

Electrode Forming Apparatus for Chip Type Electronic Components

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an apparatus for forming external electrodes on end portions of chip type electronic components such as chip capacitors or chip resistors.

10 Description of the Background Art

In order to simultaneously apply electrodes onto end portions of a number of chip type electronic components, a holding plate is generally employed for elastically holding the chip components, as disclosed in U.S. Patent
15 No. 4,395,184. This holding plate comprises a hard substrate, a thin flat plate portion which is formed at a central portion of the substrate to be provided with a number of through holes, a rubber-like elastic member which is embedded in a concave portion defined in the flat
20 plate portion to be provided with receiving holes, passing through the elastic member, in portions corresponding to the through holes.

In order to form external electrodes on end portions of chip components, the holding plate first receives the
25 chip components in the receiving holes to partially

upwardly project the same. Then the holding plate is placed on and carried by a conveyor to pass through a roll which is coated with electrode paste, so that the electrode paste is applied to the projected portions of the chip components. Thereafter the holding plate is carried by the conveyor to a portion under heating means for heating and drying the electrode paste.

In this case, however, the chip components whose upper end portions are coated with the electrode paste are directly carried toward the heating means, and hence the electrode paste disadvantageously flows down on the side surfaces of the chip components during such carriage. Therefore, electrode widths are irregularized on the side surfaces of the chip components, and shorts may be caused across the external electrodes if things come to the worst. If the chip components are 1.6 mm in length, for example, the electrode widths must be controlled to about 0.15 mm. When the undried chip components are carried in the upwardly directed state, further, foreign matters such as dust easily adhere to the electrode surfaces, and it is impossible to remove such foreign matters.

SUMMARY OF THE INVENTION

Accordingly, it is desirable to provide an electrode forming apparatus for chip components, which can form electrodes with uniform

electrode widths on the side surfaces of the chip components while protecting electrode paste against adhesion of foreign matters such as dust, for manufacturing chip components of stable quality.

5 According to one aspect of the present invention, there is provided an electrode forming apparatus for forming external electrodes on end portions of chip components said apparatus comprising: a dipping machine provided with a dipping vessel having a
10 horizontal bottom surface to be coated in use with a thin film of electrode paste and a moving portion arranged above said dipping vessel for moving said chip components with said end portions positioned in a downward direction into and out of said dipping
15 vessel thereby to apply said electrode paste to said end portions of said chip components; a drying furnace for receiving said chip components with said end portions positioned in a downward direction, and carrying the same in its interior for continuously
20 heating/drying said end portions of said chip components; and conveyor means for horizontally transferring said chip components with said end portions positioned in a downward direction, from said dipping machine to said drying furnace.

25 According to another aspect of the present invention there is provided an electrode forming

apparatus for chip components for forming external electrodes on projected portions of chip components being held by a holding plate, said apparatus comprising: a dipping machine provided with a dipping vessel having a horizontal bottom surface being coated with a thin film of electrode paste and a chucking portion arranged above said dipping vessel for horizontally chucking said holding plate to downwardly project said chip components and vertically moving the same thereby applying said electrode paste to said projected portions of said chip components; a drying furnace for receiving said holding plate, holding said chip components to downwardly direct electrode surfaces thereof, and carrying the same in its interior for continuously heating/drying said electrode surfaces of said chip components being held by said holding plate; and conveyor means for horizontally transferring said holding plate, holding said chip components to downwardly direct said electrode surfaces, from said dipping machine to said drying furnace.

Preferably the drying furnace comprises a rotor which is intermittently rotated while supporting a plurality of holding plates, means for heating and drying electrode surfaces of chip components held by the holding plates which are supported by the rotor,

means for introducing the holding plates one by one into the rotor, and means for extracting the dried holding plates one by one from the rotor.

5 According to another aspect of the present invention, there is provided a method of forming external electrodes on projected portions of chip components comprising the steps of: dipping downwardly projecting portions of chip components in a dipping vessel having a horizontal bottom surface coated in
10 use with a thin film of electrode paste, thereby applying said electrode paste evenly to said projected portions of said chip components; transferring said chip components to a drying apparatus whilst maintaining projected portions of the chip components
15 coated with electrode paste in a downward direction; and conveying the chip components within the interior of the drying apparatus to heat and dry continuously the electrode paste applied to the chip end portions of the components.

