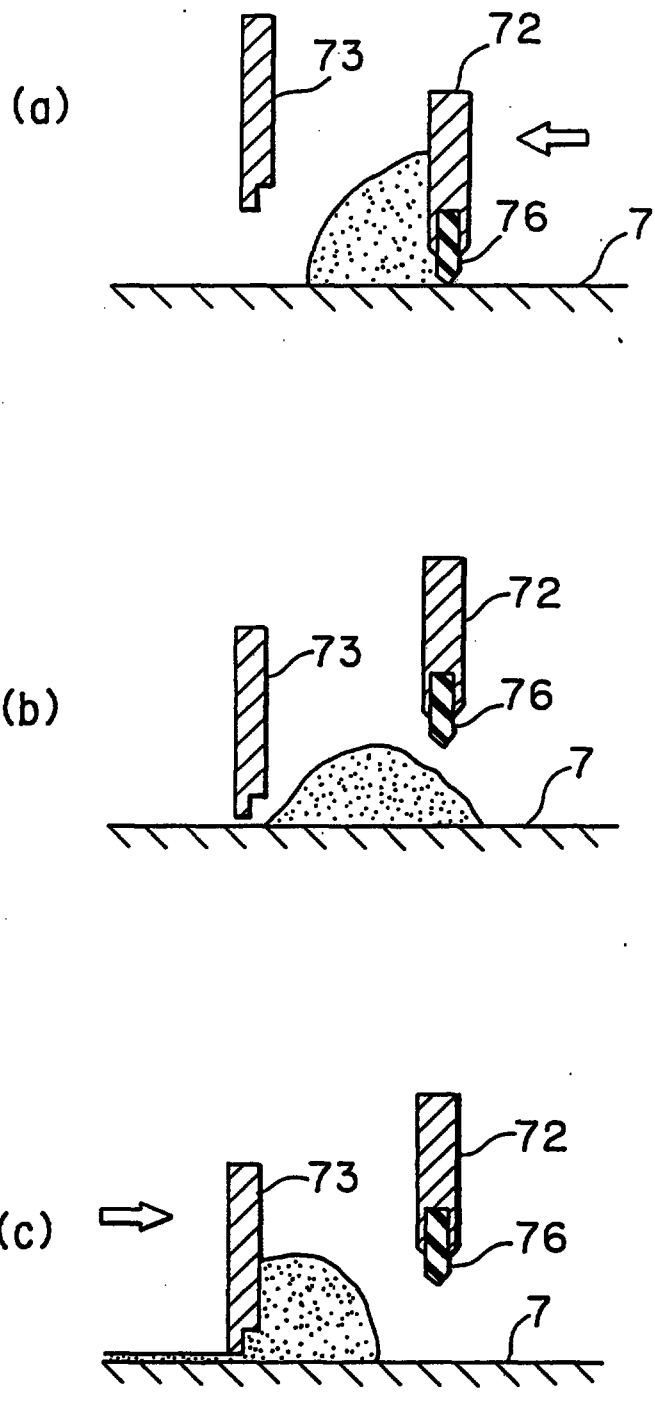


FIG. 14



Dipping Apparatus

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to a dipping apparatus, which can apply paste onto ends of miniature components such as chip type electronic components in high accuracy.

Description of the Background Art

10 In general, a holding plate having a number of receiving holes is employed for efficiently applying electrodes to end portions of a number of chip type electronic components, as disclosed in U.S. Patent No. 4,395,184. This holding plate comprises a hard substrate, a thin flat plate portion which is formed at a central
15 portion of the substrate to be provided with a number of through holes, and a rubber-like elastic member which is embedded in a concave portion defined in the flat plate portion to be provided with receiving holes, passing
20 through the elastic member, which are smaller in diameter than the through holes. The holding plate elastically holds chip type electronic components in the receiving holes to partially project the same, so that electrode paste of silver or the like is uniformly applied to the
25 projected portions. Thereafter the chip type electronic components are heated to dry the electrode paste.

