

TITLE OF THE INVENTION

Method of Manufacturing Laminated Electronic
Component

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to a method of manufacturing a laminated electronic component, and more particularly, it relates to a method of manufacturing a laminated electronic component which is formed by stacking
10 ceramic sheets.

Description of the Background Art

A laminated electronic component is typified by a laminated ceramic capacitor, which in general is manufactured in the following manner:

15 (1) Ceramic sheets are punched into prescribed handling sizes. Thereafter end surfaces of the punched ceramic sheets are used as orientation surfaces for printing internal electrodes on the ceramic sheets. Then the internal electrodes are dried.

20 (2) A prescribed type of the ceramic sheets obtained in the above step (1) are stacked by a prescribed number using the end surfaces of the ceramic sheets as orientation surfaces similarly to the step (1).

(3) The stacked ceramic sheets are thermally
25 compressed and subjected to a cutting step, a firing step

and a step of forming external electrodes, in order to obtain a desired laminated ceramic capacitor.

In the aforementioned method of manufacturing a laminated ceramic capacitor, the end surfaces of the ceramic sheets are used as orientation surfaces for carrying out the steps (1) and (2). Thus, reliability in location has been limited in the ceramic sheets having no rigidity.

When a laminated ceramic capacitor to be obtained is miniaturized, for example, high accuracy is required for the aforementioned location in order to properly oppose the internal electrodes to each other. Further, the ceramic sheets are increasingly lowered in rigidity when the same are reduced in thickness in order to attain high capacitance, to cause difficulty in location on the basis of the end surfaces thereof.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a method of manufacturing a laminated electronic component which can advantageously solve the aforementioned problems in alignment even if the electronic component is miniaturized and high accuracy is required for alignment of internal electrodes, for example, or even if ceramic sheets are reduced in thickness and lowered in rigidity.

According to the invention there is provided a method of manufacturing a laminated electronic component by stacking a plurality of electrode pattern bearing ceramic layers punched out of a ceramic sheet, said method comprising: preparing said ceramic sheet; providing a plurality of electrode patterns at different positions on said ceramic sheet; providing a plurality of orientation marks having predetermined positional relationships with respective ones of said electrode patterns; punching said ceramic layers out of said ceramic sheet with each layer being punched out of the sheet so as to determine the position on each punched ceramic layer of its electrode pattern; and stacking a plurality of said punched layers so that they are aligned with their electrode patterns in predetermined positions relative to each other in the stack; at least the punching step of the punching and stacking steps being performed in dependence upon said orientation marks.

According to one embodiment of the present invention, all steps requiring alignment, particularly the punching and stacking steps, are carried out on the basis of the positions of the plurality of orientation marks having predetermined positional relationships with respective ones of the electrode patterns. Therefore, it is not necessary to use the

end surfaces of the ceramic sheets as orientation surfaces, whereby the ceramic sheets can be aligned in high accuracy with no regard to rigidity of the ceramic sheets. Thus, it is easy to properly align thin ceramic sheets having low rigidity, for example, whereby it is possible to easily obtain a laminated electronic component such as a thin laminated ceramic capacitor having high capacitance. Furthermore, it is not necessary to carry out the steps such as punching, stacking and the like in the same equipment in order to minimize errors that may be caused in alignment. Thus, the degree of freedom is increased in the structure of the equipment such that a multitype production line can be easily formed, for example.

When, according to another embodiment of the invention, the step of stacking the punched ceramic layers is carried out after the punching step and the equipment used in the punching step can regularly carry the ceramic layers to a correct position for carrying out the stacking step, it is not necessary to relocate the ceramic layers on the basis of the orientation marks for stacking the ceramic layers after the ceramic layers have been located by use of the orientation marks in the punching step. In such a case, the location of the ceramic layers performed in the punching step on the basis of the orientation

marks is sufficient to provide for accurate stacking of the ceramic layers.

The above and further features of the present invention are set forth with particularity in the appended claims and should become clearer from the following detailed description of the following embodiments of the present invention given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view showing a ceramic sheet employed for carrying out an embodiment of the present invention;

Fig. 2 is a sectional view showing a ceramic sheet backed with a backing sheet, which is employed for carrying out another embodiment of the present invention;

Fig. 3 is a plan view showing a ceramic sheet employed for carrying out still another embodiment of the present invention; and

