

substrate 36, and heats the chip component set 34 from the upper side. Thereby, the NCF provided on the lower surface of each of the chip components 30a, 30b, and 30c constituting the chip component set 34 is hardened to bond each of the chip components 30a, 30b, and 30c to the substrate 36, and the bump 32 provided on each of the chip components 30a, 30b, and 30c and the pad 38 formed on the substrate 36 are bonded.

**[0022]** The position detection camera 49 is used when the chip component set 34 is secured to the substrate 36, and captures an image of each pad 38 (see FIG. 8) formed on the substrate 36.

**[0023]** The control device 90 (see FIG. 2) controls the conveyance head 14, the temporary placement stage 12, the mounting stage 16, the mounting head 18, the driving device 22 of the conveyance head 14, the driving device 48 of the mounting head 18, the valves 21, 42, 52, and 62, the position detection cameras 24 and 49, the cooling device 44, the heaters 54 and 64, and the suction pump 70. The control device 90 includes a processor such as a CPU, and controls each device by executing a control program stored in a storage part 92 in advance.

**[0024]** As shown in FIG. 1, the conveyance head 14 is arranged to be movable between the tray or the like (not shown) in which the chip components 30a, 30b, and 30c are stored and the temporary placement stage 12. In addition, the mounting head 18 is arranged to be movable between the temporary placement stage 12 and the mounting stage 16.

**[0025]** Next, an outline of an operation of the semiconductor mounting device 10 of the present embodiment will be described. The following operation is executed by a command of the control device 90. The control device 90 opens the valve 21 of the conveyance head 14, suctions the chip component 30a to the conveyance head 14, and conveys the chip component 30a onto the temporary placement stage 12 by the driving device 22 (see FIG. 1). Then, as shown in FIG. 3, the control device 90 closes the valve 21 of the conveyance head 14, and opens the valve 42 of the temporary placement stage 12 to load the chip component 30a on the upper surface of the porous member 40 of the temporary placement stage 12. The chip component 30a loaded on the upper surface of the porous member 40 is vacuum-suctioned onto the porous

when the chip components 30a, 30b, and 30c are secured to the substrate 36.

**[0028]** As shown in FIG. 8, the control device 90 moves the mounting head 18 to a position above the mounting stage 16 with the driving device 48. Then, the control device 90 turns on the heater 54 of the mounting head 18 to heat the chip components 30a, 30b, and 30c, and lowers the mounting head 18 to a predetermined position on the substrate 36 on the mounting stage 16 while checking the position of the pad 38 on the substrate 36 with the position detection camera 49. At this time, the control device 90 turns on the heater 64 of the mounting stage 16 to heat the mounting stage 16.

**[0029]** As shown in FIG. 9, the control device 90 applies pressure  $F_p$  and heats the chip components 30a, 30b, and 30c suctioned to the mounting head 18 simultaneously at the predetermined position on the substrate 36 to secure the chip components 30a, 30b, and 30c to the substrate 36. Specifically, the NCF 33 attached to the lower surface of each of the chip components 30a, 30b, and 30c is hardened to bond each of the chip components 30a, 30b, and 30c to the substrate 36, and the bump 32 provided on each of the chip components 30a, 30b, and 30c is bonded to the pad 38 formed on the substrate 36. The control device 90 mounts a plurality of chip component sets 34 on the substrate 36 by repeating the above-described operation.

**[0030]** Since the semiconductor mounting device 10 of the present embodiment has one stage for holding the substrate 36 and one head for mounting the chip components on the substrate 36, the semiconductor mounting device 10 has the features that the device configuration is very simple and the device is very small in size. Furthermore, in the semiconductor mounting device 10 of the present embodiment, while the mounting head 18 is securing one chip component set 34 to the substrate 36, the conveyance head 14 can convey the chip components 30a, 30b, and 30c constituting the next chip component set 34 to the temporary placement stage 12 (parallel processing is possible) so the productivity is also very high.

**[0031]** Next, the semiconductor mounting device 10 of the present embodiment will be described in more detail. In the storage part 92 of the control device 90, "configuration

positions of the chip components 30a, 30b, and 30c of the chip component set 34 are changed, each of the chip components 30a, 30b, and 30c can still be suctioned to the temporary placement stage 12.

**[0035]** FIG. 5 is a side view showing a state where the mounting head 18 is on the upper surface of each of the chip components 30a, 30b, and 30c on the temporary placement stage 12. FIG. 5 shows only the chip components 30a and 30b. The control device 90 controls the driving device 48 of the mounting head 18 to move the mounting head 18 to the upper surface of each of the chip components 30a, 30b, and 30c on the temporary placement stage 12, and opens the valve 52 of the mounting head 18. Thereby, the chip components 30a, 30b, and 30c are suctioned to the suction surface of the mounting head 18 (the lower surface of the porous member 50). Then, the control device 90 closes the valve 42 of the temporary placement stage 12 to set the suction force of the temporary placement stage 12 to zero. Then, the mounting head 18 is moved to the upper side to pick up the chip components 30a, 30b, and 30c.

