direction of the arrow D by means of a transport roller 53 which comprises radially projecting pins 65 co-operating with perforations P in the carrier B. The transport of the carrier B is so controlled that when the carrier B is stationary, a component A in the carrier B is situated directly beneath the punch 53. The punch 53 is then displaced downwards to transfer the component A from the respective opening C in the carrier B to the recess 23 in the slide 11. Subsequently, the slide 11, carrying the component A, is slide forward to the unloading position. The mounting of the component A on the substrate S is then completed by the suction tube 27 in the manner previously described. When the punch 53 has been raised, the carrier B is advanced by one step, after which another cycle

can take place.

Figures 7 and 8 show a further embodiment of the means for supplying components in succession to the recess 23 in the slide 11. In this embodiment the components A are dispensed from a magazine 73 in which they are stacked one on top of another. The mounting head, designated 71, comprises a magazine holder on the beam 15, which holder is shown in Figures 1 and 2 and comprises a chamber 77 for receiving the magazine 73. The magazine is inserted in the chamber 77 so that the stack of components A is situated directly above the recess 23 in the slide 11 when the latter is in the loading position. The portion of the slide on which the component-supporting surface 22 is formed is then situated in a recess 79 in the magazine 73, so that the lowermost component in the magazine bears on the supporting surface 22. This situation is shown in Figures 7 and 8.

For removing the lower most component A from the magazine 73, the slide 11 is displaced from the loading position shown in Figure 7, to the unloading position, so that the lowermost component A is taken along to the unloading position by the vertical abutment face 24 of the slide 11. The mounting of the component A on the substrate S is then completed by the suction 27 in the previously described manner. The slide 11 has a length such that the next component A at the bottom of the stack is locked against displacement by the slide during the forward and return movements of the slide, because this component is supported by the upper side of the slide.

The reference numeral 41 denotes a spring which permits a displacement of the suction tube 27 relative to the piston in the cylinder 31 when the force with which a component A is pressed against the substrate S by the tube 27 becomes too high thus avoiding damage to the components.

The above embodiments of the apparatus in accordance with the invention are intended for the successive mounting of a series of components on each of a succession of substrates. After the mounting of a first component in a given position on the first substrate in the described manner by a first mounting head (7, 51 or 71), this substrate is positioned beneath a second mounting head for the mounting of a second component in another given position on this substrate, whilst the second substrate is positioned beneath the first mounting head to receive a first component. Each of the succession of substrates is thus moved through a series of positions on the table 3, at each of which positions a component is mounted on the respective substrate by one of a series of mounting heads arranged on the table 3.

CLAIMS

1. An apparatus for mounting a chip-type electronic component on a substrate, comprising a table, a mounting head, and means for positioning a substrate on the table, wherein the mounting head comprises a slide which is displaceable in a guide between a loading position and an unloading position and which comprises a recess for receiving a component to carry the component from the loading position to the unloading position, said mounting head also comprising a suction device which is displaceable in the vertical direction and which is operable to pick up a component from the slide when the latter is in the unloading position, and the guide comprising a passage through which a component picked-up by the suction device can be moved downwards by this device onto the substrate positioned beneath the guide.

2. An apparatus as claimed in Claim 1, wherein the mounting head comprises a punch which is situated at the area of the recess in the slide when the slide is in the loading position, the apparatus further comprising means for transporting and guiding between the punch and the guide a strip-shaped or tape-shaped carrier carrying a succession of said components.

3. An apparatus as claimed in Claim 1, wherein the mounting head comprises a holder for a magazine containing a stack of said components, the holder being arranged to support the magazine in the area of the recess in the slide when the slide is in the loading position so that the components can be transferred one at a time from the stack to the recess in the slide.

4. An apparatus as claimed in Claim 1, 2 or 3, wherein the suction device comprises a suction tube which is displaceable axially in the vertical direction to pick up a component from the slide and move this component down onto the substrate, and which is also rotatable about its longitudinal axis.

5. An apparatus for mounting a chip-type electronic component on a substrate, the apparatus being constructed and arranged to operate substantially as herein described with reference to Figures 1, 2, 3, 4, 7 and 8 or Figures 5 and 6 of the accompanying drawings.

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can take place.

Figures 7 and 8 show a further embodiment of the means for supplying components in succession to the recess 23 in the slide 11. In this embodiment the components A are dispensed from a magazine 73 in which they are stacked one on top of another. The mounting head, designated 71, comprises a magazine holder on the beam 15, which holder is shown in Figures 1 and 2 and comprises a chamber 77 for receiving the magazine 73. The magazine is inserted in the chamber 77 so that the stack of components A is situated directly above the recess 23 in the slide 11 when the latter is in the loading position. The portion of the slide on which the component-supporting surface 22 is formed is then situated in a recess 79 in the magazine 73, so that the lowermost component in the magazine bears on the supporting surface 22. This situation is shown in Figures 7 and 8.

For removing the lower most component A from the magazine 73, the slide 11 is displaced from the loading position shown in Figure 7, to the unloading position, so that the lowermost component A is taken along to the unloading position by the vertical abutment face 24 of the slide 11. The mounting of the component A on the substrate S is then completed by the suction 27 in the previously described manner. The slide 11 has a length such that the next component A at the bottom of the stack is locked against displacement by the slide during the forward and return movements of the slide, because this component is supported by the upper side of the slide.

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4. An apparatus as claimed in Claim 1, 2 or 3, wherein the suction device comprises a suction tube which is displaceable axially in the vertical direction to pick up a component from the slide and move this component down onto the substrate, and which is also rotatable about its longitudinal axis.

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