The aforementioned U.S. Patent describes an exemplary method of applying electrode paste to such chip type electronic components with a roller. In this method, a holding plate holding chip type electronic components to partially project the same from its upper surface is carried by a conveyor, and a roller which is coated with electrode paste on its peripheral surface is brought into contact with the projected portions of the chip type electronic components to apply the electrode paste onto the chip type electronic components. In order to uniformize the thickness of the paste around the peripheral surface of the roller, a scraper is employed for scraping off excess part of the paste while rotating the roller.

When the chip type electronic components are about 1.6 to 5.7 mm in length, for example, the electrodes have extremely small thicknesses of about 0.15 to 0.3 mm, which must be controlled in high accuracy. In the aforementioned method, however, the paste which is applied to the peripheral surface of the roller flows following rotation thereof, and hence the thickness of the paste is finely varied to cause dispersion in thickness of the electrodes which are formed on the chip type electronic components. Such dispersion may also be caused by vibration of the conveyor or fluctuation of the degree of horizontality.

Japanese Patent Publication No. 3-44404 (1991)

describes a method of coating the upper surface of a flat coating plate with a thin film of electrode paste and approaching a holding plate holding chip type electronic components to partially downwardly project the same to the coating plate for pressing the projected portions of the chip type electronic components against the coating plate, thereby applying the electrode paste to the chip type electronic components.

This method causes no such inconvenience as that in the aforementioned method employing a roller. According to this method, the projected portions of the chip type electronic components are pressed against the bottom surface of the coating plate which is coated with the paste, whereby the chip type electronic components are prevented from dispersion in length of the projected portions and the electrode widths are made uniform.

However, a single holding plate generally holds thousands of chip type electronic components. Therefore, extremely strong reactive force acts on the holding plate when the chip type electronic components are pressed against the coating plate which is coated with the paste. Thus, the holding plate may be inclined to deviate from a parallel state with respect to the paste, or the holding plate itself may be deformed and deteriorated in flatness,

leading to inferiority in accuracy for application of the electrodes.

SUMMARY OF THE INVENTION

Accordingly, the present invention aims to provide a
5 dipping apparatus which can maintain a holding plate holding chip type electronic components in parallel with paste, for applying electrodes to the chip type electronic components in high accuracy.

Desirably the present invention provides a dipping
10 apparatus which can prevent a holding plate from deformation, for ensuring its flatness.

According to one aspect of the present invention, there is provided a dipping apparatus comprising a dip head portion; a dipping vessel horizontally arranged
15 under said dip head portion, said dipping vessel having a bottom surface which in use of the apparatus, is coated with thin a film of paste; and a chucking portion supported at a lower part of said dip head portion in a vertically movable manner through at least two shafts
20 including at least one ball screw arranged to be driven by a motor, said chucking portion being adapted to horizontally chuck a holding plate for holding one or more chip type electronic components and to downwardly project the same.

Preferably the chucking portion is supported by four shafts, which are arranged in a rectangular manner. Two of the shafts positioned diagonally of the rectangular arrangement are formed by synchronously driven ball screws while the other two diagonally positioned shafts serve as guide shafts for guiding vertical movement of the chucking portion.

Preferably the holding plate is provided on its side end surfaces with chucking grooves, and the chucking portion is provided with a horizontal backing plate and chucking pawls which engage with the chucking grooves to press the upper surface of the holding plate against the backing plate.

According to another aspect of the present invention there is provided a method of forming electrodes on projected portions of miniature components, said method comprising: engaging a holding plate holding downwardly projecting miniature components, by engaging means located in an engaging portion of a dipping apparatus; moving the engaging means so as to bring the holding plate into pressure contact with a horizontal backing plate; driving the engaging means vertically downwards using at least two shafts including at least one ball screw arrange to be driven by a motor, such that the projecting portions of the miniature components are

through the application of even pressure, dipped in a dipping vessel having a horizontal bottom surface coated with a thin film of electrode paste, thereby applying said electrode paste evenly to said projected portions of said components; and moving the engaging portion vertically upwards, out of the dipping vessel.