**[0036]** As shown in FIG. 5, the cooling device 44 is provided in the temporary placement stage 12. The cooling device 44 has, for example, a pipe that is piped uniformly on the lower side of the porous member 40, and cools the porous member 40 by circulating a refrigerant therein. The reason for providing the cooling device 44 is as follows. As shown in FIG. 5, the mounting head 18 includes the heater 54, and the heater 54 is turned on when the chip components 30a, 30b, and 30c are secured to the substrate 36 on the mounting stage 16. Although the heater 54 is turned off when the mounting head 18 suctions the chip components 30a, 30b, and 30c on the temporary placement stage 12, residual heat may remain on the lower surface of the mounting head 18. In that case, when the mounting head 18 suctions the chip components 30a, 30b, and 30c on the temporary placement stage 12, the residual heat of the mounting head 18 may be transmitted to the chip components 30a, 30b, and 30c, and the NCF of each of the chip components 30a, 30b, and 30c may be softened and adhere to the upper surface of the temporary placement stage 12. Therefore, by providing the cooling device 44 in the temporary placement

stage 12 to cool the upper surface of the temporary placement stage 12 (the upper surface of the porous member 40), the NCF of each of the chip components 30a, 30b, and 30c is prevented from being softened. If no residual heat remains on the lower surface of the mounting head 18, the cooling device 44 may not be provided. In addition, instead of providing the cooling device 44, the control device 90 may open the valve 42 of the temporary placement stage 12 even when the chip components 30a, 30b, and 30c are not loaded on the temporary placement stage 12, so as to suck air through the suction holes 41 of the porous member 40 to cool the upper surface of the porous member 40.

**[0037]** FIG. 6 is a view showing a cross section of the porous member 50 of the mounting head 18 and the side surface of one chip component 30a (30b, 30c). As shown in FIG. 6, similar to the porous member 40 of the temporary placement stage 12, an interval HL2 between the suction holes 51 on the lower surface of the porous member 50 of the mounting head 18 is set shorter than the length CL of one side of the chip component 30a (30b, 30c) that can be suctioned to the mounting head 18. Thereby, similar to the temporary placement stage 12, even if the combination of the chip components 30a, 30b, and 30c constituting the chip component set 34 is changed or the relative positions of the chip components 30a, 30b, and 30c of the chip component set 34 are changed, each of the chip components 30a, 30b, and 30c can still be suctioned to the mounting head 18.

**[0038]** FIG. 7 is a side view showing a state where the chip component set 34 (the chip components 30a, 30b, and 30c) is picked up by the mounting head 18. FIG. 7 shows only the chip components 30a and 30b. The control device 90 controls the driving device 48 of the mounting head 18 and moves the mounting head 18 toward the mounting stage 16 in a state where the chip components 30a, 30b, and 30c are suctioned to the lower surface (suction surface) of the mounting head 18. Then, the control device 90 reads “secured position information of chip component set” from the storage part 92 and moves the mounting head 18 to a position above the secured position of the chip component set 34 on the substrate 36 on the

the mounting head 18. Since the mounting head 18 pressurizes the chip components 30a, 30b, and 30c against the substrate 36 with the pressure  $F_p$  while suctioning the chip components 30a, 30b, and 30c, displacement of the chip components 30a, 30b, and 30c on the substrate 36 can be suppressed. The NCF 33 is hardened by the pressurization and heating, and the chip components 30a, 30b, and 30c are bonded to the substrate 36, and each bump 32 of each of the chip components 30a, 30b, and 30c is bonded to each pad 38 on the substrate 36.

**[0041]** As the semiconductor mounting device 10 of the present embodiment described above has one stage for holding the substrate 36 and one head for mounting the chip components 30a, 30b, and 30c on the substrate 36, the device configuration is simple and the size of the device can be reduced. In addition, while the mounting head 18 is securing the chip component set 34 to the substrate 36 over, for example, several tens of seconds, the conveyance head 14 can relatively position the next chip component set 34 and prepare the next chip component set 34 on the temporary placement stage 12. Therefore, the productivity is also high. The clean room for installing the semiconductor mounting device 10 requires a high maintenance cost per unit area, and it is strongly desired to increase the productivity per unit area. The semiconductor mounting device 10 of the present embodiment meets such demand.

**[0042]** In the related art (Patent Document 1), a plurality of chip components temporarily pressure-bonded to the entire surface of the circuit substrate are pressurized and heated block by block to perform the final pressure-bonding. Therefore, as the chip components of one block are being heated, the temperature of the NCF (NCF before curing) of the adjacent chip components that have not been fully pressure-bonded may rise to a transformation start temperature, for example, about 150°C, and the NCF may transform before the final pressure bonding, which causes a problem in the final pressure bonding. In contrast thereto, the semiconductor mounting device 10 of the present embodiment mounts one chip component set 34 and completes the curing of the NCF, and then mounts the next chip component set 34. Therefore, the NCF before curing does not rise to the transformation start temperature. In