

REPLACED SHEETS SG

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TITLE OF THE INVENTION

Multilayer Electronic Component, Method of
Manufacturing the Same and Method of Measuring
Characteristics Thereof

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a multilayer
electronic component having internal circuit elements
arranged therein, a method of manufacturing the same and a
10 method of measuring characteristics thereof, and more
particularly, it relates to an improvement in a mode of
forming external electrodes in a multilayer electronic
component.

Description of the Background Art

15 A multilayer electronic component, which is
represented by a multilayer capacitor, a multilayer
inductor, a multilayer circuit board or a multilayer
composite electronic component, for example, comprises a
laminate which is obtained by stacking a plurality of
20 insulating sheets with interposition of internal circuit
elements such as conductor films and/or resistor films.
The insulating sheets are typically prepared from ceramic
sheets.

Fig. 15 is a perspective view showing the appearance
25 of a conventional multilayer electronic component 1. The



multilayer electronic component 1 comprises a laminate 2 which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements .

(not shown). The laminate 2 is provided on its four side

5 surfaces, for example, with external electrodes 3

respectively. These external electrodes 3 are

electrically connected with the internal circuit elements

which are located in the interior of the laminate 2. The

external electrodes 3 are formed by applying proper metal

10 paste to specific positions of the respective side

surfaces of the laminate 2, and parts of the external

electrodes 3 necessarily extend circumferentially on upper

and lower surfaces of the laminate 2 at this time.

Fig. 16 is a perspective view showing the appearance

15 of another type of conventional multilayer electronic

component 4. This multilayer electronic component 4 also

comprises a laminate 5 which is obtained by stacking a

plurality of insulating sheets with interposition of

internal circuit elements (not shown). The laminate 5 is

20 provided on its four side surfaces, for example, with

external electrodes 6 which are electrically connected

with the internal circuit elements. These external

electrodes 6 are provided by dividing through holes 7, as

shown by phantom lines in Fig. 16. Namely, a mother

25 laminate is so prepared that a plurality of multilayer



electronic components 4 can be obtained when the same is cut along prescribed cutting lines. The through holes 7 are formed in this mother laminate so that conductor films are formed on inner peripheral surfaces thereof for
5 defining the external electrodes 6, and the mother laminate is thereafter cut to divide the through holes 7. Also in such a multilayer electronic component 4, parts of the external electrodes 6 extend circumferentially on upper and lower surfaces of the laminate 5, due to the
10 method of forming the conductor films for defining the external electrodes 6.

These multilayer electronic components 1 and 4 are surface-mounted on proper circuit boards through the external electrodes 3 and 6, in the form of chips.

15 In both of the aforementioned multilayer electronic components 1 and 4, however, the external electrodes 3 and 6 are formed to extend toward the upper and lower surfaces of the laminates 2 and 5. When other components are mounted on the upper and/or lower surface(s) of such
20 multilayer electronic components 1 and 4 to be composited with the same, therefore, areas capable of mounting such components are restricted.

Further, the parts of the external electrodes 3 and 6 extending toward the upper and lower surfaces of the
25 laminates 2 and 5 inhibit reduction of arrangement pitches



for the external electrodes 3 and 6. In addition, it is relatively difficult to form such parts of the external electrodes 3 and 5 in constant sizes and shapes, and this also inhibits reduction of the arrangement pitches for the
5 external electrodes 3 and 6.

Particularly in the multilayer electronic component 4 shown in Fig. 16, it is difficult to reduce the diameters of the through holes 7, which are formed by a drill, below 0.3 mm, and this also restricts the arrangement pitches
10 for the external electrodes 6. Further, the drill for forming the through holes 7 has a relatively short life, leading to increase in cost.

In the multilayer electronic component 1 shown in Fig. 15, on the other hand, the external electrodes 3 are
15 formed on the four side surfaces of the laminate 2 respectively and hence it is necessary to carry out at least application of the metal paste onto the respective side surfaces independently of each other. As the result, the number of steps for forming the external electrodes 3
20 is increased.

On the other hand, it is necessary to measure characteristics of the multilayer electronic components 1 and 4 at least in advance of shipping. In both of the multilayer electronic components 1 and 4, however, the
25 characteristics cannot be measured unless the same are



brought into states of chips in principle. In the multilayer electronic component 1 shown in Fig. 15, measurement of the characteristics is enabled after formation of the external electrodes 3. Also in the case shown in Fig. 16, the characteristics of each multilayer electronic component 4 cannot be measured in the stage of the mother laminate. Such measurement of the characteristics is enabled only when the mother laminate is cut to divide the through holes 7.

10 SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a multilayer electronic component which can reduce arrangement pitches for external electrodes, and a method of manufacturing the same.

15 Another object of the present invention is to provide a characteristic measuring method which can efficiently measure characteristics of a plurality of multilayer electronic components.

20 A multilayer electronic component according to the present invention comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements, and external electrodes which are formed on outer surfaces of the laminate to be electrically connected with the internal
25 circuit elements. The external electrodes are formed by



exposing at least side portions of via holes, which are provided in the insulating sheets and coated with conductive materials, by cutting the insulating sheets.

5 A method of manufacturing a multilayer electronic component according to the present invention comprises a step of preparing a mother laminate, which is to be cut along prescribed cutting lines for obtaining a plurality of multilayer electronic components, being obtained by stacking a plurality of mother insulating sheets with
10 interposition of internal circuit elements for the respective multilayer electronic components to distribute the internal circuit elements in regions parted by the cutting lines and having via holes, coated with conductive materials being electrically connected with the internal
15 circuit elements, provided in positions to be exposed on cut surfaces by cutting along the cutting lines, and a step of cutting the mother laminate along the cutting lines.

20 A method of measuring characteristics of a multilayer electronic component according to the present invention comprises a step of preparing a mother laminate, which is to be cut along prescribed cutting lines for obtaining a plurality of multilayer electronic components, obtained by stacking a plurality of mother insulating sheets with
25 interposition of internal circuit elements for the



respective multilayer electronic components to distribute the internal circuit elements in regions parted by the cutting lines and provided with via holes, coated with conductive materials being electrically connected with the internal circuit elements, in positions to be exposed on cut surfaces by cutting along the cutting lines, a step of forming grooves in the mother laminate along the cutting lines thereby exposing at least the via holes on inner side surfaces of the grooves, and a step of measuring characteristics of each multilayer electronic component while treating the via holes being exposed on the inner side surfaces of the grooves as external electrodes.

The configuration of the multilayer electronic components provided in the aforementioned characteristic measuring method, i.e., an assembly of the multilayer electronic components consisting of the mother laminate provided with the grooves, can be shipped in this state.

According to the inventive multilayer electronic component, the external electrodes are provided by exposing at least side portions of the via hole which are coated with conductive materials. In this case, the via holes can be readily formed in small diameters by punching with no employment of a drill, whereby arrangement pitches for the external electrodes can be reduced. Further, it is possible to avoid increase in cost resulting from a



short life of a drill since it is not necessary to employ such a drill.

The external electrodes provided by the via holes require no mode of formation of extending

5 circumferentially on at least one major surface of the laminate, whereby at least one major surface of the laminate can be widely employed as a surface for mounting another component to be composited with the same.. Thus, it is possible to improve density in component mounting.

10 Since the external electrodes are provided by the conductive materials which are applied to the via holes, it is possible to attain relatively large dimensions corresponding to film thicknesses of the external electrodes by filling up the via holes with the conductive
15 materials. Thus, it is possible to reduce a problem of solder leaching when the multilayer electronic component is soldered to a circuit board. Since the conductive materials for defining the external electrodes are embedded in parts of the via holes, it is possible to
20 improve strength of soldering.

According to the inventive method of manufacturing a multilayer electronic component, the via holes coated with the conductive materials for providing the external electrodes are already formed in the mother laminate so
25 that the conductive materials are exposed to define the



external electrodes by cutting the mother laminate,
whereby no specific step is required for providing the
external electrodes.

According to the inventive method of measuring
5 characteristics of a multilayer electronic component,
further, it is possible to independently measure
characteristics of a plurality of multilayer electronic
components, which are mechanically integrated with each
other in the form of a mother laminate in a state being
10 electrically independent of each other, due to formation
of the grooves. Therefore, it is not necessary to handle
mechanically independent multilayer electronic components,
but characteristics of a number of multilayer electronic
components can be efficiently measured by screening, for
15 example.

When the assembly of the multilayer electronic
components consisting of a mother laminate provided with
the grooves, which is a configuration to be subjected to
the aforementioned measurement of characteristics, is
20 shipped in this state, the user can take out the
respective multilayer electronic components from the
mother laminate by simply dividing the same along the
grooves. It is to be noted that each multilayer
electronic component can be subjected to mounting with no
25 problem in this case since the same can be through with



measurement of its characteristics, and the assembly of such multilayer electronic components is easy to pack and handle as compared with multilayer electronic components which are separated from each other.

5 The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

10 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention;

15 Fig. 2 is a perspective view showing a mother laminate 14 which is prepared for obtaining the multilayer electronic component 10 shown in Fig. 1;

Fig. 3 is an enlarged perspective view illustrating grooves 20 which are formed in the mother laminate 14 shown in Fig. 2 for enabling measurement of
20 characteristics;

Fig. 4 is a perspective view showing the appearance of a multilayer electronic component 10a according to another embodiment of the present invention;

25 Fig. 5 is a sectional view illustrating the multilayer electronic component 10a shown in Fig. 4 which



is mounted on a circuit board 31;

Fig. 6 is a sectional view illustrating a terminal member 33 which is mounted on the multilayer electronic component 10a shown in Fig. 4;

5 Fig. 7 is a perspective view showing the appearance of a multilayer electronic component 10b according to still another embodiment of the present invention;

Fig. 8 is a perspective view showing the appearance of a multilayer electronic component 10c according to a
10 further embodiment of the present invention;

Fig. 9 is a perspective view showing the appearance of a multilayer electronic component 10d according to a further embodiment of the present invention;

Fig. 10 is a perspective view showing the appearance
15 of a multilayer electronic component 10e according to a further embodiment of the present invention;

Fig. 11 is a perspective view showing the appearance of a multilayer electronic component 10f according to a further embodiment of the present invention;

20 Fig. 12 is a plan view showing a part of a mother laminate 14 for illustrating a further embodiment of the present invention;

Fig. 13 is a sectional view showing a cased multilayer electronic component 42 according to a further
25 embodiment of the present invention;



Fig. 14 is a sectional view showing a cased multilayer electronic component 42a according to a further embodiment of the present invention;

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component 1; and

Fig. 16 is a perspective view showing the appearance of another type of conventional multilayer electronic component 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention. While the multilayer electronic component 10 is mounted on a proper circuit board in the chip-type configuration as illustrated, Fig. 1 shows the multilayer electronic component 10 in a state upwardly directing its surface which is faced toward such a circuit board.

The multilayer electronic component 10 comprises a laminate 11, which is formed by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 11 is provided on respective ones of its four side surfaces, for example, with external electrodes 12 which are exposed on outer surfaces of the laminate 11. These external electrodes 12 are electrically connected with the internal circuit



elements (not shown).

The aforementioned external electrodes 12 are formed by exposing at least side portions of via holes, which are provided in the insulating sheets and filled up with
5 conductive materials, by cutting the insulating sheets, as clearly understood from the following description of a manufacturing method. The laminate 11 is provided on respective ones of its four side surfaces, for example, with steps 13, while the reason why such steps 13 are
10 formed is also clarified by the following description of the manufacturing method.

In order to obtain the aforementioned multilayer electronic component 10, a mother laminate 14 is prepared as shown in Fig. 2. The mother laminate 14, which is to
15 be cut along prescribed cutting lines 15 shown by one-dot chain lines to provide a plurality of multilayer electronic components 10, is obtained by stacking a plurality of mother insulating sheets 16 and a plurality of mother insulating sheets 17 with interposition of
20 internal circuit elements (not shown) for the respective multilayer electronic components 10 to distribute the internal circuit elements in respective regions parted through the cutting lines 15. This mother laminate 14 is provided with via holes 19 filled up with conductive
25 materials 18 which are electrically connected with the



internal circuit elements (not shown) in positions to be partitioned by cutting along the cutting lines 15. The external electrodes 12 shown in Fig. 1 are provided by the conductive materials 18 which are filled up in the via holes 19.

In order to obtain the aforementioned mother laminate 14, the following steps are carried out, for example. According to this embodiment, the mother insulating sheets 16 and 17 are formed by ceramic sheets.

First, sheet forming is carried out by a doctor blade coater or the like, to obtain ceramic green sheets for defining the mother insulating sheets 16 and 17. Specific ones of these ceramic green sheets are provided with via holes by punching or the like, in order to enable electrical conduction through the sheets along the direction of thickness. At this time, the ceramic green sheets for defining the mother insulating sheets 16, which are located on relatively upper portions in Fig. 2, are further provided with via holes 19. Then, conductor films and/or resistor films for serving as internal circuit elements are printed on specific ones of the ceramic green sheets. At this time, the already formed via holes are filled up with conductive materials, while the via holes 19 shown in Fig. 2 are filled up with conductive materials 18. When the conductor films are printed from lower



surface sides of the mother insulating sheets 16 shown in Fig. 2, it is possible to prevent the conductive materials 18 from forming conductive lands in peripheral edge portions of the via holes 19 on upper surface sides of the mother insulating sheets 16. It is pointed out that even such conductive lands are within the scope of the present invention.

Then, the aforementioned mother insulating sheets 16 and 17 are stacked with each other and pressed. Thus, the mother laminate 14 is obtained. In this mother laminate 14, the via holes 19 provided in the respective ones of the plurality of mother insulating sheets 16 are aligned along the direction of thickness, whereby the conductive materials 18 filled up in the via holes 19 are connected in series with each other.

Then, grooves 20 are formed in the mother laminate 14 along cutting lines 15 (Fig. 2) with a dicing saw, for example, so that at least the via holes 19 are parted, for example. With such formation of the grooves 20, the via holes 19 are exposed on inner side surfaces of the grooves 20, while the conductive materials 18 which are filled up in the via holes 19 are parted so that portions enclosed by the grooves 20 for defining individual multilayer electronic components 10 are electrically independent of each other. Preferably, slits 21 and 22 are formed in



bottom surfaces of the grooves 20 and lower surface portions of the mother laminate 14 opposite thereto respectively. Either the slits 21 or 22 may be omitted.

Fig. 3 shows some conductor films 23 and 24 for serving as internal circuit elements. This figure also shows states of the conductor films 23 electrically connected with the conductive materials 18.

Then, the mother laminate 14 is fired to sinter ceramic materials forming the mother insulating sheets 16 and 17. Thereafter surfaces of the mother laminate 14 are provided with conductor films and/or resistor films, covered with an overcoat, and coated with solder resist. If necessary, the conductive materials 18 for forming external electrodes 3 and other conductor films are plated.

When the aforementioned steps are completed, the plurality of multilayer electronic components 10 included in the mother laminate 14 are so electrically independent of each other that it is possible to measure characteristics of each multilayer electronic component 10 while treating the conductive materials 18 provided in the respective portions of the via holes 19 parted by the grooves 20 as external electrodes.

After the characteristics are measured, other electronic components are mounted on those of the



multilayer electronic components 10 which are determined as nondefective, to be composited with the same. The steps heretofore described can be efficiently carried out in the state of the mother laminate 14. The multilayer electronic components 10 may be shipped in this stage.

Then, the mother laminate 14 is completely cut along the cutting lines 15 (Fig. 2), i.e., the grooves 20 (Fig. 3), in order to obtain a plurality of multilayer electronic components 10 which are mechanically independent of each other. Such cutting is readily attained by dividing the mother laminate 14 like a chocolate bar along the grooves 20. The aforementioned slits 21 and 22 facilitate such division.

Thus, the multilayer electronic component 10 shown in Fig. 1 is obtained. As understood from the above description, the steps 13 result from the formation of the aforementioned grooves 20. When the laminate 11 is classified into upper and lower half portions through a boundary surface corresponding to the positions of the steps 13, the external electrodes 12 are exposed only on the upper half portion.

Then, the multilayer electronic component 10 is covered with a case at need. This case is adapted to cover other components which may be mounted on a lower surface of the multilayer electronic component 10



appearing in Fig. 1. This case is described later with reference to Figs. 13 and 14.

While the present invention has been described with reference to the embodiment shown in Figs. 1 to 3, various
5 modifications are available within the scope of the present invention.

While the external electrodes 12 shown in Fig. 1 are formed to be exposed not only on the side surfaces of the laminate 11 but on the upper surface appearing in Fig. 1,
10 such external electrodes 12a may be formed to be exposed only on side surfaces of a laminate 11 in a multilayer electronic component 10a shown in Fig. 4, for example. Referring to Fig. 4, elements corresponding to those shown in Fig. 1 are denoted by similar reference numerals, to
15 omit redundant description.

According to the multilayer electronic component 10a shown in Fig. 4, it is possible to widely utilize not only a lower surface of the laminate 11 appearing in this figure but the upper surface as mounting surfaces for
20 other components to be composited with this component 10a, with no interference by the external electrodes 12a. In order to obtain such a multilayer electronic component 10a, mother insulating sheets having no via holes 19 for forming external electrodes may be employed to form some
25 of those located on an upper portion of the mother



lamine 14 in a stage of manufacturing the mother
lamine 14 shown in Fig. 2.

