

TITLE OF THE INVENTION

Device for and Method of Detecting Positioning Marks
for Cutting Ceramic Laminated Body

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to a device for and a method of detecting positioning marks in cutting a ceramic laminated body used for, for example, ceramic laminated electronic components, and more particularly, to a device for and a method of picking up an image in portions where positioning marks are formed and processing image information obtained to detect the position of a middle point of the positioning marks.

Description of the Prior Art

A ceramic laminated electronic component represented by a multilayer capacitor is formed by sintering a laminated body obtained by laminating a plurality of ceramic green sheets each having inner electrode materials printed thereon and providing outer electrodes on the outer surface of a sintered body obtained. Generally, a plurality of mother ceramic green sheets each having inner electrodes printed thereon are laminated and a mother laminated body thus obtained is cut in the direction of thickness, thereby to obtain respective laminated bodies for a multilayer capacitor in order to increase productivity.

Fig. 2 is a plan view showing a mother ceramic green sheet as described above. A plurality of inner electrode materials 2 are printed with a predetermined pitch on the upper surface of the mother ceramic green sheet 1. In addition, positioning marks for cutting 3 are formed in the outer peripheral part of the upper surface of the mother ceramic green sheet 1. The positioning marks for cutting 3 are so formed as to have a predetermined positioning relationship with the inner electrodes 2.

In obtaining the respective laminated bodies for a multilayer capacitor, a plurality of mother ceramic green sheets 1 are laminated, to obtain a mother laminated body 4. Thereafter, the outer peripheral surface of the mother laminated body obtained is cut, to expose the positioning marks for cutting 3 to the outer side surfaces of the mother laminated body 4, as shown in Fig. 3.

As shown in Figs. 4 and 5, the above described mother laminated body 4 is mounted on a cutting table 5. The cutting table 5 is constructed movably in the direction of the Y-axis and the direction of the θ -axis as shown. In the case of cutting, the positioning marks appearing on the outer side surfaces of the laminated body 4 are confirmed by the naked eye using cameras 7.

Fig. 6 shows a field of vision 8 for the cameras 7. In the case of cutting, the left end (indicated by a one-dot

and dash line A) and the right end (indicated by a one-dot and dash line B) of a plurality of positioning marks for cutting 3 which are overlapped with each other in the direction of thickness are determined while observing the field of vision 8, and the middle between the left end and the right end, that is, a middle point (which exists on a line indicated by a one-dot and dash line C) is determined, to cut the mother laminated body 4 in a cutting position D (indicated by a broken line) spaced apart from the middle point by a predetermined distance on the basis of the middle point.

Meanwhile, when a cutting edge (not shown) is not located above the cutting position D, the cutting table 5 is moved in the direction of the Y-axis or the direction of the θ -axis such that the cutting edge is located directly over the cutting position D, to perform the cutting work.

In the above described conventional method of cutting a ceramic laminated body, however, the middle point of a group of the positioning-marks for cutting 3 which are overlapped with each other in the direction of thickness is determined on the basis of the results of the observation by the naked eye. Accordingly, the variation in measurement is large and it takes long to determine the middle point.

SUMMARY OF THE INVENTION

Accordingly, the present invention aims to provide a device for and a method of detecting a middle point of a group of positioning marks for cutting accurately and instantaneously.

The present invention according to a first and a second aspect is directed to a device for and a method of detecting positioning marks for cutting a ceramic laminated body having a plurality of inner electrodes

formed therein and intended to be cut in the direction of thickness on the basis of positioning marks for cutting so provided on its outer side surfaces as to have a predetermined positional relationship with the above inner electrodes.

A device for detecting positioning marks for cutting a ceramic laminated body according to the first aspect of the present invention is characterized by comprising detecting means for detecting image information obtained from the outer side surfaces of a ceramic laminated body; binary-coding means for binary-coding the image information detected by the above detecting means based on a color density; storing means for storing the image information binary-coded by the above binary-coding means; characteristic extracting means for extracting signal regions having a color density not less than a predetermined color density out of the binary-coded image information stored in the above storing means, removing signal regions having an area not more than a predetermined area and signal regions having a length in the lateral direction not less than a predetermined length, and selecting the remaining signal regions as candidates for positioning marks for cutting; and middle point calculating means for calculating an enlarged circumscribed rectangle obtained by enlarging a rectangle circumscribing each of the candidates for positioning marks obtained by the above characteristic extracting means to a predetermined size, dividing all the candidates for positioning marks into groups such that the candidates for positioning marks whose enlarged circumscribed rectangles are overlapped with each other constitute one group, selecting as a group of positioning marks for cutting a group in which the sum of the areas of

all the candidates for positioning marks is the largest out of the groups obtained, and calculating a middle point between the leftmost end and the rightmost end of the selected group of positioning marks for cutting.