Exemplary action of a chucking portion which is downwardly suspended from a dip head portion through ball screws is now described. When nuts which are fitted with the ball screws are rotated by a motor, the ball screws are moved in the axial direction. Thus, the chucking portion coupled to the lower ends of the ball screws is downwardly moved to press projected portions of chip type electronic components, being held by holding plate, against the bottom surface of a dipping vessel which is coated with paste. Although reactive force acts on the holding plate at this time, it is possible to prevent inclination of the chucking portion, which is vertically supported by at least two shafts including ball screws. Thus, the holding place is regularly maintained in horizontal state, whereby it is possible to uniformly apply electrodes onto the end portions of the chip type electronic components which are held by the holding plate.

In an embodiment of the present invention, a motor and ball screws are employed as means for vertical movement, whereby the speed of vertical movement can be freely adjusted by the motor, to reduce a shock which is

applied to the holding plate.

As to the arrangement of the shafts for vertically supporting the chucking portion, two ball screws and two guide shafts may be arranged in diagonal positions respectively so that the diagonally positioned ball screws are synchronously driven by the motor. Thus, it is possible to receive reactive force which is caused upon dipping in a balanced manner, thereby further effectively preventing inclination of the chucking portion.

The holding plate itself is easily deformed by the reactive force which is caused upon dipping, since the same holds a number of chip type electronic components. When the back of the holding plate is surface-supported by a backing plate, the holding plate can be prevented from deformation caused by the reactive force, and its flatness is ensured. When the chucking portion is received in the chucking grooves which are provided in the side end surfaces of the holding plate, the chucking portion will not be downwardly projected beyond the holding plate, and the dipping operation can be carried out with no hindrance.

The above and further features of the present invention are set forth with particularity in the appended claims and should become clearer from

consideration of the following detailed description of an embodiment of the present invention given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a front elevational view schematically showing a dipping apparatus embodying the present invention;

10 Fig. 2 is a perspective view of a holding plate which is employed in the dipping apparatus shown in Fig. 1;

 Fig. 3 is a sectional view showing the holding plate of Fig. 2 holding chip type electronic components;

 Fig. 4 is a plan view of a dip head portion which is included in the dipping apparatus shown in Fig. 1;

15 Fig. 5 is a sectional view taken along the line V - V in Fig. 4;

 Fig. 6 is a sectional view of a chucking portion which is included in the dipping apparatus shown in Fig. 1;

20 Fig. 7 is a partially fragmented plane view of the chucking portion shown in Fig. 6;

 Fig. 8 is a front elevational view of a supply conveyor, which is included in the dipping apparatus shown in Fig. 1, located in a working position;

Fig. 9 is a plan view of the supply conveyor shown in Fig. 8;

Fig. 10 is a left side elevational view of the supply conveyor shown in Fig. 8;

5 Fig. 11 is a plan view illustrating a dipping vessel and a blade portion which are included in the dipping apparatus shown in Fig. 1;

Fig. 12 is a sectional view taken along the line XII - XII in Fig. 11;

10 Fig. 13 is a sectional view taken along the line XIII - XIII in Fig 12; and

Figs. 14(a) to 14(c) are explanatory diagrams for illustrating a method of applying paste.

DETAILED DESCRIPTION OF THE EMBODIMENT

15 Fig. 1 shows a dipping apparatus embodying the present invention, which is adapted to apply electrodes onto end portions of chip type electronic components B. As shown in Figs. 2 and 3, the chip type electronic components B are elastically held by a holding plate A to
20 be partially projected from receiving holes a_1 . The structure of this holding plate A is similar to that disclosed in Japanese Patent Publication No. 3-44404 (1991).

The inventive dipping apparatus is formed by a body 1 which contains a control unit (not shown), a dip head portion 2 which is fixed onto the body 1 through fixed poles 3 and a top plate 4, a supply conveyor 5, a discharge conveyor 6, a dipping vessel 7, and a blade portion 8.