When the aforementioned multilayer electronic
component 10a is placed on a circuit board 31 as shown in
5 Fig. 5, a gap is defined between the circuit board 31 and
each external electrode 12a. In order to mount the
multilayer electronic component 10a on the circuit board
31 in such a state, a solder fillet 32 is advantageously
employed in order to electrically connect the external
10 electrode 12a with a conductive land (not shown) on the
circuit board 31.

Alternatively, a terminal member 33 of a metal may be
mounted on each external electrode 12a of such a
multilayer electronic component 10a, as shown in Fig. 6.

15 The external electrodes 12 of the mode shown in Fig.
1 may be mixed with the external electrodes 12a of the
mode shown in Fig. 4 in a single multilayer electronic
component.

While the via holes 19 for providing the external
20 electrodes 12 have circular sections in the embodiment
shown in Figs. 1 to 3, such sections may be changed to
other forms such as rectangular shapes. Further, a single
external electrode may be provided by a plurality of via
holes which are partially overlapped with each other in
25 section, or by a via hole long from side to side, in order



to expose such external electrodes in wider areas.

The grooves 20 and the slits 21 and 22 may be formed after firing of the mother laminate 14. If no efficiency in formation of the conductor films/resistor films on the fired laminate 14 or plating or characteristic measurement is taken into consideration, the mother laminate 14 may be cut along the cutting lines 15 before firing, so that the multilayer electronic components 10 are fired in .

mechanically separated states. Further, the mother laminate 14 may be cut along the cutting lines 15 immediately after firing, through no stage of forming the grooves 20.

The conductive materials 18 to be filled up in the via holes 19 may not be applied simultaneously with printing of the conductor films, but the via holes 19 may be filled up with metal paste in another step. In this case, it is also possible to simultaneously fill up the conductive materials 18 in the plurality of via holes 19 being aligned in series with each other in the plurality of mother insulating sheets 16 which are stacked with each other.

The insulating sheets are not restricted to ceramic sheets, but may be prepared from other materials.

As shown in Fig. 7, further, external electrodes 12b of a multilayer electronic component 10b may be provided



by conductive materials which are layered on inner peripheral surfaces of the via holes 19 (Figs. 2 and 3). In this case, the external electrodes 12b define cavities on outer surfaces thereof.

5 The present invention is not restricted to a multilayer electronic component having a plurality of external electrodes all of which are formed on the basis of via holes, but is also applicable to a multilayer electronic component including some external electrodes
10 which are formed by another method.

 As shown in Fig. 8, for example, a multilayer electronic component 10c may have some external electrodes 12 which are formed on the basis of via holes and other external electrodes, such as shielding electrodes 25, for
15 example, which are formed by another method. In formation of the grooves 20 as shown in Fig. 3, for example, grooves 20 having inner side surfaces to be provided with such shielding electrodes 25 are first prepared so that metal paste is filled up in these grooves 20 by injection.
20 Finally the grooves 20 are cut again to part conductive materials provided by the metal paste, thereby forming the shielding electrodes 25. These shielding electrodes 25 are often electrically connected with ground-side internal circuit elements (not shown) of the laminate 11.

25 The aforementioned shielding electrodes 25 may



alternatively be formed on the basis of via holes, as a matter of course. In this case, the via holes are formed by slots longitudinally extending along the shielding electrodes 25. Such shielding electrodes 25 may be formed
5 after the individual multilayer electronic components 10c are obtained.

As shown in Fig. 9, shielding electrodes 25a may be formed to extend downwardly beyond steps 13, in order to improve shielding performance. Such shielding electrodes
10 25a can be formed by any of the following methods, for example:

(a) A method of forming the overall shielding electrodes 25a on the basis of via holes.

(b) A method of forming only lower half portions of
15 the shielding electrodes 25a beyond the steps 13 on the basis of via holes while forming upper half portions by filling up the grooves 20 shown in Fig. 3 with metal paste.

(c) A method of forming upper half portions of the
20 shielding electrodes 25a by filling up the grooves 20 with metal paste, obtaining individual multilayer electronic components 10a, and thereafter forming lower half portions.

(d) A method of forming upper half portions of the
25 shielding electrodes 25a on the basis of via holes,



obtaining individual multilayer electronic components 10d,
and thereafter forming lower half portions.

(e) A method of forming the overall shielding
electrodes 25a after obtaining individual multilayer
5 electronic components 10d.

When the method (a) or (b) is employed among the
aforementioned methods of forming the shielding electrodes
25a, the plurality of multilayer electronic components 10d
are electrically connected with each other through the
10 shielding electrodes 25a and not yet completely
electrically independent of each other in a stage provided
with the grooves 20 shown in Fig. 3. However, no
hindrance is caused in measurement of characteristics of
the individual multilayer electronic components 10d in the
15 aforementioned state of the mother laminate 14 when the
shielding electrodes 25a are adapted to serve as a common
earthed electrode in such characteristics measurement.

In the multilayer electronic component 10d shown in
Fig. 9, an area which is provided on the lower surface of
20 the laminate 11 for mounting other components may be
narrowed by the shielding electrodes 25a. In order to
avoid such inconvenience, shielding electrodes 25b may be
formed not to reach a lower surface of a laminate 11
provided in a multilayer electronic component 10e, as
25 shown in Fig. 10.



In relation to each mode of formation of the shielding electrodes 25, 25a and 25b shown in Figs. 8 to 10, the upper half portion(s) of the shielding electrode(s) may be formed on only one or three side surfaces of the laminate 11. The lower half portions of the shielding electrodes may be formed on three or four side surfaces of the laminate 11. Although only the shielding electrodes 25 corresponding to upper half portions are provided in Fig. 8, only shielding electrodes corresponding to lower half portions may alternatively be provided.

As shown in Fig. 11, further, a shielding electrode 25c may be provided on a multilayer electronic component 10f to cover only a part of one side surface of a laminate 11 along the cross direction.

In each of the aforementioned embodiments, each via hole 19 is so parted as to define external electrodes 12 for respective ones of two multilayer electronic components 10. When the width of each groove 20 shown in Fig. 3 occupies a considerable part along the diameter of each via hole 19, however, a single via hole 19a may be adapted to define a single external electrode, as shown in Fig. 12. Fig. 12 shows parts of the via holes 19a before formation of the groove 20 with two-dot chain lines.

Fig. 13 is a sectional view showing a multilayer

electronic component 42 which is covered with a case 41.

A laminate 43 provided in the multilayer electronic component 42 has steps 44, and external electrodes 45 are formed under these steps 44. Some electronic components
5 46 are mounted on an upper surface of the laminate 43 appearing in Fig. 13 for compositing this multilayer electronic component 42. The case 41 is made of a metal. This case 41 is provided with steps 47 in conformity with side surfaces of the laminate 43, and soldered to the
10 external electrodes 45, for example.

Fig. 14 shows another multilayer electronic component 42a which is covered with a case 41a. Referring to Fig. 14, elements corresponding to those shown in Fig. 13 are denoted by similar reference numerals, to omit redundant
15 description.

Referring to Fig. 14, a laminate 43 which is provided in the multilayer electronic component 42a is formed not only with steps 44 but with further steps 48. On the other hand, the case 41a is provided with steps 49 which
20 are engaged with the steps 48. The steps 49 of the case 41a are so engaged with the steps 48 of the laminate 43 that the case 41a is further strongly mounted on the laminate 43. Even if force is applied to the upper surface of the case 41a to downwardly press the same, in
25 particular, the case 41a is not disengaged from the



external electrodes 45. Such force of downwardly pressing the case 41a is often applied from a vacuum suction chuck (not shown) which sucks the multilayer electronic component 42a toward the upper surface of the case 41 for holding the same. The steps 48 can be formed on the laminate 43 by a method similar to that for the steps 44. Namely, grooves similar to the grooves 20 may be formed from below in positions corresponding to the grooves 20 in the stage of the mother laminate 14 shown in Fig. 3.

Although the present invention has been described and illustrated in detail, it is clearly understood that the 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 limited only by the terms of the appended claims.





WHAT IS CLAIMED IS:

1. A multilayer electronic component comprising:
a laminate (11) being obtained by stacking a plurality of insulating sheets (16, 17) with interposition of internal circuit elements (23, 24), said laminate
5 having first and second opposite major surfaces and side surfaces coupling said major surfaces with each other; and
external electrodes (12) being formed on outer surfaces of said laminate (11) to be electrically connected with said internal circuit elements (23, 24),
10 said external electrodes (12) being formed by exposing at least side portions of via holes (19), being provided in said insulating sheets (16, 17) and coated with conductive materials (18), by cutting said insulating sheets (16, 17).
2. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are filled up in said via holes (19).
3. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are layered on inner peripheral surfaces of said via holes (19).



4. A multilayer electronic component in accordance with claim 1, wherein said laminate (11) is classified into a first half portion being closer to said first major surface and a second half portion being closer to said second major surface by a boundary surface extending in parallel with said major surfaces, said external electrodes (12) being exposed only on said first half portion.

5. A multilayer electronic component in accordance with claim 4, further comprising a second electronic component (46) being formed on said second major surface of said laminate (43).

6. A multilayer electronic component in accordance with claim 4, wherein steps (13) are formed on said side surfaces of said laminate (11) in correspondence to the position of said boundary surface between said first and second half portions.

7. A multilayer electronic component in accordance with claim 5, further comprising a case (41) being so mounted on said laminate (43) as to cover said second electronic component (46).

This Sheet Has Been Replaced





8. A multilayer electronic component in accordance with claim 4, wherein said external electrodes are exposed on said side surfaces and said first major surface of said laminate.

9. A multilayer electronic component in accordance with claim 4, wherein said external electrodes (12a) are exposed only on said side surfaces of said laminate (11).

10. A method of manufacturing a multilayer electronic component, comprising the steps of:

preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45);

15 and

cutting said mother laminate (14) along said cutting





lines (15).

11. A method of manufacturing a multilayer electronic component in accordance with claim 10, wherein said step of cutting said mother laminate (14) comprises a step of forming grooves (20) in said mother laminate (14) to expose said via holes (19) on said cut surfaces, and a
5 step of dividing said mother laminate (14), being provided with said grooves (20), in positions of said grooves (20).

12. A method of manufacturing a multilayer electronic component in accordance with claim 10, wherein said mother insulating sheets (16, 17) are ceramic green sheets, said method further comprising a step of firing
5 said mother laminate (14).

13. A method of measuring characteristics of a multilayer electronic component, comprising the steps of:
preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of
5 multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective





10 regions parted by said cutting lines (15) and having via
holes (19), coated with conductive materials (18) being
electrically connected with said internal circuit elements
(23, 24), provided on positions to be exposed on cut
surfaces by said cutting along said cutting lines (45);
15 forming grooves (20) in said mother laminate (14)
along said cutting lines (15), thereby exposing at least
said via holes (19) on inner side surfaces of said grooves
(20); and
measuring characteristics of each said multilayer
20 electronic component (10) while treating said via holes
(19), being exposed on said inner side surfaces of said
grooves (20), as external electrodes (12).

14. An assembly of multilayer electronic components,
comprising:

a mother laminate (14), to be cut along prescribed
cutting lines (15) for obtaining a plurality of multilayer
5 electronic components (10), being formed by stacking a
plurality of mother insulating sheets (16, 17) with
interposition of internal circuit elements (23, 24) for
respective said multilayer electronic components (10) to
distribute said internal circuit elements in respective
10 regions parted by said cutting lines (15) and having via
holes (19), coated with conductive materials (18) being



electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45),

15 said mother laminate (14) being formed with grooves (20) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20).

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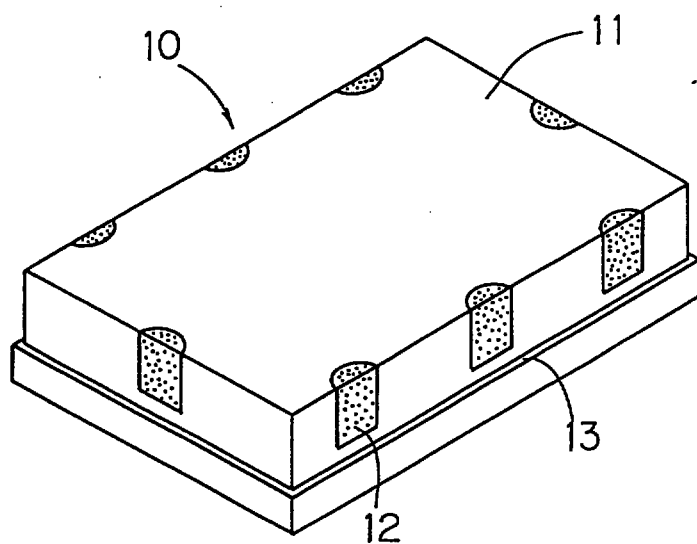
ABSTRACT OF THE DISCLOSURE

In order to provide a multilayer electronic component (10) which can reduce arrangement pitches for external electrodes (12), via holes (19) filled up with conductive materials (18) are provided in a mother laminate (14), which is obtained by stacking a plurality of insulating sheets (16, 17) with interposition of conductor films (23, 24), in positions parted by cutting. The conductive materials (18) define external electrodes (12) of individual multilayer electronic components (10) which are obtained by cutting the mother laminate (14). No specific step is required for forming the external electrodes (12), and characteristics of each multilayer electronic component (10) can be efficiently measured in the state of the mother laminate (14).

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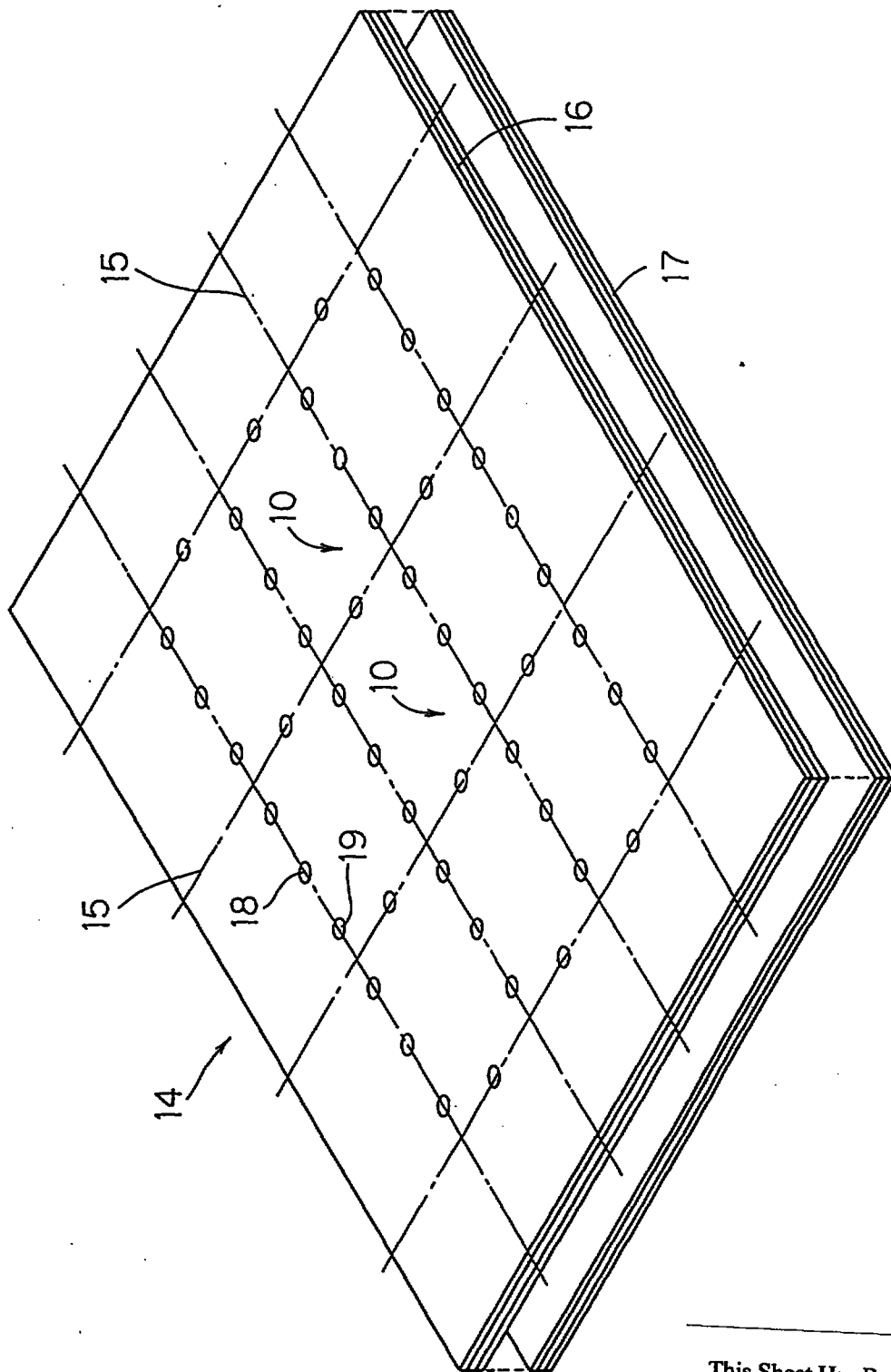
FIG. 1