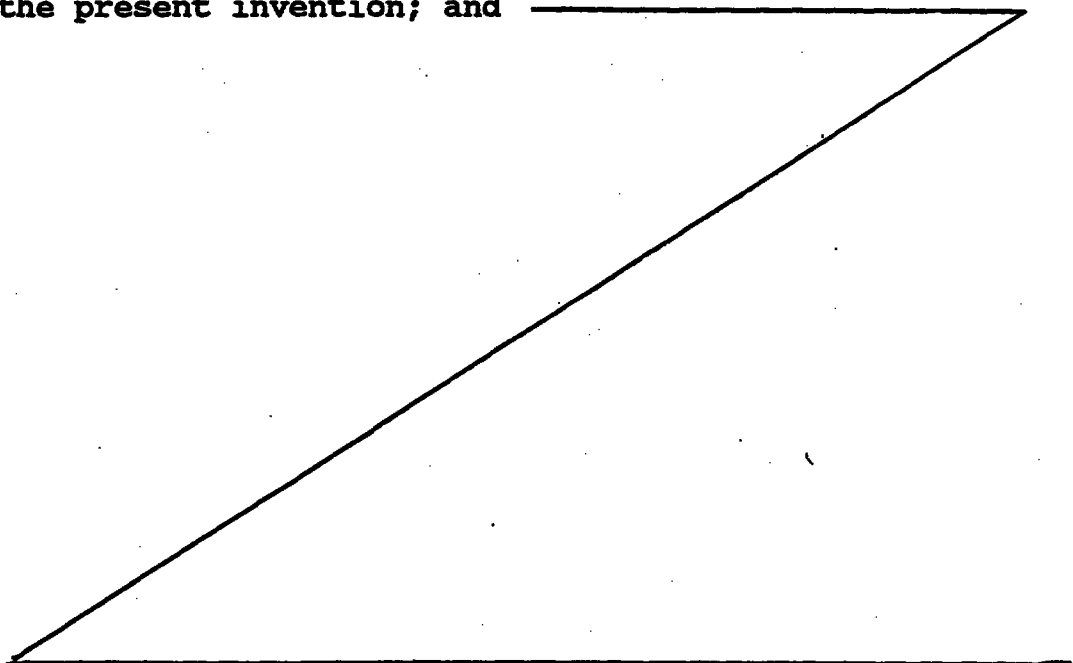


Fig. 4 is a plan view showing a ceramic sheet backed with a backing sheet, which is employed for carrying out a further embodiment of the present invention.

5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a plan view showing a ceramic sheet 1 which is employed for carrying out an embodiment of the present invention. This ceramic sheet 1 is used for manufacturing laminated ceramic capacitors, which are exemplary laminated electronic components.

The ceramic sheet 1 is subjected to a later stacking step, and thereafter cut so as to obtain a number of laminated ceramic capacitors. Thus, a number of internal electrodes 2 are vertically and transversely arranged on the ceramic sheet 1. Two orientation marks 3, for example, are formed on the surface of the ceramic sheet 1 provided with the internal electrodes 2 in regions provided with no internal electrodes 2. The orientation marks 3, which are illustrated in cross-shaped configurations, for example, may have any arbitrary configurations such as circular, T-shaped or L-shaped configurations. By providing the ceramic sheet 1 with a plurality of orientation marks 3 which are preferably separated as far as possible the accuracy in alignment is greatly improved.

The orientation marks 3 are preferably formed by printing, simultaneously with the internal electrodes

2. In this case, patterns for printing the orientation marks 3 may be formed in a screen for printing the internal electrodes 2.

The ceramic sheet 1 has a longitudinal configuration and successively fed every size Δ shown in Fig. 1, so that the same is repeatedly printed with the internal electrodes 2 and the orientation marks 3 and dried.

Then, the ceramic sheet 1 is punched and stacked on the basis of the positions of the orientation marks 3.

In more concrete terms, the ceramic sheet 1 is fed to a prescribed punching station, where the orientation marks 3 are sensed and the ceramic sheet 1 is punched by a punching blade on the basis of the positions of the orientation marks 3. The ceramic sheet 1 may be relatively roughly aligned at the punching station, so that at least the orientation marks 3 can be sensed. The ceramic sheet 1 may be further provided with other sensing marks for such rough alignment. The orientation marks 3 may be sensed at the aforementioned punching station by a well-known sensing technique through an image sensor or the like.

Then, punched ceramic sheets 1 are stacked on the basis of the positions of the orientation marks 3. The ceramic sheets 1 may be stacked in dies for compression, or on a simple plate. A laminate of the stacked ceramic sheets 1 is directly compressed when the ceramic sheets 1 are stacked in the dies for compression. When the ceramic sheets 1 are stacked on the simple plate, on the other hand, the laminate is carried into dies for compression and compressed therein.

10 When the aforementioned ceramic sheets 1 are punched and stacked in the same equipment, it may not be necessary to re-align the ceramic sheets 1 through the orientation marks 3. In this case, the orientation marks 3 may be removed in the step of punching the ceramic sheets 1.

15 The laminate of the ceramic sheets 1 compressed in the aforementioned manner is appropriately cut and subjected to a firing step and a step of forming external electrodes. Thus, desired laminated ceramic capacitors are obtained.

20 The orientation marks 3 may be formed by a method other than that employed in the aforementioned embodiment.

For example, the orientation marks 3 may be previously formed on the ceramic sheet 1, so that the internal electrodes 2 are printed on the basis of the positions of the orientation marks 3.

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Further, the orientation marks 3 may be formed by a method of providing holes, in place of the printing method.