As shown in Figs. 4 and 5, a chucking portion 10 is vertically movably suspended from the lower part of the dip head portion 2 through four shafts 11a, 11b, 11c and 11d, which are arranged to define a rectangle about the center of gravity of the chucking portion 10. Diagonally positioned two 11a and 11b of these shafts are formed by ball screws, and the other diagonally positioned two 11c and 11d serve as guide shafts. The guide shafts 11c and 11d are vertically slidably guided in the top plate 4 of the dip head portion 2 through guide bushes 108. The top plate 4 is provided thereon with a vertical motor 12 for rotating a nut 103 which is fitted with the first ball screw 11a through a pulley 100, a belt 101 and another pulley 102. The nut 103 rotates a nut 107 fitted with the second ball screw 11b through a pulley 104, which is integrally rotated with the pulley 102, a belt 105 and another pulley 106. Thus, the two ball screws 11a and 11b are driven in a synchronous manner. The chucking portion 10, which is thus supported by the four shafts 11a to 11d,

can be vertically moved while regularly remaining in a horizontal state.

Figs. 6 and 7 illustrate the chucking portion 10 in detail. This chucking portion 10 comprises a substrate 14 which is mounted on the lower end portions of the shafts 11a to 11d, and a backing plate 15 which is horizontally fixed to the lower side of the substrate 14. Two switching cylinders 16 and one vertical cylinder 17 are provided on each side of the substrate 14. A pair of sliding shafts 18 are fixed to the substrate 14 in upright states for guiding a vertically movable chuck holder 19, which is coupled to a piston rod of the vertical cylinder 17 through a stay 20. Thus, the chuck holder 19 is vertically movable through the vertical cylinder 17. Two vertical pairs of sliding shafts 21 slidably pass through both side portions of the chuck holder 19, while a horizontal pair of chucking pawls 22 are coupled to outer end portions of the sliding shafts 21 and sliders 23 are fixed to side end portions of the sliding shafts 21 in vertically extending manners. Forward end surfaces of piston rods of the switching cylinders 16 are slidably in contact with side surfaces of the sliders 23. Contact pressures between the piston rods of the switching cylinders 16 and the sliders 23 are supplied by springs 24 which are provided on the sliding shafts 21.

In operation, the switching cylinders 16 outwardly open the chucking pawls 22 in a first stage, and the vertical cylinder 17 downwardly moves the opened chucking pawls 22 in a second stage. In a third stage, the switching cylinders 16 inwardly close the chucking pawls 22 to engage forward ends thereof with chucking grooves a_2 , which are provided on both sides of the holding plate A. In a fourth stage, the vertical cylinder 17 upwardly moves the closed chucking pawls 22, to bring the upper surface of the holding plate A into close contact with the backing plate 15. Since the lower surface of the backing plate 15 is regularly maintained in a horizontal state by the shafts 11a to 11d, the holding plate A is also horizontally held to maintain the projected portions of the chip type electronic components B, which are received in the receiving holes a_1 , in horizontal states. Referring to Fig. 6, the chucking pawls 22 provided on the left side are closed while those provided on the right side are opened.

In order to release the holding plate A, an operation reverse to the above is carried out. Namely, the chucking pawls 22 are downwardly moved in the closed states in a first stage to bring the holding plate A onto the conveyors 5 and 6 as described later, and the chucking pawls 22 are opened in a second stage to release the

holding plate A. The opened chucking pawls 22 are upwardly moved in a third stage, and then inwardly closed in a fourth stage, to complete the series of operation.

Figs. 8 to 10 show the supply conveyor 5 in detail.

5 Guide rails 32a and 32b are horizontally provided on a pair of supports 31a and 31b, each of which is horizontally fixed onto the body 1 through a plurality of support legs 30, so that a conveyor body 33 is slidable on the guide rails 32a and 32b through slide bearings 34a and
10 34b. A sliding motor 36 is fixed onto the body 1 through a bracket 35, and a driving pulley 37 is mounted on the rotary shaft of this motor 36. The driving pulley 37 is coupled in a power transmittable manner with an intermediate pulley 39, which is rotatably supported by a
15 beginning end portion of the first support 31a, by a belt 38, and the intermediate pulley 39 is integrally rotated with a transmission pulley 40, which is located in an opposite position through the support 31a. A sliding belt 42 extends across the transmission pulley 40 and another
20 transmission pulley 41, which is rotatably supported by a terminal end portion of the support 31a, and a clamp member 43 for partially clamping the sliding belt 42 is provided on the lower surface of one side portion of the conveyor body 33. Thus, it is possible to horizontally
25 slide the conveyor body 33 by driving the sliding motor

36.