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FIG. 2



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FIG. 3

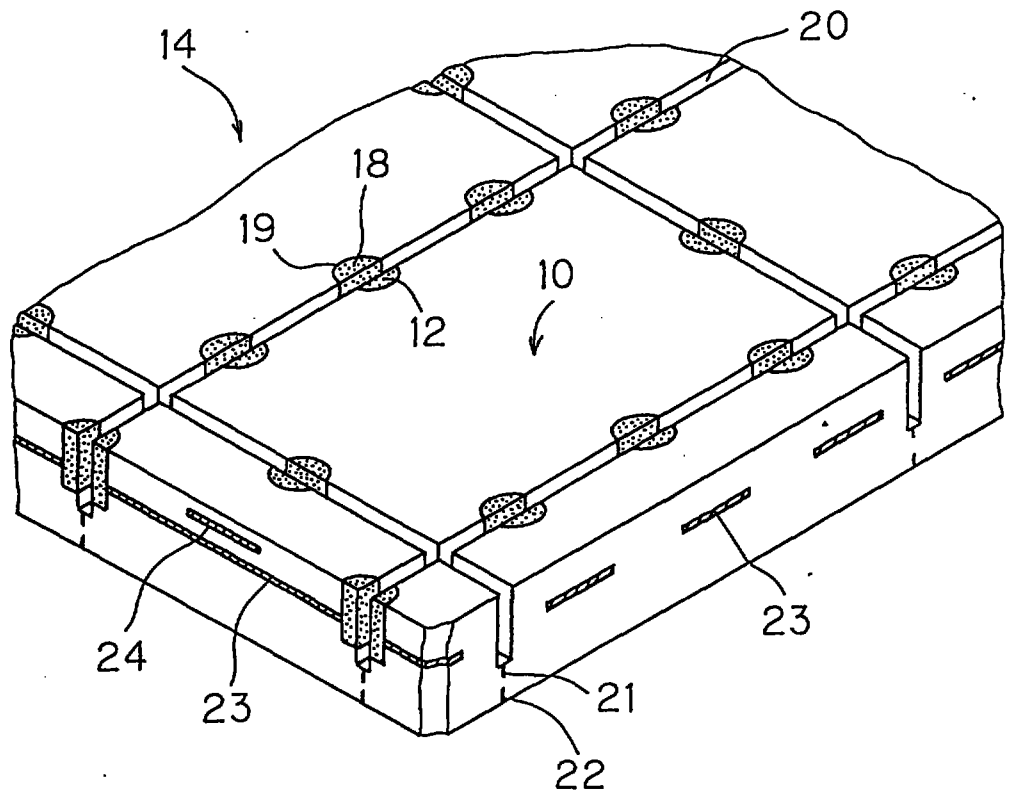
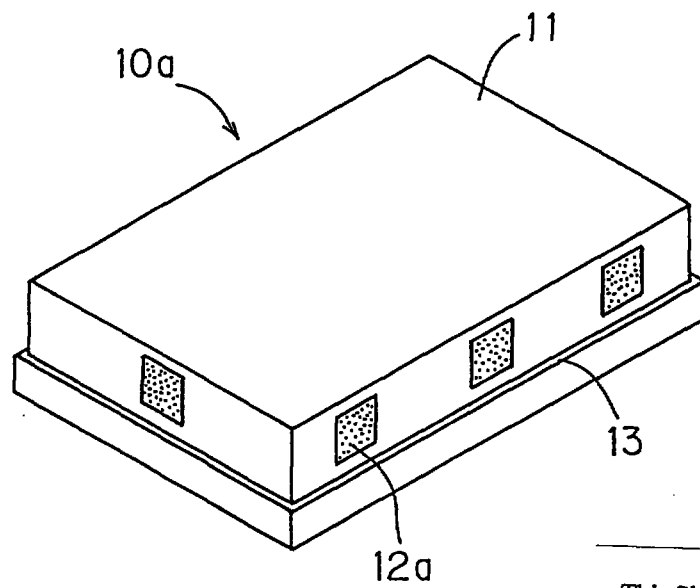


FIG. 4



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FIG. 5

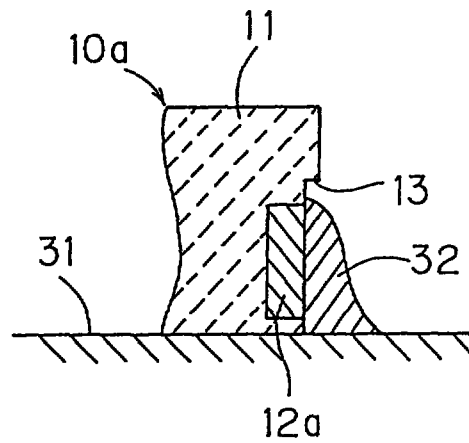
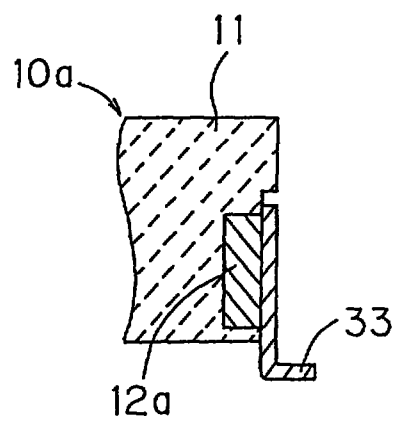


FIG. 6



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FIG. 7

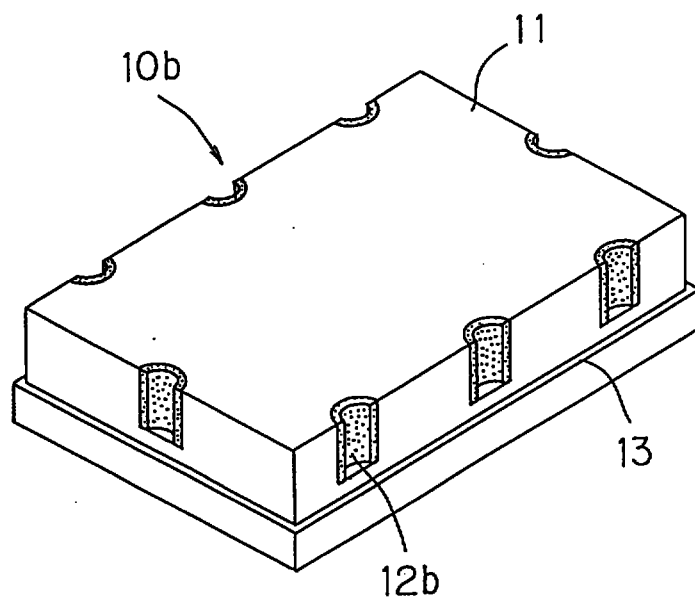
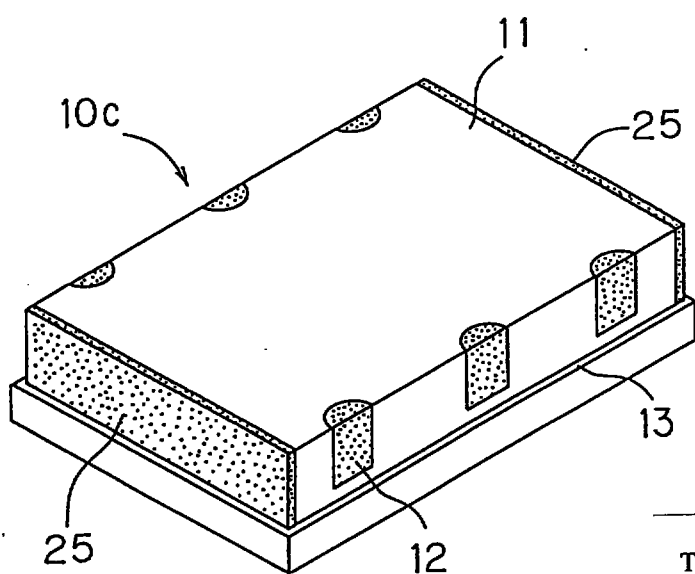


FIG. 8



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FIG. 9

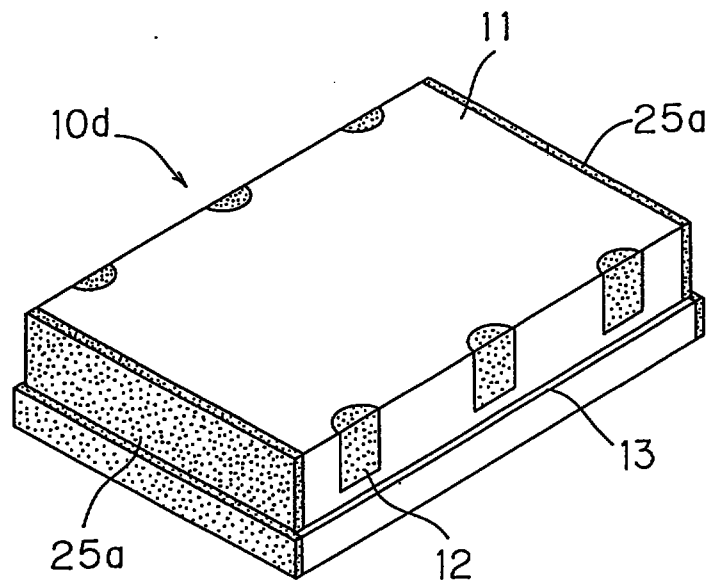
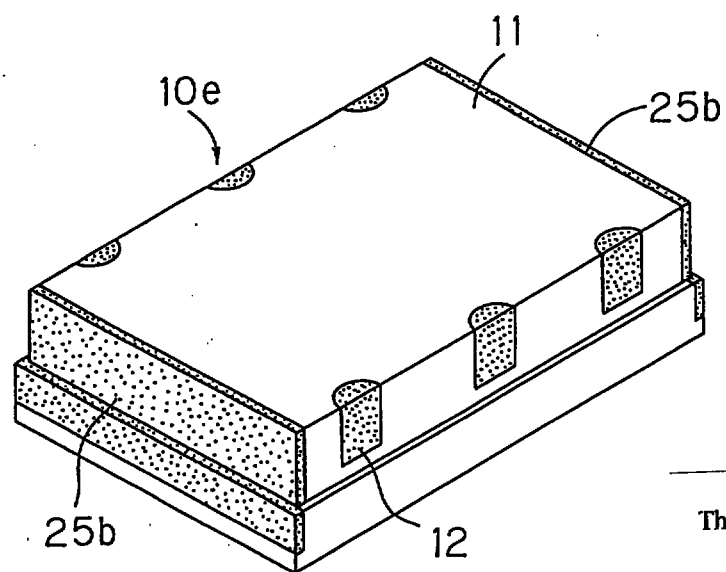


FIG. 10



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FIG. 11

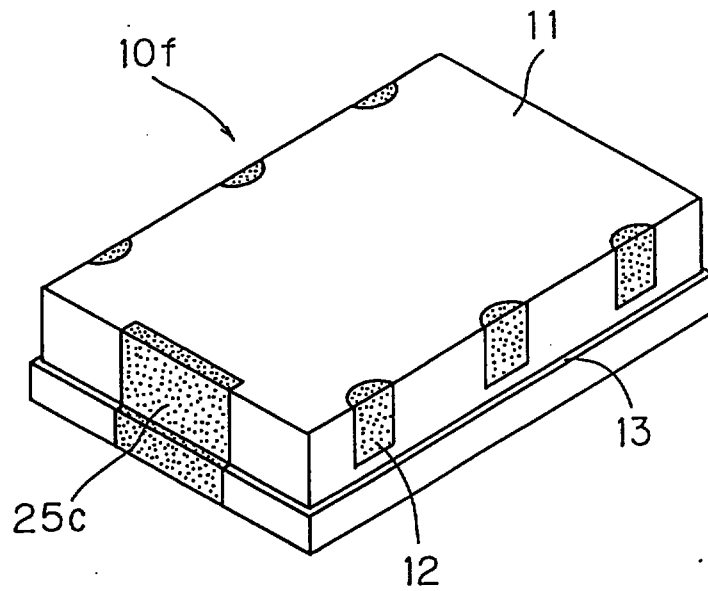
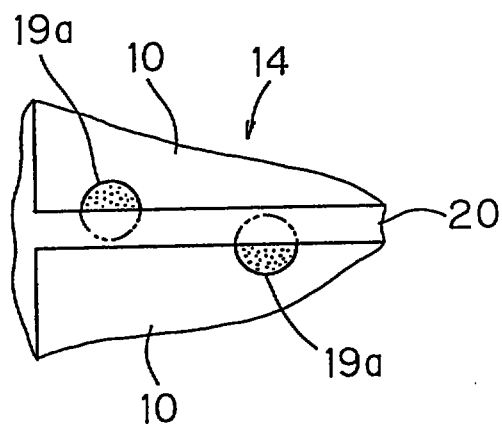


FIG. 12



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FIG. 13

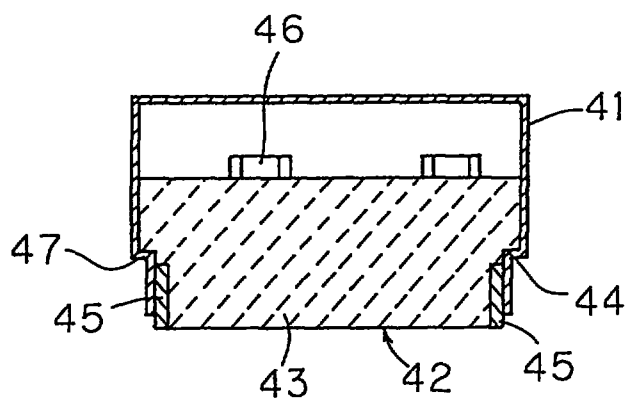
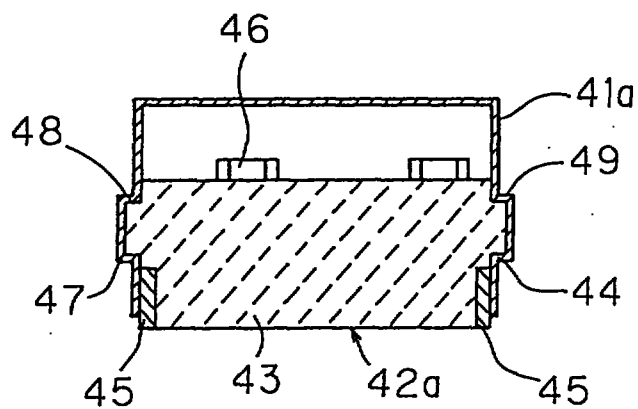


FIG. 14



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FIG. 15

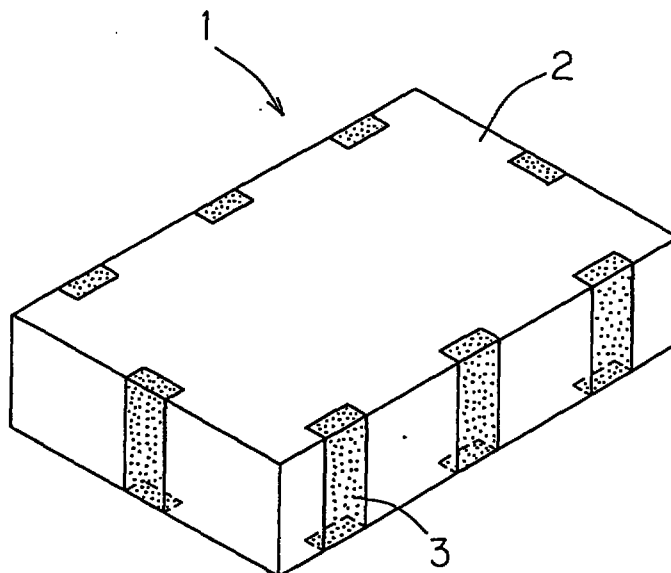
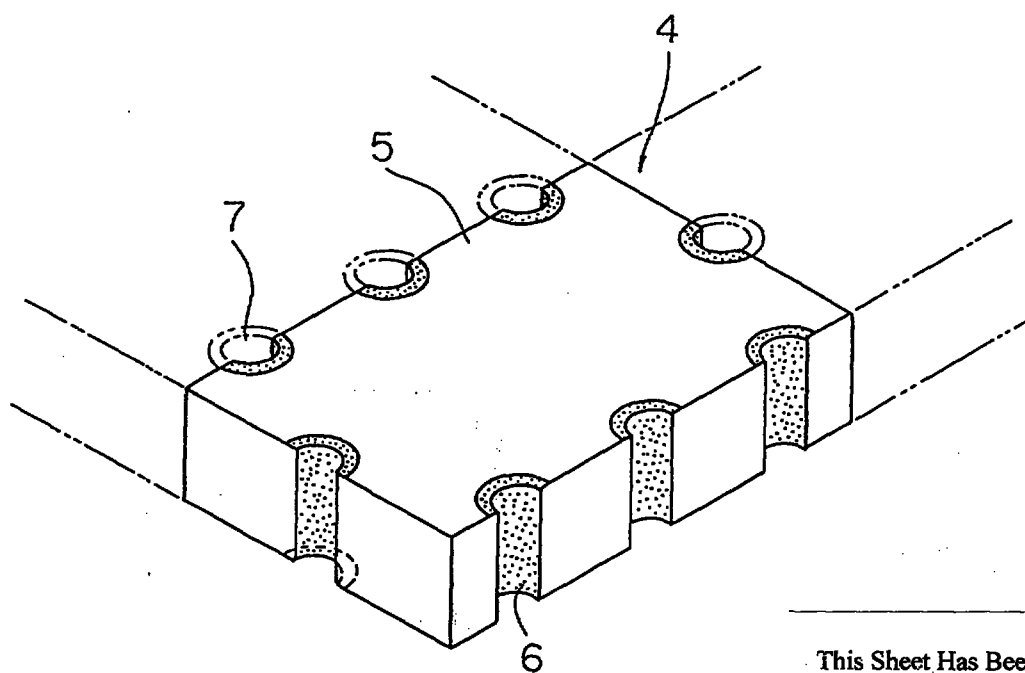


FIG. 16



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REPLACED SHEETS SG

☒ Description : paged 1 to paged 26
☒ Claim(s) : paged 27 to paged 32
☒ Drawing(s) : paged 1 to paged 9
☒ Abstract : paged 33 to paged -

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REPLACEMENT SHEETS SG

☒ Description : paged 1 to paged 26
☒ Claim(s) : paged 27 to paged 32
☒ Drawing(s) : paged 1 to paged 9
☒ Abstract : paged 33 to paged -

DATE OF RECEIPT - 9 OCT 1996

TITLE OF THE INVENTION

Multilayer Electronic Component, Method of
Manufacturing the Same and Method of Measuring
Characteristics Thereof

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a multilayer electronic component having internal circuit elements arranged therein, a method of manufacturing the same and a method of measuring characteristics thereof, and more particularly, it relates to an improvement in a mode of forming external electrodes in a multilayer electronic component.