20 In an embodiment of the invention, a holding plate first receives the chip components in its receiving holes to partially downwardly project the same, and is then set in the dipping machine. The dipping machine horizontally chucks the holding plate
25 with the chucking portion. The dipping vessel, whose bottom surface is coated with a thin film of electrode

paste, is set under the chucking portion. The
chucking portion is downwardly moved to bring the
downwardly projected portions of the chip components
into contact with the bottom surface of the dipping
5 vessel. Then the chucking portion is upwardly moved,
so that the projected portions of the chip components
are coated with the electrode paste with constant
thicknesses. The holding plate chucked by the
chucking portion is transferred to the conveyor means
10 and carried into the drying furnace. The drying
furnace receives the holding plate holding the chip
components,

having downwardly directed electrode surfaces, for continuously heating and drying the same. Thus, the electrode surfaces can be efficiently dried with no long waiting time, dissimilarly to batch processing. Thus, the chip components are carried from the dipping vessel to the drying furnace while downwardly directing the electrode surfaces, whereby the electrode paste will not flow down on the side surfaces of the chip components to irregularize the electrode widths. Further, the downwardly directed electrode surfaces are protected against adhesion of foreign matters such as dust.

As hereinabove described, the drying furnace preferably comprises an intermittently rotated rotor, which can support a plurality of holding plates. This rotor is stopped when the holding plates are introduced into the same one by one by introduction means. After the holding plates are introduced, the rotor is rotated at a constant pitch, to dry the electrode surfaces of the chip components held by the holding plates passing through heating zones of a prescribed temperature. After the electrode surfaces are completely dried, the holding plates are extracted by the extraction means.

The conveyor means can be arbitrarily formed by means comprising a carriage table which is mounted on a nut member engaged with a ball

screw for receiving the holding plate on the carriage table and carrying the same, means for receiving both side portions of the holding plate on a pair of carriage belts and carrying the same, or the like.

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The electrode surfaces are downwardly directed when the chip components are carried from the dipping vessel to the drying furnace, to cause no drip of the electrode paste. Thus, it is possible to obtain chip components having uniform electrode widths. Further, the electrode paste is protected against adhesion of foreign matters such as dust, since the electrode surfaces are downwardly directed.

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In addition, it is not necessary to invert the holding plate for carrying the same to the drying furnace after dipping, whereby workability is improved and no vibration is applied to the holding plate, to cause no inclination nor droppage of the chip components.

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Above and further features of the 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 invention given with reference to the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

25 Fig. 1 is a plan view schematically showing an

electrode forming apparatus embodying
the present invention;

Fig. 2 is a sectional view of an exemplary holding
plate which is employed in the electrode forming apparatus
5 shown in Fig. 1;

Fig. 3 is a side elevational view of a loader which
is included in the electrode forming apparatus shown in
Fig. 1;

Fig. 4 is a front elevational view of a dipping
10 machine which is included in the electrode forming
apparatus shown in Fig. 1;

Fig. 5 is an enlarged sectional view taken along the
line V - V in Fig. 1; and

Fig. 6 is a plan view schematically showing an
15 electrode forming apparatus of another
embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Fig. 1 is a general view showing an apparatus for
manufacturing chip components, which is formed by an
20 introducer 1, an insertion/transfer press 2, an extraction
press 3, and an electrode forming apparatus 4
embodying the present invention.

The introducer 1, which is adapted to bring chip
components B into contact with upper surfaces of receiving
25 holes a₁ being provided in a holding plate A (see Fig. 2),

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sets a guide plate (not shown), having through holes corresponding to the receiving holes a_1 , on the holding plate A. Then the introducer 1 places a number of chip components B on the guide plate at random, and downwardly vacuum-sucks the same with vibration, thereby introducing the chip components B one by one into the through holes of the guide plate. U.S. Patent No. 4,395,184 discloses an example of such an introducer 1.

The insertion/transfer press 2 receives the guide plate receiving the chip components B in the through holes and the holding plate A in an overlapped manner, and pushes the chip components B from the through holes into the receiving holes a_1 with press pins. At this time, the chip components B are partially upwardly projected from the receiving holes a_1 . Then the electrode forming apparatus 4 forms electrodes on the projected portions of the chip components B, and the insertion/transfer press 2 transfers the chip components B from the holding plate A to another holding plate A. This operation of the insertion/transfer press 2 is described in U.S. Patent No. 4,664,943, for example.

Thereafter the electrode forming apparatus 4 forms electrodes on other end portions of the chip components B, and the extraction press 3, which is similar in structure to the insertion/transfer press 2, extracts the chip

components B from the holding plate A, to complete the series of steps.