Furthermore, a method of detecting positioning marks for cutting a ceramic laminated body according to the second aspect of the present invention is characterized by comprising detecting image information obtained from the outer side surfaces of a ceramic laminated body; binary-coding the detected image information based on a color density; storing a binary-coded image signal in storing means; extracting signal regions having a color density not less than a predetermined color density from the binary-coded image signal stored in the storing means, removing signal regions having an area not more than a predetermined area as well as signal regions having a length in the lateral direction not less than a predetermined length out of the signal regions, and selecting the remaining signal regions as candidates for positioning marks for cutting; and calculating an enlarged circumscribed rectangle obtained by enlarging a rectangle circumscribing each of the selected candidates for positioning marks to a predetermined size, dividing all the candidates for positioning marks into groups such that the candidates for positioning marks whose enlarged circumscribed rectangles are overlapped with each other constitute one group, selecting as a group of positioning marks for cutting a group in which the sum of the areas of all the candidates for positioning marks is the largest out of the groups obtained, and calculating a middle point between the leftmost end and the rightmost end of the selected group of positioning

marks.

According to a third aspect of the present invention there is provided a method of positioning an article having a plurality of registration marks thereon, the method comprising identifying at least some of the registration marks, detecting extremes of position in said identified registration marks, and determining a reference position in relation to the detected extremes of position the identification of at least some of the registration marks being effected by analysing a captured image of the article to determine regions having particular color density, area and length characteristics, and selecting said registration marks from said determined regions.

According to a fourth aspect of the present invention there is provided an apparatus for positioning an article having a plurality of registration marks thereon, the apparatus comprising means for identifying at least some of the registration marks, means for detecting extremes of position in said identified registration marks, and means for determining a reference position in relation to the detected extremes of position, said means for identifying at least some of the registration marks comprising means for analysing a captured image of the article to determine regions having particular color density, area and length characteristics, and means for selecting said registration marks from said determined regions.

In the present invention, an image on the outer surface of the ceramic laminated body on which the positioning marks are arranged is detected as image information by the detecting means, and the image information is subjected to image processing, thereby to detect the position of a middle point of the

positioning marks. Consequently, a middle point of a group of positioning marks can be detected without depending on the naked eye, thereby to make it possible to detect the middle point of the group of positioning marks accurately and rapidly.

The above and further features of the present invention are set forth with particularity in the appended claims and together with the advantages thereof will become clearer by consideration of the following detailed description of an embodiment of the invention given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic block diagram showing a device for detecting positioning marks for cutting embodying the present invention;

Fig. 2 is a plan view of a conventional arrangement showing inner electrode materials and positioning marks for cutting formed on a mother ceramic green sheet;

Fig. 3 is a perspective view of a conventional mother ceramic laminated body having positioning marks appearing on its outer side surfaces;

Figs. 4 and 5 are respective plan and front views of a conventional device for cutting the conventional mother ceramic laminated body of Figure 3;

Fig. 6 is a diagram showing the field of vision of cameras in the conventional device of Figures 4 and 5;

Fig. 7 is a schematic diagram of an image of a mother ceramic laminated body stored in an image memory according to the embodiment of the invention;

Fig. 8 is a schematic diagram showing the use of a rectangle circumscribing a positioning mark and an enlarged circumscribed rectangle embodying the present

invention; and

Fig. 9 is a schematic diagram showing the step of finding a middle point of positioning marks embodying the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENT

Fig. 1 is a schematic block diagram showing a positioning mark detecting device according to an embodiment of the present invention. A mother ceramic laminated body 4 is mounted on a stage 11. The stage 11 is constructed similarly to the cutting stage 5 in the description of the prior art. More specifically, the stage 11 is so constructed that it can be moved in the direction of the Y-axis and the direction of the θ -axis shown in Fig. 4.