Description of the Background Art

A multilayer electronic component, which is represented by a multilayer capacitor, a multilayer inductor, a multilayer circuit board or a multilayer composite electronic component, for example, comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements such as conductor films and/or resistor films. The insulating sheets are typically prepared from ceramic sheets.

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component 1. The

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multilayer electronic component 1 comprises a laminate 2 which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 2 is provided on its four side surfaces, for example, with external electrodes 3 respectively. These external electrodes 3 are electrically connected with the internal circuit elements which are located in the interior of the laminate 2. The external electrodes 3 are formed by applying proper metal paste to specific positions of the respective side surfaces of the laminate 2, and parts of the external electrodes 3 necessarily extend circumferentially on upper and lower surfaces of the laminate 2 at this time.

Fig. 16 is a perspective view showing the appearance of another type of conventional multilayer electronic component 4. This multilayer electronic component 4 also comprises a laminate 5 which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 5 is provided on its four side surfaces, for example, with external electrodes 6 which are electrically connected with the internal circuit elements. These external electrodes 6 are provided by dividing through holes 7, as shown by phantom lines in Fig. 16. Namely, a mother laminate is so prepared that a plurality of multilayer

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electronic components 4 can be obtained when the same is cut along prescribed cutting lines. The through holes 7 are formed in this mother laminate so that conductor films are formed on inner peripheral surfaces thereof for defining the external electrodes 6, and the mother laminate is thereafter cut to divide the through holes 7. Also in such a multilayer electronic component 4, parts of the external electrodes 6 extend circumferentially on upper and lower surfaces of the laminate 5, due to the method of forming the conductor films for defining the external electrodes 6.

These multilayer electronic components 1 and 4 are surface-mounted on proper circuit boards through the external electrodes 3 and 6, in the form of chips.

In both of the aforementioned multilayer electronic components 1 and 4, however, the external electrodes 3 and 6 are formed to extend toward the upper and lower surfaces of the laminates 2 and 5. When other components are mounted on the upper and/or lower surface(s) of such multilayer electronic components 1 and 4 to be composited with the same, therefore, areas capable of mounting such components are restricted.

Further, the parts of the external electrodes 3 and 6 extending toward the upper and lower surfaces of the laminates 2 and 5 inhibit reduction of arrangement pitches

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for the external electrodes 3 and 6. In addition, it is relatively difficult to form such parts of the external electrodes 3 and 5 in constant sizes and shapes, and this also inhibits reduction of the arrangement pitches for the external electrodes 3 and 6.

Particularly in the multilayer electronic component 4 shown in Fig. 16, it is difficult to reduce the diameters of the through holes 7, which are formed by a drill, below 0.3 mm, and this also restricts the arrangement pitches for the external electrodes 6. Further, the drill for forming the through holes 7 has a relatively short life, leading to increase in cost.

In the multilayer electronic component 1 shown in Fig. 15, on the other hand, the external electrodes 3 are formed on the four side surfaces of the laminate 2 respectively and hence it is necessary to carry out at least application of the metal paste onto the respective side surfaces independently of each other. As the result, the number of steps for forming the external electrodes 3 is increased.

On the other hand, it is necessary to measure characteristics of the multilayer electronic components 1 and 4 at least in advance of shipping. In both of the multilayer electronic components 1 and 4, however, the characteristics cannot be measured unless the same are



brought into states of chips in principle. In the multilayer electronic component 1 shown in Fig. 15, measurement of the characteristics is enabled after formation of the external electrodes 3. Also in the case shown in Fig. 16, the characteristics of each multilayer electronic component 4 cannot be measured in the stage of the mother laminate. Such measurement of the characteristics is enabled only when the mother laminate is cut to divide the through holes 7.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a multilayer electronic component which can reduce arrangement pitches for external electrodes, and a method of manufacturing the same.

Another object of the present invention is to provide a characteristic measuring method which can efficiently measure characteristics of a plurality of multilayer electronic components.

A multilayer electronic component according to the present invention comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements, and external electrodes which are formed on outer surfaces of the laminate to be electrically connected with the internal circuit elements. The external electrodes are formed by



exposing at least side portions of via holes, which are provided in the insulating sheets and coated with conductive materials, by cutting the insulating sheets.

A method of manufacturing a multilayer electronic component according to the present invention comprises a step of preparing a mother laminate, which is to be cut along prescribed cutting lines for obtaining a plurality of multilayer electronic components, being obtained by stacking a plurality of mother insulating sheets with interposition of internal circuit elements for the respective multilayer electronic components to distribute the internal circuit elements in regions parted by the cutting lines and having via holes, coated with conductive materials being electrically connected with the internal circuit elements, provided in positions to be exposed on cut surfaces by cutting along the cutting lines, and a step of cutting the mother laminate along the cutting lines.

A method of measuring characteristics of a multilayer electronic component according to the present invention comprises a step of preparing a mother laminate, which is to be cut along prescribed cutting lines for obtaining a plurality of multilayer electronic components, obtained by stacking a plurality of mother insulating sheets with interposition of internal circuit elements for the

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respective multilayer electronic components to distribute the internal circuit elements in regions parted by the cutting lines and provided with via holes, coated with conductive materials being electrically connected with the internal circuit elements, in positions to be exposed on cut surfaces by cutting along the cutting lines, a step of forming grooves in the mother laminate along the cutting lines thereby exposing at least the via holes on inner side surfaces of the grooves, and a step of measuring characteristics of each multilayer electronic component while treating the via holes being exposed on the inner side surfaces of the grooves as external electrodes.

The configuration of the multilayer electronic components provided in the aforementioned characteristic measuring method, i.e., an assembly of the multilayer electronic components consisting of the mother laminate provided with the grooves, can be shipped in this state.

According to the inventive multilayer electronic component, the external electrodes are provided by exposing at least side portions of the via hole which are coated with conductive materials. In this case, the via holes can be readily formed in small diameters by punching with no employment of a drill, whereby arrangement pitches for the external electrodes can be reduced. Further, it is possible to avoid increase in cost resulting from a

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short life of a drill since it is not necessary to employ such a drill.

The external electrodes provided by the via holes require no mode of formation of extending circumferentially on at least one major surface of the laminate, whereby at least one major surface of the laminate can be widely employed as a surface for mounting another component to be composited with the same.. Thus, it is possible to improve density in component mounting.

Since the external electrodes are provided by the conductive materials which are applied to the via holes, it is possible to attain relatively large dimensions corresponding to film thicknesses of the external electrodes by filling up the via holes with the conductive materials. Thus, it is possible to reduce a problem of solder leaching when the multilayer electronic component is soldered to a circuit board. Since the conductive materials for defining the external electrodes are embedded in parts of the via holes, it is possible to improve strength of soldering.

According to the inventive method of manufacturing a multilayer electronic component, the via holes coated with the conductive materials for providing the external electrodes are already formed in the mother laminate so that the conductive materials are exposed to define the



external electrodes by cutting the mother laminate, whereby no specific step is required for providing the external electrodes.

According to the inventive method of measuring characteristics of a multilayer electronic component, further, it is possible to independently measure characteristics of a plurality of multilayer electronic components, which are mechanically integrated with each other in the form of a mother laminate in a state being electrically independent of each other, due to formation of the grooves. Therefore, it is not necessary to handle mechanically independent multilayer electronic components, but characteristics of a number of multilayer electronic components can be efficiently measured by screening, for example.

When the assembly of the multilayer electronic components consisting of a mother laminate provided with the grooves, which is a configuration to be subjected to the aforementioned measurement of characteristics, is shipped in this state, the user can take out the respective multilayer electronic components from the mother laminate by simply dividing the same along the grooves. It is to be noted that each multilayer electronic component can be subjected to mounting with no problem in this case since the same can be through with

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measurement of its characteristics, and the assembly of such multilayer electronic components is easy to pack and handle as compared with multilayer electronic components which are separated from each other.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention;

Fig. 2 is a perspective view showing a mother laminate 14 which is prepared for obtaining the multilayer electronic component 10 shown in Fig. 1;

Fig. 3 is an enlarged perspective view illustrating grooves 20 which are formed in the mother laminate 14 shown in Fig. 2 for enabling measurement of characteristics;

Fig. 4 is a perspective view showing the appearance of a multilayer electronic component 10a according to another embodiment of the present invention;

Fig. 5 is a sectional view illustrating the multilayer electronic component 10a shown in Fig. 4 which

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is mounted on a circuit board 31;

Fig. 6 is a sectional view illustrating a terminal member 33 which is mounted on the multilayer electronic component 10a shown in Fig. 4;

Fig. 7 is a perspective view showing the appearance of a multilayer electronic component 10b according to still another embodiment of the present invention;

Fig. 8 is a perspective view showing the appearance of a multilayer electronic component 10c according to a further embodiment of the present invention;

Fig. 9 is a perspective view showing the appearance of a multilayer electronic component 10d according to a further embodiment of the present invention;

Fig. 10 is a perspective view showing the appearance of a multilayer electronic component 10e according to a further embodiment of the present invention;

Fig. 11 is a perspective view showing the appearance of a multilayer electronic component 10f according to a further embodiment of the present invention;

Fig. 12 is a plan view showing a part of a mother laminate 14 for illustrating a further embodiment of the present invention;

Fig. 13 is a sectional view showing a cased multilayer electronic component 42 according to a further embodiment of the present invention;



Fig. 14 is a sectional view showing a cased multilayer electronic component 42a according to a further embodiment of the present invention;

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component 1; and

Fig. 16 is a perspective view showing the appearance of another type of conventional multilayer electronic component 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention. While the multilayer electronic component 10 is mounted on a proper circuit board in the chip-type configuration as illustrated, Fig. 1 shows the multilayer electronic component 10 in a state upwardly directing its surface which is faced toward such a circuit board.

The multilayer electronic component 10 comprises a laminate 11, which is formed by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 11 is provided on respective ones of its four side surfaces, for example, with external electrodes 12 which are exposed on outer surfaces of the laminate 11. These external electrodes 12 are electrically connected with the internal circuit



elements (not shown).

The aforementioned external electrodes 12 are formed by exposing at least side portions of via holes, which are provided in the insulating sheets and filled up with conductive materials, by cutting the insulating sheets, as clearly understood from the following description of a manufacturing method. The laminate 11 is provided on respective ones of its four side surfaces, for example, with steps 13, while the reason why such steps 13 are formed is also clarified by the following description of the manufacturing method.

In order to obtain the aforementioned multilayer electronic component 10, a mother laminate 14 is prepared as shown in Fig. 2. The mother laminate 14, which is to be cut along prescribed cutting lines 15 shown by one-dot chain lines to provide a plurality of multilayer electronic components 10, is obtained by stacking a plurality of mother insulating sheets 16 and a plurality of mother insulating sheets 17 with interposition of internal circuit elements (not shown) for the respective multilayer electronic components 10 to distribute the internal circuit elements in respective regions parted through the cutting lines 15. This mother laminate 14 is provided with via holes 19 filled up with conductive materials 18 which are electrically connected with the

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internal circuit elements (not shown) in positions to be partitioned by cutting along the cutting lines 15. The external electrodes 12 shown in Fig. 1 are provided by the conductive materials 18 which are filled up in the via holes 19.

In order to obtain the aforementioned mother laminate 14, the following steps are carried out, for example. According to this embodiment, the mother insulating sheets 16 and 17 are formed by ceramic sheets.

First, sheet forming is carried out by a doctor blade coater or the like, to obtain ceramic green sheets for defining the mother insulating sheets 16 and 17. Specific ones of these ceramic green sheets are provided with via holes by punching or the like, in order to enable electrical conduction through the sheets along the direction of thickness. At this time, the ceramic green sheets for defining the mother insulating sheets 16, which are located on relatively upper portions in Fig. 2, are further provided with via holes 19. Then, conductor films and/or resistor films for serving as internal circuit elements are printed on specific ones of the ceramic green sheets. At this time, the already formed via holes are filled up with conductive materials, while the via holes 19 shown in Fig. 2 are filled up with conductive materials 18. When the conductor films are printed from lower



surface sides of the mother insulating sheets 16 shown in Fig. 2, it is possible to prevent the conductive materials 18 from forming conductive lands in peripheral edge portions of the via holes 19 on upper surface sides of the mother insulating sheets 16. It is pointed out that even such conductive lands are within the scope of the present invention.

Then, the aforementioned mother insulating sheets 16 and 17 are stacked with each other and pressed. Thus, the mother laminate 14 is obtained. In this mother laminate 14, the via holes 19 provided in the respective ones of the plurality of mother insulating sheets 16 are aligned along the direction of thickness, whereby the conductive materials 18 filled up in the via holes 19 are connected in series with each other.

Then, grooves 20 are formed in the mother laminate 14 along cutting lines 15 (Fig. 2) with a dicing saw, for example, so that at least the via holes 19 are parted, for example. With such formation of the grooves 20, the via holes 19 are exposed on inner side surfaces of the grooves 20, while the conductive materials 18 which are filled up in the via holes 19 are parted so that portions enclosed by the grooves 20 for defining individual multilayer electronic components 10 are electrically independent of each other. Preferably, slits 21 and 22 are formed in

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bottom surfaces of the grooves 20 and lower surface portions of the mother laminate 14 opposite thereto respectively. Either the slits 21 or 22 may be omitted.

Fig. 3 shows some conductor films 23 and 24 for serving as internal circuit elements. This figure also shows states of the conductor films 23 electrically connected with the conductive materials 18.

Then, the mother laminate 14 is fired to sinter ceramic materials forming the mother insulating sheets 16 and 17. Thereafter surfaces of the mother laminate 14 are provided with conductor films and/or resistor films, covered with an overcoat, and coated with solder resist. If necessary, the conductive materials 18 for forming external electrodes 3 and other conductor films are plated.

When the aforementioned steps are completed, the plurality of multilayer electronic components 10 included in the mother laminate 14 are so electrically independent of each other that it is possible to measure characteristics of each multilayer electronic component 10 while treating the conductive materials 18 provided in the respective portions of the via holes 19 parted by the grooves 20 as external electrodes.

After the characteristics are measured, other electronic components are mounted on those of the

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multilayer electronic components 10 which are determined as nondefective, to be composited with the same. The steps heretofore described can be efficiently carried out in the state of the mother laminate 14. The multilayer electronic components 10 may be shipped in this stage.

Then, the mother laminate 14 is completely cut along the cutting lines 15 (Fig. 2), i.e., the grooves 20 (Fig. 3), in order to obtain a plurality of multilayer electronic components 10 which are mechanically independent of each other. Such cutting is readily attained by dividing the mother laminate 14 like a chocolate bar along the grooves 20. The aforementioned slits 21 and 22 facilitate such division.

Thus, the multilayer electronic component 10 shown in Fig. 1 is obtained. As understood from the above description, the steps 13 result from the formation of the aforementioned grooves 20. When the laminate 11 is classified into upper and lower half portions through a boundary surface corresponding to the positions of the steps 13, the external electrodes 12 are exposed only on the upper half portion.