In addition, the orientation marks 3 may not necessarily be formed on the surface of the ceramic sheet 1 provided with the internal electrodes 2. When a ceramic sheet is backed with a backing sheet of polyethylene terephthalate for example, it is possible to form orientation marks on a surface opposite to that provided with internal electrodes, i.e., the backing sheet. Also when a ceramic sheet is independently handled, it is possible to form orientation marks on a surface opposite to that provided with internal electrodes.

When a ceramic sheet 1 is backed with a backing sheet 12 as shown in Fig. 2, orientation marks 13 as well as internal electrodes 14 may be formed on a surface of the backing sheet 12 provided with the ceramic sheet 11. In this case, the internal electrodes 14 may be formed simultaneously with the orientation marks 13 by printing, for example. Alternatively, the internal electrodes 14 may be formed in another step on the basis of the positions of the orientation marks 13. The ceramic sheet 11 is formed on the backing sheet 12 which is provided

with the orientation marks 13 and the internal electrodes 14.

The aforementioned backing sheet 12 is formed of a light transmissive material. The ceramic sheet 11 is sensed by a camera 15, for example, through the backing sheet 12, to be subjected to punching and stacking steps. When the ceramic sheet 11 is separated from the backing sheet 12, at least the internal electrodes 14 are transferred onto the ceramic sheet 11.

When a plurality of electrodes 22 are formed on a ceramic sheet 21 as shown in Fig. 3, specific ones of the electrodes 22 may be employed as orientation marks. In this case, the orientation marks are preferably defined by two of these electrodes 22, such as electrodes 22a and 22b, for example, which are diagonally opposite to each other and located in most separated positions.

When a ceramic sheet 31 is formed on a backing sheet 32 by a doctor blade coater, for example, and the backing sheet 32 has portions 33' jutting out from the outlines of the ceramic sheet 31 as shown in Fig. 4, orientation marks 34 may be formed on the jutting out portions 33. When electrodes 35 are formed on the ceramic sheet 31, the same may be formed simultaneously with the orientation marks 34, or in another step on the basis of the positions of the orientation marks 34.

Although the orientation marks 34 are provided in circular configurations in Fig. 4, the same may alternatively be provided in other configurations.

The present invention is also applicable to a method of manufacturing a laminated electronic component other than the laminated ceramic capacitor. For example, the inventive method can also be applied to manufacturing of a laminated electronic component such as a multilayer circuit board, a laminated type LC filter, an L-chip, or a C-network.

Although the present invention has been described and illustrated with reference to particular embodiments, it is to be clearly understood that the embodiments described are by way of illustration and example only and that modifications and variations thereto are possible without departure from the scope of the appended claims.

**CLAIMS:**

1. A method of manufacturing a laminated electronic component by stacking a plurality of electrode pattern bearing ceramic layers punched out of a ceramic sheet,
5 said method comprising:
 preparing said ceramic sheet;
 providing a plurality of electrode patterns at different positions on said ceramic sheet;
 providing a plurality of orientation marks having
10 predetermined positional relationships with respective ones of said electrode patterns;
 punching said ceramic layers out of said ceramic sheet with each layer being punched out of the sheet so as to determine the position on each punched
15 ceramic layer of its electrode pattern; and
 stacking a plurality of said punched layers so that they are aligned with their electrode patterns in predetermined positions relative to each other in the stack;
20 at least the punching step of the punching and stacking steps being performed in dependence upon said orientation marks.
2. A method according to claim 1 wherein both of the punching and stacking steps are carried out in



dependence upon said orientation marks, each layer being punched out of the ceramic sheet by use of a respective one or more of said orientation marks, and each layer being stacked by use of the one or more orientation marks associated with the respective layer.

3. A method according to claim 1 wherein only the punching step is carried out in dependence upon said orientation marks, each layer being punched out of the ceramic sheet by use of a respective one or more of said orientation marks, and the punched sheets being carried by the equipment used in the punching step to the correct position for carrying out the stacking step.

4. A method according to claim 3 wherein the orientation marks are removed in the punching step.

5. A method according to any of the preceding claims wherein the orientation marks are first provided, and the electrode patterns are then provided at positions determined by the positions of the orientation marks.

6. A method according to any of claims 1 to 4 wherein the orientation marks and the electrode



patterns are provided simultaneously.

7. A method according to claim 6 wherein the orientation marks are constituted by parts of said electrode patterns.

5 8. A method according to any of the preceding claims wherein the electrode patterns and/or the orientation marks are provided by printing.

9. A method according to any of the preceding claims wherein the ceramic sheet is provided on a backing
10 sheet and the electrode patterns and/or the orientation marks are provided on the surface of the backing sheet that is in contact with the ceramic sheet.

10. A method according to claim 9 wherein the backing
15 sheet is formed of a transparent material enabling the orientation marks to be viewed through the backing sheet.

11. A method according to claim 9 wherein the backing
sheet has a portion which extends beyond the ceramic
20 sheet and the orientation marks are provided at said portion of the backing sheet.



12. A method substantially as herein described with reference to any of the accompanying drawings.