A camera 12 is disposed in the side part of the mother ceramic laminated body 4. The camera 12 is so provided as to image the outer side surfaces of the ceramic laminated body 4 on the basis of light irradiated to the outer side surfaces of the ceramic laminated body 4 from a light source (not shown). This camera 12 images the outer side surfaces of the ceramic laminated body 4 and outputs its image information in the form of an analog signal.

An analog-to-digital converter 13 serving as binary-coding means is connected to the camera 12, to binary-code

an image information signal outputted from the camera 12 based on a color density.

An image memory 14 is connected to the analog-to-digital converter 13, to store the image information signal binary-coded by the analog-to-digital converter 13.

A characteristic extractor 15 is connected to the image memory 14, to extract positioning marks and regions similar to the positioning marks, that is, candidates for positioning marks from the image information obtained from the outer side surfaces of the mother ceramic laminated body 4. In addition, a middle point calculating device 16 is connected to the characteristic extractor 15, to select positioning marks from the candidates for positioning marks for cutting selected by the characteristic extractor 15 and calculate a middle point of a group of positioning marks for cutting.

Fig. 7 is a diagram schematically showing an image of the mother ceramic laminated body 4 picked up by the camera 12. In Fig. 7, reference numeral 21 denotes the outer side surface of the mother ceramic laminated body 4, and reference numerals 22a and 22b denote backgrounds. In addition, portions hatched in the direction different from hatching of the backgrounds 22a and 22b are portions having a color density relatively higher than that of the base portion of the mother ceramic laminated body 4, and include

positioning marks 23a to 23f and spots 24 to 26.

In the above described analog-to-digital converter 13, the backgrounds 22a and 22b, the positioning marks 23a to 23f, the spots 24 to 26 and the like are distinguished from the base portion of the outer side surface 21 of the ceramic laminated body 4 on the basis of the difference in color density.

In the characteristic extractor 15, regions having a color density not less than a predetermined color density, that is, regions hatched are first extracted from the image information signal based on the image shown in Fig. 7 and then, it is determined whether or not each of the regions has an area not more than a predetermined area and has a length in the lateral direction not less than a predetermined length, to remove the regions having an area not more than the predetermined area and the regions having a length in the lateral direction not less than the predetermined length. This predetermined area is previously determined so as to distinguish the positioning marks 23a to 23f from the spot 24 which is significantly smaller than the positioning marks 23a to 23f, and is set to a suitable area depending on the sizes of the ceramic laminated body and the positioning marks. On the other hand, the above described predetermined length in the lateral direction is determined so as to distinguish the positioning marks 23a to 23f from

the backgrounds 22a and 22b, and is also set to a suitable length depending on the sizes of the ceramic laminated body and the positioning marks.

In the above described manner, in the characteristic extractor 15, the spot 24 having an area much smaller than that of the positioning marks 23a to 23f is removed, and the remaining regions having a color density not less than a predetermined color density, that is, the positioning marks 23a to 23f and the spots 25 and 26 are selected as candidates for positioning marks.

The following calculation is performed in the middle point calculating device 16 using the regions selected in the characteristic extractor 15 as candidates for positioning marks, to detect the position of a middle point of a group of positioning marks.

As shown in Fig. 8, a rectangle P circumscribing, for example, a candidate for a positioning mark 12a selected is first calculated, and an enlarged circumscribed rectangle Q obtained by enlarging the rectangle P to a predetermined size is calculated. Then, all the candidates for positioning marks are divided into groups such that the candidates for positioning marks whose enlarged circumscribed rectangles Q are overlapped with each other constitute one group. More specifically, in Fig. 7, the positioning marks 23a to 23f constitute one group, and the

relatively large spots 25 and 26 constitute another group.

A group in which the sum of the areas of all the candidates for positioning marks is the largest is then selected out of the groups obtained, to determine the group as a group of positioning marks for cutting. More specifically, in Fig. 7, the group comprising the positioning marks 23a to 23f is determined as a group of positioning marks because the sum of the areas of the candidates for positioning marks in the group is the largest.

Additionally, as shown in Fig. 9, the position of a middle point U is calculated on the basis of the leftmost end and the rightmost end (respectively indicated by broken lines S and T) of the positioning marks 23a to 23d (23e and 23f are omitted in Fig. 9) in the selected group of positioning marks.