Then, the multilayer electronic component 10 is covered with a case at need. This case is adapted to cover other components which may be mounted on a lower surface of the multilayer electronic component 10



appearing in Fig. 1. This case is described later with reference to Figs. 13 and 14.

While the present invention has been described with reference to the embodiment shown in Figs. 1 to 3, various modifications are available within the scope of the present invention.

While the external electrodes 12 shown in Fig. 1 are formed to be exposed not only on the side surfaces of the laminate 11 but on the upper surface appearing in Fig. 1, such external electrodes 12a may be formed to be exposed only on side surfaces of a laminate 11 in a multilayer electronic component 10a shown in Fig. 4, for example. Referring to Fig. 4, elements corresponding to those shown in Fig. 1 are denoted by similar reference numerals, to omit redundant description.

According to the multilayer electronic component 10a shown in Fig. 4, it is possible to widely utilize not only a lower surface of the laminate 11 appearing in this figure but the upper surface as mounting surfaces for other components to be composited with this component 10a, with no interference by the external electrodes 12a. In order to obtain such a multilayer electronic component 10a, mother insulating sheets having no via holes 19 for forming external electrodes may be employed to form some of those located on an upper portion of the mother



laminate 14 in a stage of manufacturing the mother laminate 14 shown in Fig. 2.

When the aforementioned multilayer electronic component 10a is placed on a circuit board 31 as shown in Fig. 5, a gap is defined between the circuit board 31 and each external electrode 12a. In order to mount the multilayer electronic component 10a on the circuit board 31 in such a state, a solder fillet 32 is advantageously employed in order to electrically connect the external electrode 12a with a conductive land (not shown) on the circuit board 31.

Alternatively, a terminal member 33 of a metal may be mounted on each external electrode 12a of such a multilayer electronic component 10a, as shown in Fig. 6.

The external electrodes 12 of the mode shown in Fig. 1 may be mixed with the external electrodes 12a of the mode shown in Fig. 4 in a single multilayer electronic component.

While the via holes 19 for providing the external electrodes 12 have circular sections in the embodiment shown in Figs. 1 to 3, such sections may be changed to other forms such as rectangular shapes. Further, a single external electrode may be provided by a plurality of via holes which are partially overlapped with each other in section, or by a via hole long from side to side, in order

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to expose such external electrodes in wider areas.

The grooves 20 and the slits 21 and 22 may be formed after firing of the mother laminate 14. If no efficiency in formation of the conductor films/resistor films on the fired laminate 14 or plating or characteristic measurement is taken into consideration, the mother laminate 14 may be cut along the cutting lines 15 before firing, so that the multilayer electronic components 10 are fired in mechanically separated states. Further, the mother laminate 14 may be cut along the cutting lines 15 immediately after firing, through no stage of forming the grooves 20.

The conductive materials 18 to be filled up in the via holes 19 may not be applied simultaneously with printing of the conductor films, but the via holes 19 may be filled up with metal paste in another step. In this case, it is also possible to simultaneously fill up the conductive materials 18 in the plurality of via holes 19 being aligned in series with each other in the plurality of mother insulating sheets 16 which are stacked with each other.

The insulating sheets are not restricted to ceramic sheets, but may be prepared from other materials.

As shown in Fig. 7, further, external electrodes 12b of a multilayer electronic component 10b may be provided

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by conductive materials which are layered on inner peripheral surfaces of the via holes 19 (Figs. 2 and 3). In this case, the external electrodes 12b define cavities on outer surfaces thereof.

The present invention is not restricted to a multilayer electronic component having a plurality of external electrodes all of which are formed on the basis of via holes, but is also applicable to a multilayer electronic component including some external electrodes which are formed by another method.

As shown in Fig. 8, for example, a multilayer electronic component 10c may have some external electrodes 12 which are formed on the basis of via holes and other external electrodes, such as shielding electrodes 25, for example, which are formed by another method. In formation of the grooves 20 as shown in Fig. 3, for example, grooves 20 having inner side surfaces to be provided with such shielding electrodes 25 are first prepared so that metal paste is filled up in these grooves 20 by injection. Finally the grooves 20 are cut again to part conductive materials provided by the metal paste, thereby forming the shielding electrodes 25. These shielding electrodes 25 are often electrically connected with ground-side internal circuit elements (not shown) of the laminate 11.

The aforementioned shielding electrodes 25 may

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alternatively be formed on the basis of via holes, as a matter of course. In this case, the via holes are formed by slots longitudinally extending along the shielding electrodes 25. Such shielding electrodes 25 may be formed after the individual multilayer electronic components 10c are obtained.

As shown in Fig. 9, shielding electrodes 25a may be formed to extend downwardly beyond steps 13, in order to improve shielding performance. Such shielding electrodes 25a can be formed by any of the following methods, for example:

(a) A method of forming the overall shielding electrodes 25a on the basis of via holes.

(b) A method of forming only lower half portions of the shielding electrodes 25a beyond the steps 13 on the basis of via holes while forming upper half portions by filling up the grooves 20 shown in Fig. 3 with metal paste.

(c) A method of forming upper half portions of the shielding electrodes 25a by filling up the grooves 20 with metal paste, obtaining individual multilayer electronic components 10a, and thereafter forming lower half portions.

(d) A method of forming upper half portions of the shielding electrodes 25a on the basis of via holes,



obtaining individual multilayer electronic components 10d, and thereafter forming lower half portions.

(e) A method of forming the overall shielding electrodes 25a after obtaining individual multilayer electronic components 10d.

When the method (a) or (b) is employed among the aforementioned methods of forming the shielding electrodes 25a, the plurality of multilayer electronic components 10d are electrically connected with each other through the shielding electrodes 25a and not yet completely electrically independent of each other in a stage provided with the grooves 20 shown in Fig. 3. However, no hindrance is caused in measurement of characteristics of the individual multilayer electronic components 10d in the aforementioned state of the mother laminate 14 when the shielding electrodes 25a are adapted to serve as a common earthed electrode in such characteristics measurement.

In the multilayer electronic component 10d shown in Fig. 9, an area which is provided on the lower surface of the laminate 11 for mounting other components may be narrowed by the shielding electrodes 25a. In order to avoid such inconvenience, shielding electrodes 25b may be formed not to reach a lower surface of a laminate 11 provided in a multilayer electronic component 10e, as shown in Fig. 10.

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In relation to each mode of formation of the shielding electrodes 25, 25a and 25b shown in Figs. 8 to 10, the upper half portion(s) of the shielding electrode(s) may be formed on only one or three side surfaces of the laminate 11. The lower half portions of the shielding electrodes may be formed on three or four side surfaces of the laminate 11. Although only the shielding electrodes 25 corresponding to upper half portions are provided in Fig. 8, only shielding electrodes corresponding to lower half portions may alternatively be provided.

As shown in Fig. 11, further, a shielding electrode 25c may be provided on a multilayer electronic component 10f to cover only a part of one side surface of a laminate 11 along the cross direction.

In each of the aforementioned embodiments, each via hole 19 is so parted as to define external electrodes 12 for respective ones of two multilayer electronic components 10. When the width of each groove 20 shown in Fig. 3 occupies a considerable part along the diameter of each via hole 19, however, a single via hole 19a may be adapted to define a single external electrode, as shown in Fig. 12. Fig. 12 shows parts of the via holes 19a before formation of the groove 20 with two-dot chain lines.

Fig. 13 is a sectional view showing a multilayer

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electronic component 42 which is covered with a case 41.

A laminate 43 provided in the multilayer electronic component 42 has steps 44, and external electrodes 45 are formed under these steps 44. Some electronic components 46 are mounted on an upper surface of the laminate 43 appearing in Fig. 13 for compositing this multilayer electronic component 42. The case 41 is made of a metal. This case 41 is provided with steps 47 in conformity with side surfaces of the laminate 43, and soldered to the external electrodes 45, for example.

Fig. 14 shows another multilayer electronic component 42a which is covered with a case 41a. Referring to Fig. 14, elements corresponding to those shown in Fig. 13 are denoted by similar reference numerals, to omit redundant description.

Referring to Fig. 14, a laminate 43 which is provided in the multilayer electronic component 42a is formed not only with steps 44 but with further steps 48. On the other hand, the case 41a is provided with steps 49 which are engaged with the steps 48. The steps 49 of the case 41a are so engaged with the steps 48 of the laminate 43 that the case 41a is further strongly mounted on the laminate 43. Even if force is applied to the upper surface of the case 41a to downwardly press the same, in particular, the case 41a is not disengaged from the



external electrodes 45. Such force of downwardly pressing the case 41a is often applied from a vacuum suction chuck (not shown) which sucks the multilayer electronic component 42a toward the upper surface of the case 41 for holding the same. The steps 48 can be formed on the laminate 43 by a method similar to that for the steps 44. Namely, grooves similar to the grooves 20 may be formed from below in positions corresponding to the grooves 20 in the stage of the mother laminate 14 shown in Fig. 3.

Although the present invention has been described and illustrated in detail, it is clearly understood that the 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 limited only by the terms of the appended claims.

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WHAT IS CLAIMED IS:

1. A multilayer electronic component comprising:
a laminate (11) being obtained by stacking a plurality of insulating sheets (16, 17) with interposition of internal circuit elements (23, 24), said laminate having first and second opposite major surfaces and side surfaces coupling said major surfaces with each other; and
external electrodes (12) being formed on outer surfaces of said laminate (11) to be electrically connected with said internal circuit elements (23, 24),
said external electrodes (12) being formed by exposing at least side portions of via holes (19), being provided in said insulating sheets (16, 17) and coated with conductive materials (18), by cutting said insulating sheets (16, 17).
2. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are filled up in said via holes (19).
3. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are layered on inner peripheral surfaces of said via holes (19).

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4. A multilayer electronic component in accordance with claim 1, wherein said laminate (11) is classified into a first half portion being closer to said first major surface and a second half portion being closer to said second major surface by a boundary surface extending in parallel with said major surfaces, said external electrodes (12) being exposed only on said first half portion.

5. A multilayer electronic component in accordance with claim 4, further comprising a second electronic component (46) being formed on said second major surface of said laminate (43).

6. A multilayer electronic component in accordance with claim 4, wherein steps (13) are formed on said side surfaces of said laminate (11) in correspondence to the position of said boundary surface between said first and second half portions.

7. A multilayer electronic component in accordance with claim 5, further comprising a case (41) being so mounted on said laminate (43) as to cover said second electronic component (46).



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8. A multilayer electronic component in accordance with claim 4, wherein said external electrodes are exposed on said side surfaces and said first major surface of said laminate.

9. A multilayer electronic component in accordance with claim 4, wherein said external electrodes (12a) are exposed only on said side surfaces of said laminate (11).

10. A method of manufacturing a multilayer electronic component, comprising the steps of:

preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45); and

cutting said mother laminate (14) along said cutting

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lines (15).

11. A method of manufacturing a multilayer electronic component in accordance with claim 10, wherein said step of cutting said mother laminate (14) comprises a step of forming grooves (20) in said mother laminate (14) to expose said via holes (19) on said cut surfaces, and a step of dividing said mother laminate (14), being provided with said grooves (20), in positions of said grooves (20).

12. A method of manufacturing a multilayer electronic component in accordance with claim 10, wherein said mother insulating sheets (16, 17) are ceramic green sheets, said method further comprising a step of firing said mother laminate (14).

13. A method of measuring characteristics of a multilayer electronic component, comprising the steps of:
preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective

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regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45);

forming grooves (20) in said mother laminate (14) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20); and

measuring characteristics of each said multilayer electronic component (10) while treating said via holes (19), being exposed on said inner side surfaces of said grooves (20), as external electrodes (12).

14. An assembly of multilayer electronic components, comprising:

a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being



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electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45),

said mother laminate (14) being formed with grooves (20) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20).

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MULTILAYER ELECTRONIC COMPONENT, METHOD OF MANUFACTURING
THE SAME AND METHOD OF MEASURING CHARACTERISTICS THEREOF

ABSTRACT OF THE DISCLOSURE

In order to provide a multilayer electronic component (10) which can reduce arrangement pitches for external electrodes (12), via holes (19) filled up with conductive materials (18) are provided in a mother laminate (14), which is obtained by stacking a plurality of insulating sheets (16, 17) with interposition of conductor films (23, 24), in positions parted by cutting. The conductive materials (18) define external electrodes (12) of individual multilayer electronic components (10) which are obtained by cutting the mother laminate (14). No specific step is required for forming the external electrodes (12), and characteristics of each multilayer electronic component (10) can be efficiently measured in the state of the mother laminate (14).

FIGURE 3.

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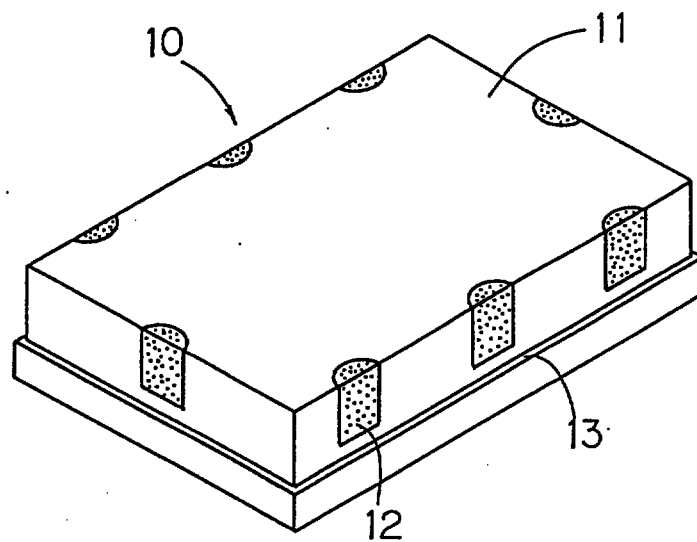
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FIG. 1



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FIG. 3

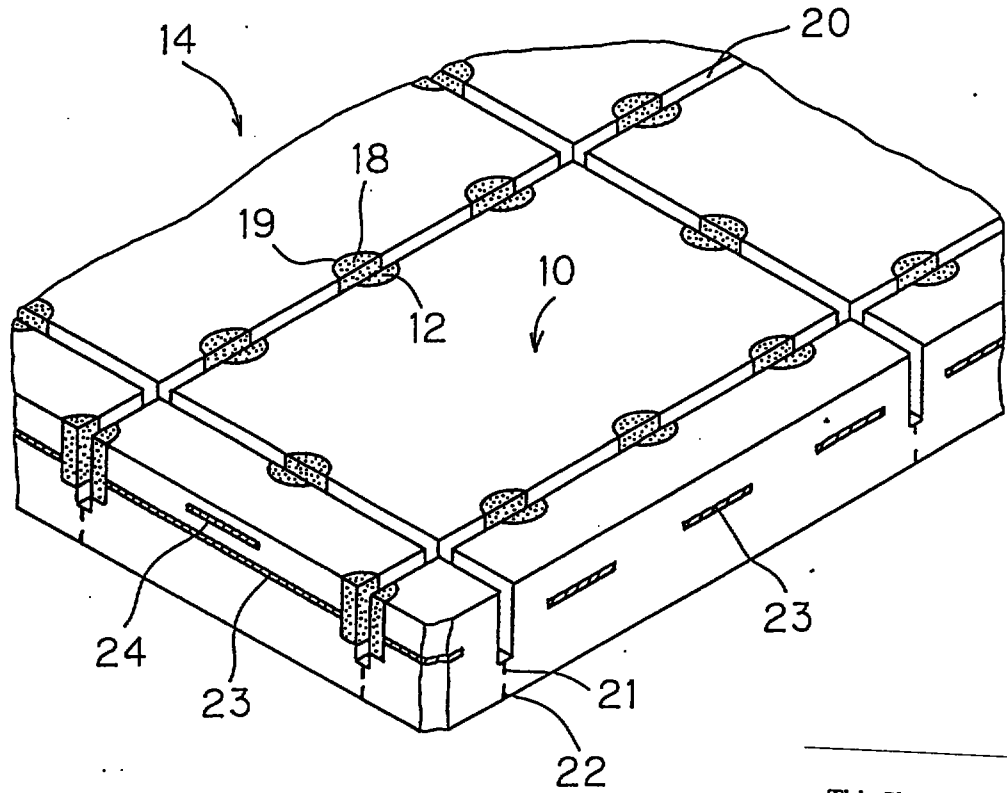
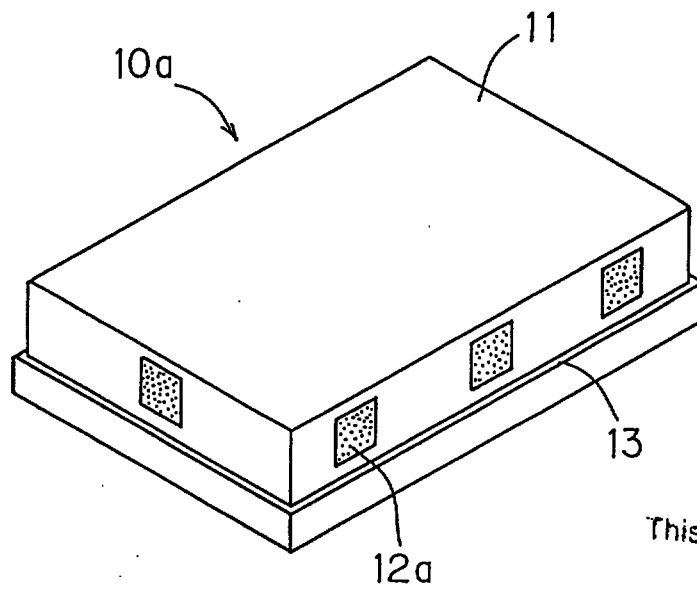