5 The holding plate A may be manually carried from the introducer 1 to the insertion/transfer press 2, from the insertion/transfer press 2 to the electrode forming apparatus 4, from the electrode forming apparatus 4 to the insertion/transfer press 2, and from the electrode forming apparatus 4 to the extraction press 3, or by a robot. Alternatively, carriage means such as conveyors may be
10 provided between these apparatuses.

The electrode forming apparatus 4 comprises a loader 5 for storing a plurality of holding plates A, which are received from the insertion/transfer press 2, to downwardly direct the projected portions of the chip components B, a dipping machine 6 for receiving the
15 holding plates A one by one from the loader 5 and performing prescribed dipping, a conveyor 7 for discharging the dipped holding plates A one by one from the dipping machine 6, a drying furnace 8 for heating and
20 drying electrode surfaces of the chip components B being held by the holding plates A, a reversibly drivable introduction/extraction conveyor 9 for transferring the holding plates A from the conveyor 7 to the drying furnace 8, a transfer conveyor 11 for transferring the dried
25 holding plates A from the introduction/extraction conveyor

9 to another conveyor 10, and two unloaders 12 for temporarily storing the holding plates A carried on the conveyor 10.

As shown in Fig. 3, the loader 5 comprises a pair of rack frames 13 for vertically movably supporting a plurality of holding plates A in a parallel manner, and a conveyor 14 which is horizontally arranged between the rack frames 13. As shown in Fig. 2, each holding plate A holds a number of chip components B to partially downwardly project the same. The rack frames 13 are stepwisely moved down to place the holding plates A one by one on the conveyor 14. The conveyor 14 carries the holding plates A to the dipping machine 6, which is located in a direction perpendicular to the plane of Fig. 3.

As shown in Fig. 4, the dipping machine 6 is formed by a dip head driving portion 22 which is fixed to a dipping machine body 20 through supports 21, a supply conveyor 23, a discharge conveyor 24, a dipping vessel 25, and a blade portion 26. In the dip head driving portion 22, a chucking portion 27 for chucking both sides of each holding plate A is vertically movably supported by a vertical shaft 28. The supply conveyor 23 and the discharge conveyor 24, which are adapted to rightwardly carry each holding plate A in Fig. 4, are movable to such

positions that upper portions thereof approach each other as shown by two-dot chain lines in Fig. 4. After the conveyors 23 and 24 are moved to such positions, the holding plate A is carried to a position across the conveyors 23 and 24. Then the chucking portion 27 is downwardly moved to easily chuck the holding plate A, which is located across the conveyors 23 and 24.

Thereafter the conveyors 23 and 24 are moved back to the positions shown by solid lines, and the chucking portion 27 chucking the holding plate A is moved down into the dipping vessel 25, for prescribed dipping. The holding plate A may be provided with grooves a_2 (see Fig. 2) on shorter edges thereof for receiving forward end portions of the chucking portion 27, so that the chucking portion 27 will not hinder the dipping operation but electrodes can be uniformly applied to the chip components B.

The bottom surface of the dipping vessel 25 is in the form of a horizontal container, and the blade portion 26 is movable across the dipping vessel 25 perpendicularly to the plane of Fig. 4. A small clearance is defined between the lower edge of the blade portion 26 and the bottom surface of the dipping vessel 25, so that electrode paste is applied onto the bottom surface of the dipping vessel 25 in the form of a thin film and excess paste is scraped off by movement of the blade portion 26. The chip

components B are so pressed against the bottom surface of the dipping vessel 25 that the thickness of the applied electrode paste directly defines electrode widths of the chip components B. Even if the portions of the chip components B projected from the receiving holes a_1 of the holding plate A are dispersed in length, such dispersed lengths are adjusted when the projected portions are pressed against the bottom surface of the dipping vessel 25 to be coated with the electrode paste. Thus, it is possible to obtain uniform electrode widths.

When the dipping operation is completed, the chucking portion 27 is upwardly moved beyond the conveyors 23 and 24, which in turn are moved to the approaching positions so that the chucking portion 27 places the holding plate A across the conveyors 23 and 24. Then the conveyors 23 and 24 are driven at the same speed, to transfer the holding plate A to the subsequent conveyor 7.