The cutting stage shown in Fig. 1 is moved in the direction of the Y-axis and the direction of the θ -axis on the basis of the position of the middle point obtained in the above described manner, to cut the mother ceramic laminated body 4 in the direction of thickness in a predetermined cutting position.

Having thus described the present invention with reference to a particular embodiment, it is to be appreciated that the described embodiment is exemplary

only and is susceptible to modification and variation without departure from the scope of the invention as determined by the appended claims..



CLAIMS:

1. A device for detecting positioning marks for cutting a ceramic laminated body having a plurality of inner electrodes formed therein and having positioning marks for cutting so formed on its outer side surfaces as to have a predetermined positional relationship with said inner electrodes, and intended to be cut in the direction of thickness on the basis of the positioning marks for cutting, said device comprising:

detecting means for detecting image information obtained from the outer side surfaces of said ceramic laminated body;

binary-coding means for binary-coding the image information detected by said detecting means based on a color density;

storing means for storing the image information binary-coded by said binary-coding means;

characteristic extracting means for extracting signal regions having a color density not less than a predetermined color density from the binary-coded image information stored in said storing means, removing regions having an area not more than a predetermined area as well as regions having a length in the lateral direction not less than a predetermined length out of the signal regions having a color



density not less than a predetermined color density, and selecting the remaining regions as candidates for positioning marks for cutting; and

middle point calculating means for calculating an enlarged circumscribed rectangle obtained by enlarging a rectangle circumscribing each of the candidates for positioning marks obtained by said characteristic extracting means to a predetermined size, dividing all the candidates for positioning marks into a plurality of groups such that the candidates for positioning marks whose enlarged circumscribed rectangles, are overlapped with each other constitute one group, selecting as a group of positioning marks a group in which the sum of the areas of all the candidates for positioning marks is the largest out of the groups, finding the leftmost end and the rightmost end of the selected group of positioning marks, and calculating a middle point of the positioning marks.

2. A device according to claim 1, wherein the color density for obtaining the binary-coded signal by said binary-coding means is a color density between the color density of the base of said ceramic laminated body and the color density of the positioning marks.

3. A method of detecting positioning marks for



cutting a ceramic laminated body having a plurality of inner electrodes formed therein, having a plurality of positioning marks for cutting so formed on its outer side surfaces as to have a predetermined positional relationship with said inner electrodes, and intended to be cut in the direction of thickness on the basis of the positioning marks for cutting, said method comprising:

obtaining image information from the outer side surfaces of the ceramic laminated body;

binary-coding the image information based on the difference in color density;

extracting signal regions having a color density not less than a predetermined color density from a binary-coded image signal, removing regions having an area not more than a predetermined area as well as regions having a length in the lateral direction not less than a predetermined length out of the signal regions having a color density not less than a predetermined color density, and selecting the remaining regions as candidates for positioning marks; and

calculating an enlarged circumscribed rectangle obtained by enlarging a rectangle circumscribing each of the candidates for positioning marks to a predetermined size, dividing all the candidates for



positioning marks into a plurality of groups such that the candidate for positioning marks whose enlarged circumscribed rectangles are overlapped with each other constitute one group, selecting as a group of positioning marks a group in which the sum of the areas of all the candidates for positioning marks is the largest out of the groups, and finding a middle point of the positioning marks on the basis of the leftmost end and the rightmost end of the selected group of positioning marks.

4. A method according to claim 3, wherein said predetermined color density is a color density between the color density of the base of the ceramic laminated body and the color density of the positioning marks.

5. A method of positioning an article having a plurality of registration marks thereon, the method comprising identifying at least some of the registration marks, detecting extremes of position in said identified registration marks, and determining a reference position in relation to the detected extremes of position the identification of at least some of the registration marks being effected by analysing a captured image of the article to determine regions having particular color density, area and



length characteristics, and selecting said registration marks from said determined regions.

6. An apparatus for positioning an article having a plurality of registration marks thereon, the apparatus comprising means for identifying at least some of the registration marks, means for detecting extremes of position in said identified registration marks, and means for determining a reference position in relation to the detected extremes of position, said means for identifying at least some of the registration marks comprising means for analysing a captured image of the article to determine regions having particular color density, area and length characteristics, and means for selecting said registration marks from said determined regions.

7. A method substantially as described herein with reference to the accompanying drawings.

8. An apparatus substantially as described herein with reference to Figures 1, 4, 5 and 7 to 9 of the accompanying drawings.