FIG. 4



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FIG. 5

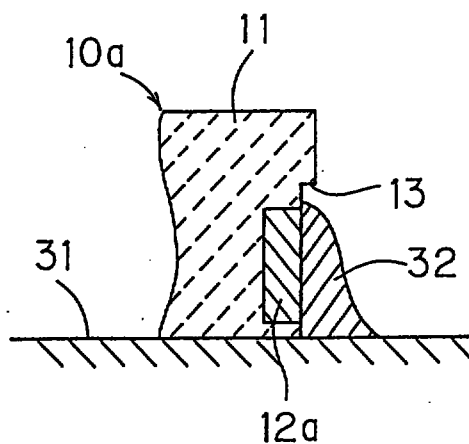
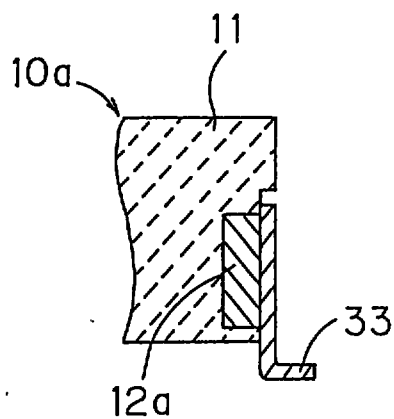


FIG. 6



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FIG. 7

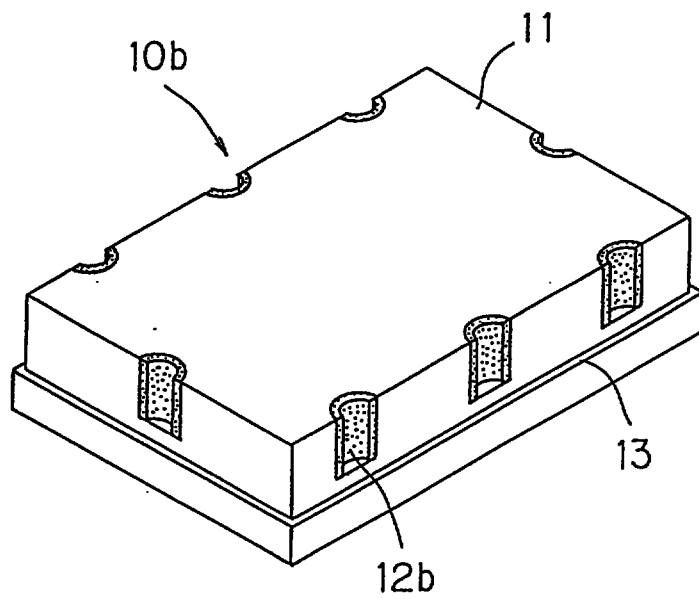
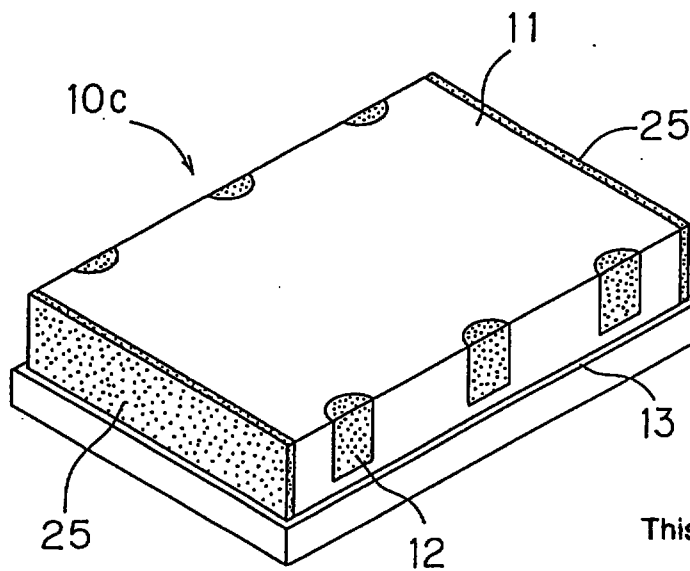


FIG. 8



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FIG. 9

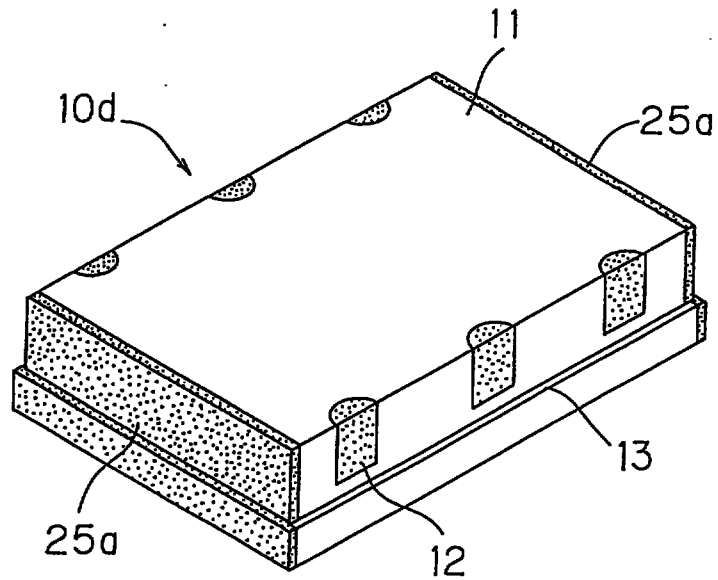
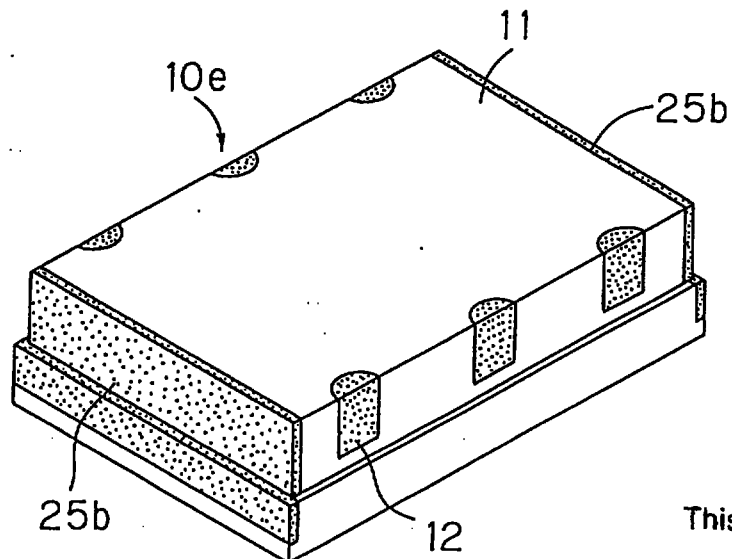


FIG. 10



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FIG. 11

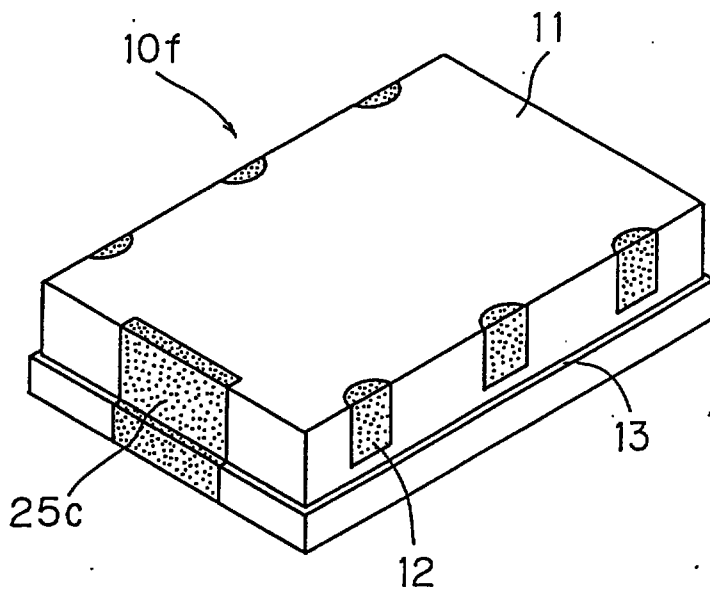
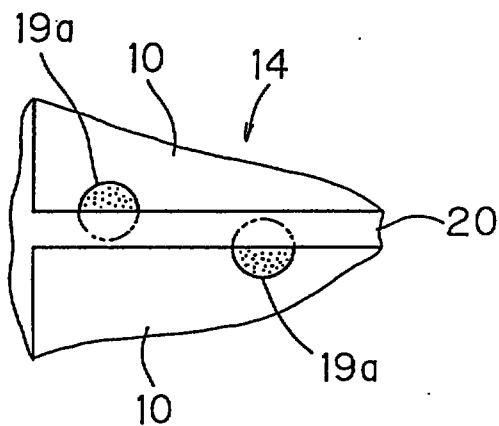


FIG. 12



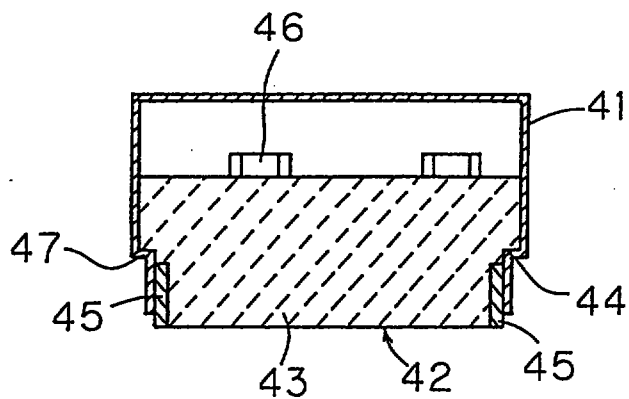
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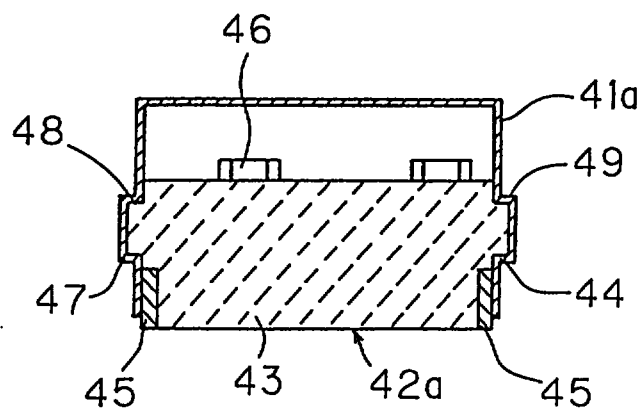
FIG. 13



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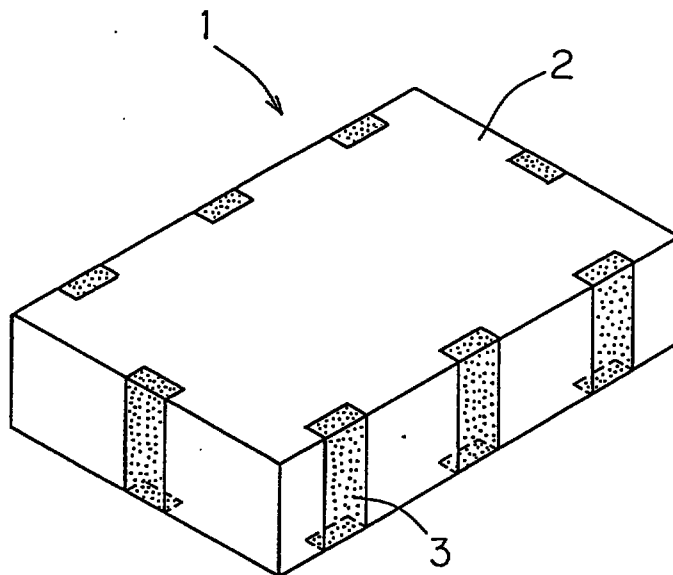
FIG. 14



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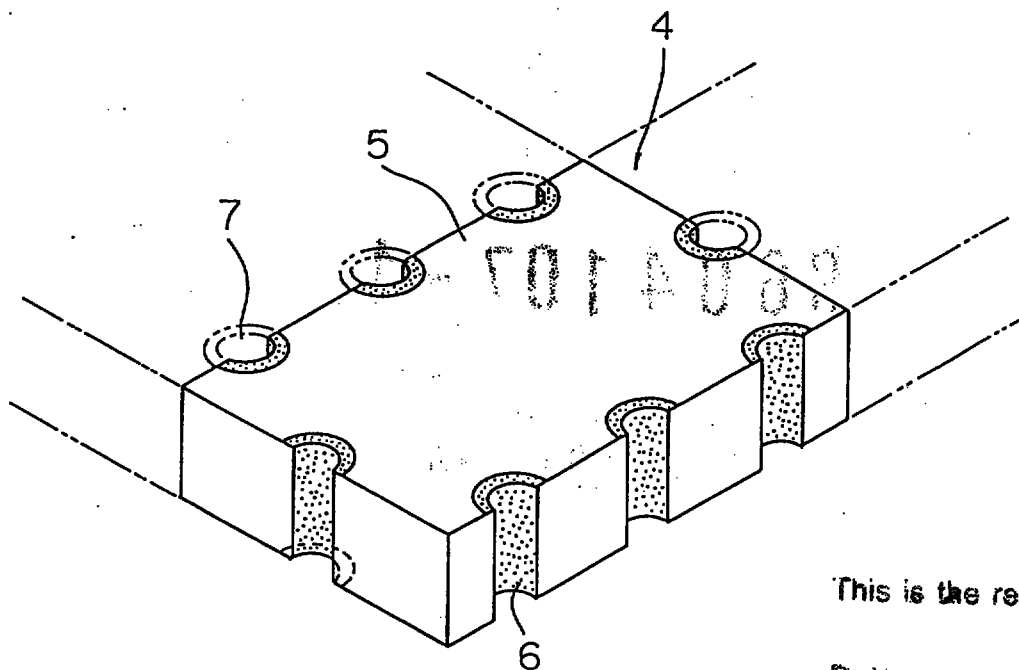
FIG. 15



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FIG. 16



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REPLACED SHEETS SG

☒ Description : paged 1 to paged 5
☒ Claim(s) : paged 23 to paged 30
☐ Drawing(s) : paged to paged
☐ Abstract : paged to paged

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REPLACEMENT SHEETS SG

☒ Description : paged 1 to paged 22
☒ Claim(s) : paged 23 to paged 30
☒ Drawing(s) : paged 1 to paged 9
☐ Abstract : paged to paged

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DATE OF RECEIPT

~~TITLE OF THE INVENTION~~

~~Multilayer Electronic Component, Method of
Manufacturing the Same and Method of Measuring
Characteristics Thereof~~

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a multilayer electronic component having internal circuit elements arranged therein, a method of manufacturing the same and a method of measuring characteristics thereof, and more particularly, it relates to an improvement in a mode of forming external electrodes in a multilayer electronic component.

Description of the Background Art

A multilayer electronic component, which is represented by a multilayer capacitor, a multilayer inductor, a multilayer circuit board or a multilayer composite electronic component, for example, comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements such as conductor films and/or resistor films. The insulating sheets are typically prepared from ceramic sheets.

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component ^{< 3} 1/. The

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multilayer electronic component 1 comprises a laminate 2 which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 2 is provided on its four side surfaces, for example, with external electrodes 3 respectively. These external electrodes 3 are electrically connected with the internal circuit elements which are located in the interior of the laminate 2. The external electrodes 3 are formed by applying proper metal paste to specific positions of the respective side surfaces of the laminate 2, and parts of the external electrodes 3 necessarily extend circumferentially on upper and lower surfaces of the laminate 2 at this time.

Fig. 16 is a perspective view showing the appearance of another type of conventional multilayer electronic component 4. This multilayer electronic component 4 also comprises a laminate 5 which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 5 is provided on its four side surfaces, for example, with external electrodes 6 which are electrically connected with the internal circuit elements. These external electrodes 6 are provided by dividing through holes 7, as shown by phantom lines in Fig. 16. Namely, a mother laminate is so prepared that a plurality of multilayer

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electronic components 4 can be obtained when the same is cut along prescribed cutting lines. The through holes 7 are formed in this mother laminate so that conductor films are formed on inner peripheral surfaces thereof for defining the external electrodes 6, and the mother laminate is thereafter cut to divide the through holes 7. Also in such a multilayer electronic component 4, parts of the external electrodes 6 extend circumferentially on upper and lower surfaces of the laminate 5, due to the method of forming the conductor films for defining the external electrodes 6.

These multilayer electronic components 1 and 4 are surface-mounted on proper circuit boards through the external electrodes 3 and 6, in the form of chips.