A beginning end position (standby position) and a terminal end position (working position) of the conveyor body 33 in sliding operation can be detected when a detection member 44 provided on one side surface of the conveyor body 33 reaches position detectors 45 and 46, which are formed by photointerruptors mounted on the second support 31b with a constant space, respectively. The position detectors 45 and 46 output detection signals, to stop the sliding motor 36. In order to reduce shocks which may be caused when the conveyor body 33 is stopped at the beginning and terminal end positions, a pair of shock absorbers 47 and 48 are mounted on the first support 31a, and a stopper 49 is fixed to the side portion of the conveyor body 33 in response thereto.

Cross-directionally extending shafts 50 and 51 are rotatably supported at front and rear portions of the conveyor body 33, and carriage pulleys 54 and 55, which are horizontally provided with carriage belts 52 and 53, are mounted on both end portions of the shafts 50 and 51. The carriage belts 52 and 53 are adapted to support both side portions of the holding plate A. A carriage motor 57 is fixed to the lower surface of the conveyor body 33 through a bracket 56, and a driving pulley 58 is mounted on the rotary shaft of this motor 57. The driving pulley

58 interlocks with another pulley 60, which is mounted on an intermediate portion of the shaft 50, provided on the beginning end, through a belt 59. Thus, it is possible to drive the carriage belts 52 and 53 at the same speed by the carriage motor 57, to carry the holding plate A, which is supported on these belts 52 and 53, from the beginning end to the terminal end in a parallel manner.

The supply conveyor 5 further comprises a tension roller 61 for supplying constant tension to the sliding belt 42, a horizontal pair of guide plates 62 and 63 for slidably supporting the lower surfaces of the carriage belts 52 and 53, tension rollers 64 and 65 for supplying constant tension to the carriage belts 52 and 53, and a rear cover 66 for preventing the dipping vessel 7 from droppage of dust etc. adhering to the carriage system.

Since the discharge conveyor 6 is symmetrical in structure to the supply conveyor 5, redundant description is omitted. The discharge conveyor 6 is so synchronized in sliding and carrying operation with the supply conveyor 5 that the former is slid to the working position in synchronization with the latter and carriage belts of the former are driven at the same speed in the same direction as those of the latter.

The discharge conveyor 6 is different in structure from the supply conveyor 5 in a point that a photoelectric

switch 67 and a proximity switch 68 are mounted on an upper surface of a rear cover 66, which is provided on the bottom surface of a conveyor body 33, and a beginning end side surface of the conveyor body 33 respectively for

5 detecting positions of the holding plate A, as provisionally illustrated in Fig. 7. The photoelectric switch 67 is adapted to temporarily stop the holding plate A for carrying the same from the dipping step to a subsequent step, while the proximity switch 68 is adapted to decide a position for stopping the holding plate A when
10 the same is supported across the conveyors 5 and 6 before dipping.

Figs. 11 to 13 illustrate the dipping vessel 7 and the blade portion 8.

15 The dipping vessel 7 is in the form of a rectangle having a U-shaped section, which is slightly larger than the holding plate A, and provided with guide rails 70 on both sides of longer edges thereof. A blade supporting frame 71 is slidably supported on the guide rails 70 to
20 horizontally extend across the dipping vessel 7. A recovery blade 72 for collecting electrode paste on an end portion of the dipping vessel 7 and a levelling blade 73 for adjusting the electrode paste in a prescribed thickness are independently mounted on the blade
25 supporting frame 71 in vertically movable manners. The



driving the engaging means vertically downwards
using at least two shafts including at least one ball
screw arranged to be driven by a motor, such that the
projecting portions of the miniature components are
5 through the application of even pressure, dipped in a
dipping vessel having a horizontal bottom surface
coated with a thin film of electrode paste, thereby
applying said electrode paste evenly to said projected
portions of said components; and

10 moving the engaging portion vertically upwards,
out of the dipping vessel.

11. An apparatus or method substantially as described
herein with reference to the accompanying drawings.