The conveyor 7 carries the holding plate A, holding the chip components B to downwardly direct the electrode surfaces, along the direction of the arrow shown in Fig. 1 toward a position immediately in front of the drying furnace 8 through the introduction/extraction conveyor 9. A pair of introduction and extraction arms 30 and 31 are provided immediately in front of the drying furnace 8. These arms 30 and 31 are integrally reciprocable along a shaft 32

which is parallel to the conveyor 9, and upwardly swingable about the shaft 32. The arms 30 and 31 are generally located in upwardly swinging positions not to interfere with the holding plate A, which is carried by the conveyor 9. When the holding plate A is carried to the position immediately in front of the drying furnace 8, the arms 30 and 31 swing downwardly to positions along the conveyor 9. Thus, the holding plate A is held between the arms 30 and 31. Then the shaft 32 is frontwardly moved so that the holding plate A is pushed by the introduction arm 30 and inserted into an inlet/outlet port 40 of the drying furnace 8. At this time, the conveyor 9 is preferably driven in synchronization with the introduction arm 30, so that no unwanted vibration is applied to the holding plate A.

As shown in Fig. 5, the drying furnace 8 comprises the inlet/outlet port 40 opening perpendicularly to the plane of Fig. 5, a rotor 42 which is rotatable about a horizontal shaft 41, a motor 43 for intermittently rotating the rotor 42 at a constant pitch, a plurality of heaters 44 provided in the interior of the furnace 8, fans 45 for circulating heat generated by the heaters 44 and diaphragms 46 dividing the interior of the furnace 8 into a plurality of heating zones. The rotor 42 has a plurality of radial vanes 47, each of which is provided

with a pair of inward insertion grooves 47a. The holding plate A, which is pushed into the inlet/outlet port 40 by the introduction arm 30, is horizontally inserted into the insertion grooves 47a of a vane 47 corresponding to the inlet/outlet port 40. Since the lower surface, exposing the electrode surfaces, of the holding plate A thus inserted in the grooves 47a is opened, the chip components B will not come into contact with the vane 47, and excellent air permeability is attained.

The holding plate A thus held by the vane 47 is rotated by 360° to pass through the five heating zones, whereby the electrode paste applied to the chip components B is dried. When the dried holding plate A reaches the inlet/outlet port 40, the extraction arm 31 is leftwardly moved in Fig. 1 to push the holding plate A onto the introduction/extraction conveyor 9. Then, the arms 30, 31 swing upwardly. The conveyor 9, which is reversibly drivable, is preferably leftwardly driven in Fig. 1 in synchronization with the extraction arm 31. The holding plate A thus placed on the conveyor 9 is reversely transferred toward the dipping machine 6, and stopped at a position under the transfer conveyor 11. The transfer conveyor 11 grasps the holding plate A with a hand 50, and transfers the same to another conveyor 10. The transfer conveyor 11 can be formed by a well-known uniaxial unit,

while the hand 50 can be formed by a well-known chucking mechanism for holding both sides of the holding plate A. Also in this case, the holding plate A can be reliably chucked if the grooves a_2 are formed on side surfaces thereof.

After the last one of the dried holding plates A is raised up by the transfer conveyor 11 from the introduction/extraction conveyor 9, subsequent undried holding plates A are transferred from the conveyor 7 to the introduction/extraction conveyor 9, and inserted into the drying furnace 8 by the introduction arm 30. After the dried holding plates A are extracted, rotation of the drying furnace 8 is stopped until the undried holding plates A are introduced.

The holding plates A are carried on the conveyor 10 in the direction of the arrow in Figure 1, and successively stored in the unloaders 12. The unloaders 12, which are absolutely similar in structure to the loader 5, stepwisely move up the holding plates A, which are received from the conveyor 10, one by one in a reverse manner to the loader 5. When the holding plates A are stored in all rack frames, the unloaders 12 are automatically stopped.

The drying furnace employable in the present invention is not restricted to the aforementioned one, which is adapted to dry the electrode paste during

rotation by 360° and provided with a common inlet/outlet port.

Fig. 6 shows an electrode forming apparatus according to another embodiment of the present invention. Referring to Fig. 6, a drying furnace 60 is provided with an inlet 61 and an outlet 62 in positions symmetrical by 180° to each other, for drying electrode paste during rotation by 180°. The inlet 61 and the outlet 62 are provided with an introduction arm 63 and an extraction arm 64 respectively. The internal structure of the drying furnace 60 is similar to that shown in Fig. 5, except for the heaters 44 and the fans 45 provided in the lower portion. Although the lower half of the drying furnace 60 cannot be effectively utilized in this case as compared with the drying furnace 8 shown in Fig. 5, it is possible to easily confirm finished states of electrodes since a holding plate A received in a state downwardly directing electrode surfaces is extracted from the outlet 62 in an upwardly directed state. Further, the introduction/extraction conveyor 9 and the transfer conveyor 11 can be omitted to simplify the apparatus, while the holding plate A may not be reversely carried nor transferred, to reduce the time therefor.