In both of the aforementioned multilayer electronic components 1 and 4, however, the external electrodes 3 and 6 are formed to extend toward the upper and lower surfaces of the laminates 2 and 5. When other components are mounted on the upper and/or lower surface(s) of such multilayer electronic components 1 and 4 to be composited with the same, therefore, areas capable of mounting such components are restricted.

Further, the parts of the external electrodes 3 and 6 extending toward the upper and lower surfaces of the laminates 2 and 5 inhibit reduction of arrangement pitches

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for the external electrodes 3 and 6. In addition, it is relatively difficult to form such parts of the external electrodes 3 and 5 in constant sizes and shapes, and this also inhibits reduction of the arrangement pitches for the external electrodes 3 and 6.

Particularly in the multilayer electronic component 4 shown in Fig. 16, it is difficult to reduce the diameters of the through holes 7, which are formed by a drill, below 0.3 mm, and this also restricts the arrangement pitches for the external electrodes 6. Further, the drill for forming the through holes 7 has a relatively short life, leading to increase in cost.

In the multilayer electronic component 1 shown in Fig. 15, on the other hand, the external electrodes 3 are formed on the four side surfaces of the laminate 2 respectively and hence it is necessary to carry out at least application of the metal paste onto the respective side surfaces independently of each other. As the result, the number of steps for forming the external electrodes 3 is increased.

On the other hand, it is necessary to measure characteristics of the multilayer electronic components 1 and 4 at least in advance of shipping. In both of the multilayer electronic components 1 and 4, however, the characteristics cannot be measured unless the same are

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brought into states of chips in principle. In the multilayer electronic component 1 shown in Fig. 15, measurement of the characteristics is enabled after formation of the external electrodes 3. Also in the case shown in Fig. 16, the characteristics of each multilayer electronic component 4 cannot be measured in the stage of the mother laminate. Such measurement of the characteristics is enabled only when the mother laminate is cut to divide the through holes 7.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a multilayer electronic component which can reduce arrangement pitches for external electrodes, and a method of manufacturing the same.

Another object of the present invention is to provide a characteristic measuring method which can efficiently measure characteristics of a plurality of multilayer electronic components.

~~A multilayer electronic component according to the present invention comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements, and external electrodes which are formed on outer surfaces of the laminate to be electrically connected with the internal circuit elements. The external electrodes are formed by~~

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These objects are achieved by a multilayer electronic component according to claim 1, a method for manufacturing a multilayer electronic component according to claim 9, a method of measuring characteristics of a multilayer electronic component, and an assembly of multilayer electronic components.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention;

Fig. 2 is a perspective view showing a mother laminate 14 which is prepared for obtaining the multilayer electronic component 10 shown in Fig. 1;

Fig. 3 is an enlarged perspective view illustrating grooves 20 which are formed in the mother laminate 14 shown in Fig. 2 for enabling measurement of characteristics;

Fig. 4 is a perspective view showing the appearance of a multilayer electronic component 10a according to another embodiment of the present invention;

Fig. 5 is a sectional view illustrating the multilayer electronic component 10a shown in Fig. 4 which

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is mounted on a circuit board 31;

Fig. 6 is a sectional view illustrating a terminal member 33 which is mounted on the multilayer electronic component 10a shown in Fig. 4;

Fig. 7 is a perspective view showing the appearance of a multilayer electronic component 10b according to still another embodiment of the present invention;

Fig. 8 is a perspective view showing the appearance of a multilayer electronic component 10c according to a further embodiment of the present invention;

Fig. 9 is a perspective view showing the appearance of a multilayer electronic component 10d according to a further embodiment of the present invention;

Fig. 10 is a perspective view showing the appearance of a multilayer electronic component 10e according to a further embodiment of the present invention;

Fig. 11 is a perspective view showing the appearance of a multilayer electronic component 10f according to a further embodiment of the present invention;

Fig. 12 is a plan view showing a part of a mother laminate 14 for illustrating a further embodiment of the present invention;

Fig. 13 is a sectional view showing a cased multilayer electronic component 42 according to a further embodiment of the present invention;

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Fig. 14 is a sectional view showing a cased multilayer electronic component 42a according to a further embodiment of the present invention;

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component 1; and

Fig. 16 is a perspective view showing the appearance of another type of conventional multilayer electronic component 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a perspective view showing the appearance of a multilayer electronic component 10 according to an embodiment of the present invention. While the multilayer electronic component 10 is mounted on a proper circuit board in the chip-type configuration as illustrated, Fig. 1 shows the multilayer electronic component 10 in a state upwardly directing its surface which is faced toward such a circuit board.

The multilayer electronic component 10 comprises a laminate 11, which is formed by stacking a plurality of insulating sheets with interposition of internal circuit elements (not shown). The laminate 11 is provided on respective ones of its four side surfaces, for example, with external electrodes 12 which are exposed on outer surfaces of the laminate 11. These external electrodes 12 are electrically connected with the internal circuit

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elements (not shown).

The aforementioned external electrodes 12 are formed by exposing at least side portions of via holes, which are provided in the insulating sheets and filled up with conductive materials, by cutting the insulating sheets, as clearly understood from the following description of a manufacturing method. The laminate 11 is provided on respective ones of its four side surfaces, for example, with steps 13, while the reason why such steps 13 are formed is also clarified by the following description of the manufacturing method.

In order to obtain the aforementioned multilayer electronic component 10, a mother laminate 14 is prepared as shown in Fig. 2. The mother laminate 14, which is to be cut along prescribed cutting lines 15 shown by one-dot chain lines to provide a plurality of multilayer electronic components 10, is obtained by stacking a plurality of mother insulating sheets 16 and a plurality of mother insulating sheets 17 with interposition of internal circuit elements (not shown) for the respective multilayer electronic components 10 to distribute the internal circuit elements in respective regions parted through the cutting lines 15. This mother laminate 14 is provided with via holes 19 filled up with conductive materials 18 which are electrically connected with the

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internal circuit elements (not shown) in positions to be partitioned by cutting along the cutting lines 15. The external electrodes 12 shown in Fig. 1 are provided by the conductive materials 18 which are filled up in the via holes 19.

In order to obtain the aforementioned mother laminate 14, the following steps are carried out, for example. According to this embodiment, the mother insulating sheets 16 and 17 are formed by ceramic sheets.

First, sheet forming is carried out by a doctor blade coater or the like, to obtain ceramic green sheets for defining the mother insulating sheets 16 and 17. Specific ones of these ceramic green sheets are provided with via holes by punching or the like, in order to enable electrical conduction through the sheets along the direction of thickness. At this time, the ceramic green sheets for defining the mother insulating sheets 16, which are located on relatively upper portions in Fig. 2, are further provided with via holes 19. Then, conductor films and/or resistor films for serving as internal circuit elements are printed on specific ones of the ceramic green sheets. At this time, the already formed via holes are filled up with conductive materials, while the via holes 19 shown in Fig. 2 are filled up with conductive materials 18. When the conductor films are printed from lower

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surface sides of the mother insulating sheets 16 shown in Fig. 2, it is possible to prevent the conductive materials 18 from forming conductive lands in peripheral edge portions of the via holes 19 on upper surface sides of the mother insulating sheets 16. It is pointed out that even such conductive lands are within the scope of the present invention.

Then, the aforementioned mother insulating sheets 16 and 17 are stacked with each other and pressed. Thus, the mother laminate 14 is obtained. In this mother laminate 14, the via holes 19 provided in the respective ones of the plurality of mother insulating sheets 16 are aligned along the direction of thickness, whereby the conductive materials 18 filled up in the via holes 19 are connected in series with each other.

Then, grooves 20 are formed in the mother laminate 14 along cutting lines 15 (Fig. 2) with a dicing saw, for example, so that at least the via holes 19 are parted, for example. With such formation of the grooves 20, the via holes 19 are exposed on inner side surfaces of the grooves 20, while the conductive materials 18 which are filled up in the via holes 19 are parted so that portions enclosed by the grooves 20 for defining individual multilayer electronic components 10 are electrically independent of each other. Preferably, slits 21 and 22 are formed in

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bottom surfaces of the grooves 20 and lower surface portions of the mother laminate 14 opposite thereto respectively. Either the slits 21 or 22 may be omitted.

Fig. 3 shows some conductor films 23 and 24 for serving as internal circuit elements. This figure also shows states of the conductor films 23 electrically connected with the conductive materials 18.

Then, the mother laminate 14 is fired to sinter ceramic materials forming the mother insulating sheets 16 and 17. Thereafter surfaces of the mother laminate 14 are provided with conductor films and/or resistor films, covered with an overcoat, and coated with solder resist. If necessary, the conductive materials 18 for forming external electrodes 3 and other conductor films are plated.

When the aforementioned steps are completed, the plurality of multilayer electronic components 10 included in the mother laminate 14 are so electrically independent of each other that it is possible to measure characteristics of each multilayer electronic component 10 while treating the conductive materials 18 provided in the respective portions of the via holes 19 parted by the grooves 20 as external electrodes.

After the characteristics are measured, other electronic components are mounted on those of the

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multilayer electronic components 10 which are determined as nondefective, to be composited with the same. The steps heretofore described can be efficiently carried out in the state of the mother laminate 14. The multilayer electronic components 10 may be shipped in this stage.

Then, the mother laminate 14 is completely cut along the cutting lines 15 (Fig. 2), i.e., the grooves 20 (Fig. 3), in order to obtain a plurality of multilayer electronic components 10 which are mechanically independent of each other. Such cutting is readily attained by dividing the mother laminate 14 like a chocolate bar along the grooves 20. The aforementioned slits 21 and 22 facilitate such division.

Thus, the multilayer electronic component 10 shown in Fig. 1 is obtained. As understood from the above description, the steps 13 result from the formation of the aforementioned grooves 20. When the laminate 11 is classified into upper and lower half portions through a boundary surface corresponding to the positions of the steps 13, the external electrodes 12 are exposed only on the upper half portion.

Then, the multilayer electronic component 10 is covered with a case at need. This case is adapted to cover other components which may be mounted on a lower surface of the multilayer electronic component 10

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appearing in Fig. 1. This case is described later with reference to Figs. 13 and 14.

While the present invention has been described with reference to the embodiment shown in Figs. 1 to 3, various modifications are available within the scope of the present invention.

While the external electrodes 12 shown in Fig. 1 are formed to be exposed not only on the side surfaces of the laminate 11 but on the upper surface appearing in Fig. 1, such external electrodes 12a may be formed to be exposed only on side surfaces of a laminate 11 in a multilayer electronic component 10a shown in Fig. 4, for example. Referring to Fig. 4, elements corresponding to those shown in Fig. 1 are denoted by similar reference numerals, to omit redundant description.

According to the multilayer electronic component 10a shown in Fig. 4, it is possible to widely utilize not only a lower surface of the laminate 11 appearing in this figure but the upper surface as mounting surfaces for other components to be composited with this component 10a, with no interference by the external electrodes 12a. In order to obtain such a multilayer electronic component 10a, mother insulating sheets having no via holes 19 for forming external electrodes may be employed to form some of those located on an upper portion of the mother

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laminate 14 in a stage of manufacturing the mother laminate 14 shown in Fig. 2.

When the aforementioned multilayer electronic component 10a is placed on a circuit board 31 as shown in Fig. 5, a gap is defined between the circuit board 31 and each external electrode 12a. In order to mount the multilayer electronic component 10a on the circuit board 31 in such a state, a solder fillet 32 is advantageously employed in order to electrically connect the external electrode 12a with a conductive land (not shown) on the circuit board 31.

Alternatively, a terminal member 33 of a metal may be mounted on each external electrode 12a of such a multilayer electronic component 10a, as shown in Fig. 6.

The external electrodes 12 of the mode shown in Fig. 1 may be mixed with the external electrodes 12a of the mode shown in Fig. 4 in a single multilayer electronic component.

While the via holes 19 for providing the external electrodes 12 have circular sections in the embodiment shown in Figs. 1 to 3, such sections may be changed to other forms such as rectangular shapes. Further, a single external electrode may be provided by a plurality of via holes which are partially overlapped with each other in section, or by a via hole long from side to side, in order

to expose such external electrodes in wider areas.

The grooves 20 and the slits 21 and 22 may be formed after firing of the mother laminate 14. If no efficiency in formation of the conductor films/resistor films on the fired laminate 14 or plating or characteristic measurement is taken into consideration, the mother laminate 14 may be cut along the cutting lines 15 before firing, so that the multilayer electronic components 10 are fired in mechanically separated states. Further, the mother laminate 14 may be cut along the cutting lines 15 immediately after firing, through no stage of forming the grooves 20.

The conductive materials 18 to be filled up in the via holes 19 may not be applied simultaneously with printing of the conductor films, but the via holes 19 may be filled up with metal paste in another step. In this case, it is also possible to simultaneously fill up the conductive materials 18 in the plurality of via holes 19 being aligned in series with each other in the plurality of mother insulating sheets 16 which are stacked with each other.

The insulating sheets are not restricted to ceramic sheets, but may be prepared from other materials.

As shown in Fig. 7, further, external electrodes 12b of a multilayer electronic component 10b may be provided

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by conductive materials which are layered on inner peripheral surfaces of the via holes 19 (Figs. 2 and 3). In this case, the external electrodes 12b define cavities on outer surfaces thereof.

The present invention is not restricted to a multilayer electronic component having a plurality of external electrodes all of which are formed on the basis of via holes, but is also applicable to a multilayer electronic component including some external electrodes which are formed by another method.

As shown in Fig. 8, for example, a multilayer electronic component 10c may have some external electrodes 12 which are formed on the basis of via holes and other external electrodes, such as shielding electrodes 25, for example, which are formed by another method. In formation of the grooves 20 as shown in Fig. 3, for example, grooves 20 having inner side surfaces to be provided with such shielding electrodes 25 are first prepared so that metal paste is filled up in these grooves 20 by injection. Finally the grooves 20 are cut again to part conductive materials provided by the metal paste, thereby forming the shielding electrodes 25. These shielding electrodes 25 are often electrically connected with ground-side internal circuit elements (not shown) of the laminate 11.

The aforementioned shielding electrodes 25 may

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alternatively be formed on the basis of via holes, as a matter of course. In this case, the via holes are formed by slots longitudinally extending along the shielding electrodes 25. Such shielding electrodes 25 may be formed after the individual multilayer electronic components 10c are obtained.

As shown in Fig. 9, shielding electrodes 25a may be formed to extend downwardly beyond steps 13, in order to improve shielding performance. Such shielding electrodes 25a can be formed by any of the following methods, for example:

(a) A method of forming the overall shielding electrodes 25a on the basis of via holes.

(b) A method of forming only lower half portions of the shielding electrodes 25a beyond the steps 13 on the basis of via holes while forming upper half portions by filling up the grooves 20 shown in Fig. 3 with metal paste.

(c) A method of forming upper half portions of the shielding electrodes 25a by filling up the grooves 20 with metal paste, obtaining individual multilayer electronic components 10a, and thereafter forming lower half portions.

(d) A method of forming upper half portions of the shielding electrodes 25a on the basis of via holes,

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obtaining individual multilayer electronic components 10d, and thereafter forming lower half portions.

(e) A method of forming the overall shielding electrodes 25a after obtaining individual multilayer electronic components 10d.

When the method (a) or (b) is employed among the aforementioned methods of forming the shielding electrodes 25a, the plurality of multilayer electronic components 10d are electrically connected with each other through the shielding electrodes 25a and not yet completely electrically independent of each other in a stage provided with the grooves 20 shown in Fig. 3. However, no hindrance is caused in measurement of characteristics of the individual multilayer electronic components 10d in the aforementioned state of the mother laminate 14 when the shielding electrodes 25a are adapted to serve as a common earthed electrode in such characteristics measurement.

In the multilayer electronic component 10d shown in Fig. 9, an area which is provided on the lower surface of the laminate 11 for mounting other components may be narrowed by the shielding electrodes 25a. In order to avoid such inconvenience, shielding electrodes 25b may be formed not to reach a lower surface of a laminate 11 provided in a multilayer electronic component 10e, as shown in Fig. 10.

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In relation to each mode of formation of the shielding electrodes 25, 25a and 25b shown in Figs. 8 to 10, the upper half portion(s) of the shielding electrode(s) may be formed on only one or three side surfaces of the laminate 11. The lower half portions of the shielding electrodes may be formed on three or four side surfaces of the laminate 11. Although only the shielding electrodes 25 corresponding to upper half portions are provided in Fig. 8, only shielding electrodes corresponding to lower half portions may alternatively be provided.

As shown in Fig. 11, further, a shielding electrode 25c may be provided on a multilayer electronic component 10f to cover only a part of one side surface of a laminate 11 along the cross direction.

In each of the aforementioned embodiments, each via hole 19 is so parted as to define external electrodes 12 for respective ones of two multilayer electronic components 10. When the width of each groove 20 shown in Fig. 3 occupies a considerable part along the diameter of each via hole 19, however, a single via hole 19a may be adapted to define a single external electrode, as shown in Fig. 12. Fig. 12 shows parts of the via holes 19a before formation of the groove 20 with two-dot chain lines.

Fig. 13 is a sectional view showing a multilayer

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electronic component 42 which is covered with a case 41.