The inlet/outlet port as well as the inlet and the outlet of the drying furnaces shown in Figs. 1 and 6 are

provided on the front sides so that the conveyors are arranged on the front sides of the drying furnaces in a U-shaped manner, whereby spaces for installing the overall electrode forming apparatuses 4 can be reduced. If spaces
5 allow, the holding plates A may be inserted from the front sides of the drying furnaces 8 and 60 and extracted from the back sides thereof.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the
10 same is by way of illustration and example only and is not to be taken by way of limitation, the scope of the present invention being determined by the terms of the appended claims.



CLAIMS:

1. An electrode forming apparatus for chip components for forming external electrodes on projected portions of chip components being held by a holding plate, said apparatus comprising:

5 a dipping machine provided with a dipping vessel having a horizontal bottom surface being coated with a thin film of electrode paste and a chucking portion arranged above said dipping vessel for horizontally chucking said holding plate to downwardly project said
10 chip components and vertically moving the same thereby applying said electrode paste to said projected portions of said chip components;

a drying furnace for receiving said holding plate, holding said chip components to downwardly direct
15 electrode surfaces thereof, and carrying the same in its interior for continuously heating/drying said electrode surfaces of said chip components being held by said holding plate; and

conveyor means for horizontally transferring said
20 holding plate, holding said chip components to downwardly direct said electrode surfaces, from said dipping machine to said drying furnace.

2. An electrode forming apparatus in accordance with claim 1, wherein said drying furnace comprises a rotor supporting a plurality of said holding plates and being intermittently rotated, means for
5 drying/heating said electrode surfaces of said chip components held by said holding plates being supported by said rotor, means for introducing said holding plates one by one into said rotor, and means for extracting dried said holding plates one by one from
10 said rotor.

3. An electrode forming apparatus in accordance with claim 1 or claim 2, wherein said conveyor means comprises a path for carrying said holding plate in of said drying furnace and a path for carrying said
15 holding plate out of said drying furnace, and said carrying-in and carrying-out paths are located on the same side of said drying furnace.

4. An electrode forming apparatus in accordance with any preceding claim, further comprising a loader
20 for supplying said holding plate one by one to said dipping machine, said loader comprising a pair of rack frames for vertically movably supporting a plurality of said holding plates in a parallel manner, and a conveyor which is horizontally arranged between said

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rack frames.



5 5. An electrode forming apparatus in accordance
with any preceding claim, further comprising an
unloader for temporarily storing a plurality of said
holding plates discharged from said drying furnace,
said unloader comprising a pair of rack frames for
vertically movably supporting a plurality of said
holding plates in a parallel manner, and a conveyor
which is horizontally arranged between said rack
frames.

6. An electrode forming apparatus for forming
external electrodes on end portions of chip components
said apparatus comprising:

15 a dipping machine provided with a dipping vessel
having a horizontal bottom surface to be coated in use
with a thin film of electrode paste and a moving
portion arranged above said dipping vessel for moving
said chip components with said end portions positioned
in a downward direction into and out of said dipping
vessel thereby to apply said electrode paste to said
20 end portions of said chip components;

 a drying furnace for receiving said chip
components with said end portions positioned in a
downward direction, and carrying the same in its

interior for continuously heating/drying said end portions of said chip components; and

conveyor means for horizontally transferring said chip components with said end portions positioned in a downward direction, from said dipping machine to said drying furnace.

7. A method of forming external electrodes on projected portions of chip components comprising the steps of:

dipping downwardly projecting portions of chip components in a dipping vessel having a horizontal bottom surface coated in use with a thin film of electrode paste, thereby applying said electrode paste evenly to said projected portions of said chip components;

transferring said chip components to a drying apparatus whilst maintaining projected portions of the chip components coated with electrode paste in a downward direction; and

conveying the chip components within the interior of the drying apparatus to heat and dry continuously the electrode paste applied to the chip end portions of the components.

8. An apparatus or method of forming external



electrodes on chip components substantially as herein
described with reference to the accompanying drawings.