A laminate 43 provided in the multilayer electronic component 42 has steps 44, and external electrodes 45 are formed under these steps 44. Some electronic components 46 are mounted on an upper surface of the laminate 43 appearing in Fig. 13 for compositing this multilayer electronic component 42. The case 41 is made of a metal. This case 41 is provided with steps 47 in conformity with side surfaces of the laminate 43, and soldered to the external electrodes 45, for example.

Fig. 14 shows another multilayer electronic component 42a which is covered with a case 41a. Referring to Fig. 14, elements corresponding to those shown in Fig. 13 are denoted by similar reference numerals, to omit redundant description.

Referring to Fig. 14, a laminate 43 which is provided in the multilayer electronic component 42a is formed not only with steps 44 but with further steps 48. On the other hand, the case 41a is provided with steps 49 which are engaged with the steps 48. The steps 49 of the case 41a are so engaged with the steps 48 of the laminate 43 that the case 41a is further strongly mounted on the laminate 43. Even if force is applied to the upper surface of the case 41a to downwardly press the same, in particular, the case 41a is not disengaged from the

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external electrodes 45. Such force of downwardly pressing the case 41a is often applied from a vacuum suction chuck (not shown) which sucks the multilayer electronic component 42a toward the upper surface of the case 41 for holding the same. The steps 48 can be formed on the laminate 43 by a method similar to that for the steps 44. Namely, grooves similar to the grooves 20 may be formed from below in positions corresponding to the grooves 20 in the stage of the mother laminate 14 shown in Fig. 3.

Although the present invention has been described and illustrated in detail, it is clearly understood that the 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 limited only by the terms of the appended claims.

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Claims:

1. A multilayer electronic component comprising:

a laminate (11) comprising a stack of a first plurality of insulating sheets (16) and a stack of a second plurality of insulating sheets (17) with interposition of internal circuit elements (23,24), said laminate having first and second opposite major surfaces and side surfaces coupling said major surfaces with each other; and

external electrodes (12) being formed on said side surfaces of said laminate (11) to be electrically connected with said internal circuit elements (23,24),

said external electrodes (12) being formed by exposing at least side portions of via holes (19), being coated with conductive materials (18), by cutting said insulating sheets (16,17),

characterized in that

said via holes (19) are provided only in said first plurality of insulating sheet₁ (16).

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~~WHAT IS CLAIMED IS:~~

~~1. A multilayer electronic component comprising
a laminate (11) being obtained by stacking a
plurality of insulating sheets (16, 17) with interposition
of internal circuit elements (23, 24), said laminate
having first and second opposite major surfaces and side
surfaces coupling said major surfaces with each other; and
external electrodes (12) being formed on outer
surfaces of said laminate (11) to be electrically
connected with said internal circuit elements (23, 24),
said external electrodes (12) being formed by
exposing at least side portions of via holes (19), being
provided in said insulating sheets (16, 17) and coated
with conductive materials (18), by cutting said insulating
sheets (16, 17);~~

2. A multilayer electronic component in accordance
with claim 1, wherein said conductive materials (18) are
filled up in said via holes (19).

3. A multilayer electronic component in accordance
with claim 1, wherein said conductive materials (18) are
layered on inner peripheral surfaces of said via holes
(19).



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~~4. A multilayer electronic component in accordance with claim 1, wherein said laminate (11) is classified into a first half portion being closer to said first major surface and a second half portion being closer to said second major surface by a boundary surface extending in parallel with said major surfaces, said external electrodes (12) being exposed only on said first half portion.~~

4. ~~5~~⁴ A multilayer electronic component in accordance with claim ~~4~~⁴, further comprising a second electronic component (46) being formed on said ~~second major surface~~^{stack of a plurality of insulating sheets (17)} of said laminate (43).

5. ~~5~~⁴ A multilayer electronic component in accordance with claim ~~4~~⁴, wherein steps (13) are formed on said side surfaces of said laminate (11) in correspondence to the position of said boundary surface between said first and ~~second half portions~~^{stack of a plurality of insulating sheets (17)} and ~~second half portions~~^{stack of a plurality of insulating sheets (17)}.

6. ~~5~~⁴ A multilayer electronic component in accordance with claim ~~5~~⁴, further comprising a case (41) being so mounted on said laminate (43) as to cover said second electronic component (46).

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7. ~~B~~¹ A multilayer electronic component in accordance with claim ~~H~~¹, wherein said external electrodes are exposed on said side surfaces and said first ~~major surface~~ ^{stack of a plurality of insulating sheets (16)} of said laminate.

8. ~~19~~¹ A multilayer electronic component in accordance with claim ~~H~~¹, wherein said external electrodes (12a) are exposed only on said side surfaces of said laminate (11).

~~10. A method of manufacturing a multilayer~~
electronic component, comprising the steps of:
preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45);
and
~~cutting said mother laminate (14) along said cutting~~



9. A method of manufacturing a multilayer electronic component, comprising the steps of:

preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16,17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23,24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23,24), provided on positions to be exposed on cut surfaces by said cutting along said cutting line (45); and

cutting said mother laminate (14) along said cutting lines (15),

characterized in that

said via holes (19) are provided only in said first plurality of mother insulating sheets (16).

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~~lines (15)~~

10. ~~11~~ A method of manufacturing a multilayer⁹ electronic component in accordance with claim ~~11~~⁹, wherein said step of cutting said mother laminate (14) comprises a step of forming grooves (20) in said mother laminate (14) to expose said via holes (19) on said cut surfaces, and a step of dividing said mother laminate (14), being provided with said grooves (20), in positions of said grooves (20).

11. ~~12~~ A method of manufacturing a multilayer electronic component in accordance with claim ~~12~~⁹, wherein said mother insulating sheets (16, 17) are ceramic green sheets, said method further comprising a step of firing said mother laminate (14).

~~13. A method of measuring characteristics of a multilayer electronic component, comprising the steps of: preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective~~



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12. A method of measuring characteristics of a multilayer electronic component, comprising the steps of:

preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16,17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23,24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via hole (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23,24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45);

characterized by the following steps:

forming grooves (20) in said mother laminate (14) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20); and

measuring characteristics of each said multilayer electronic component (10) while treating said via holes (19), being exposed on said inner side surfaces of said grooves (20), as external electrodes (12),

wherein said via holes (19) are provided only in said first plurality of mother insulating sheets (16).

13. An assembly of multilayer electronic components, comprising:

a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic

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components (10), being formed by stacking a plurality of mother insulating sheets (16,17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23,24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23,24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45),

characterized in that

said mother laminate (14) is formed with grooves (20) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20), and

said via holes (19) are provided only in said first plurality of mother insulating sheets (16).

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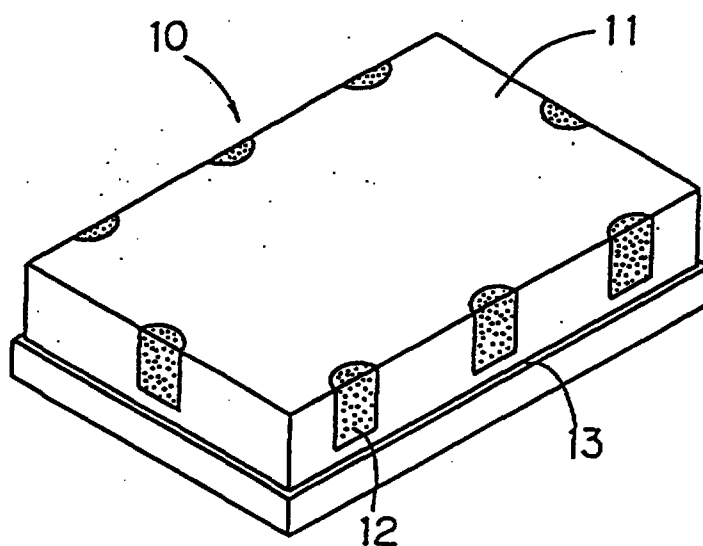


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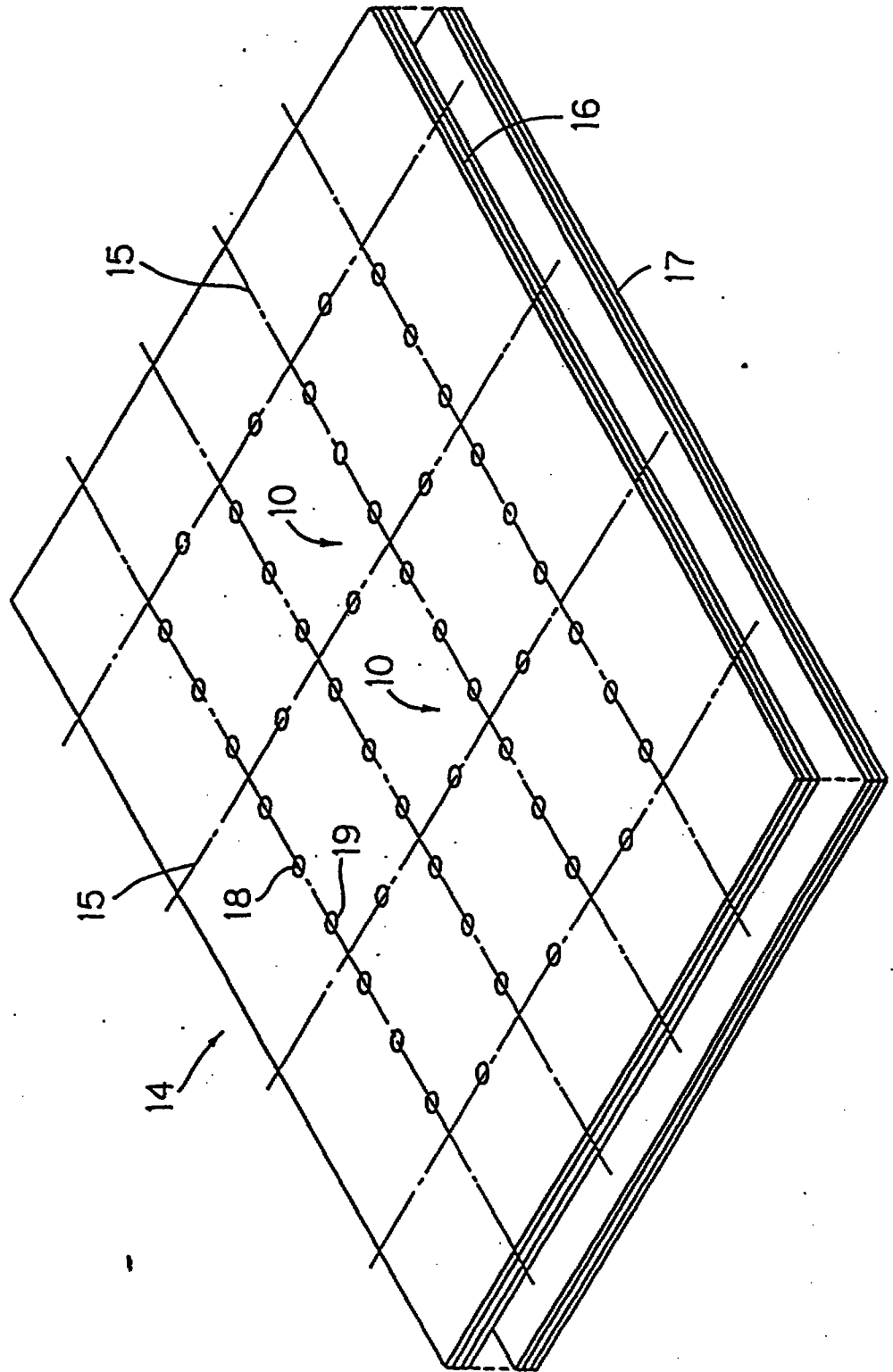
FIG. 1



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FIG. 2



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FIG. 3

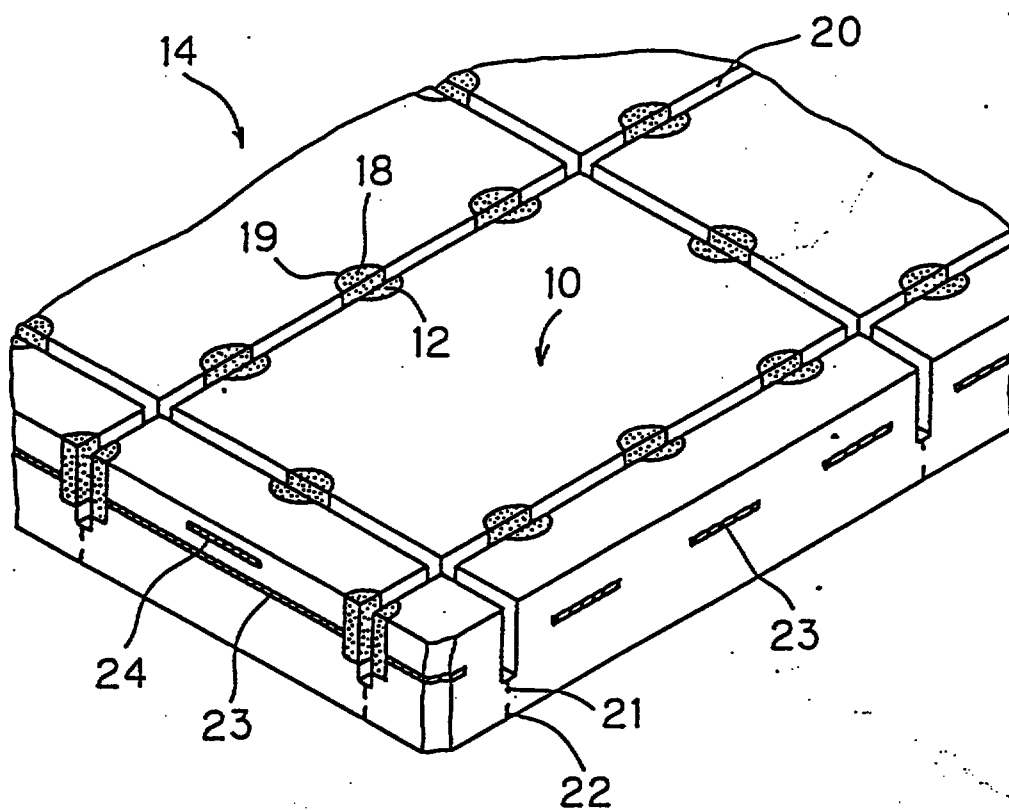
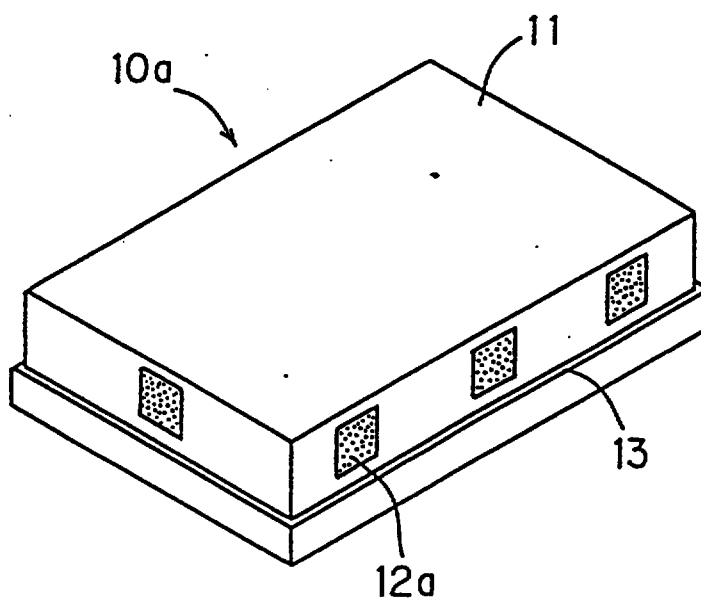


FIG. 4



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FIG. 5

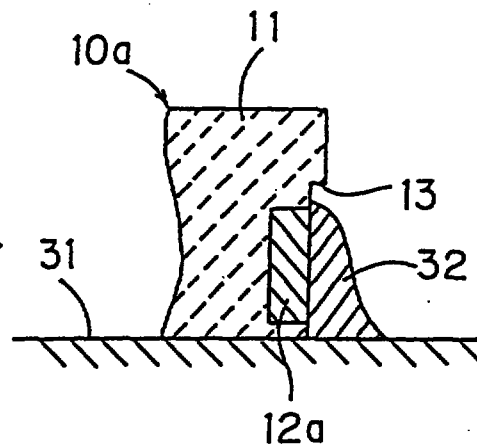


FIG. 6

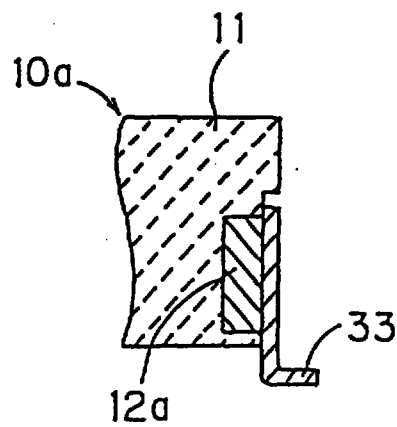


FIG. 7

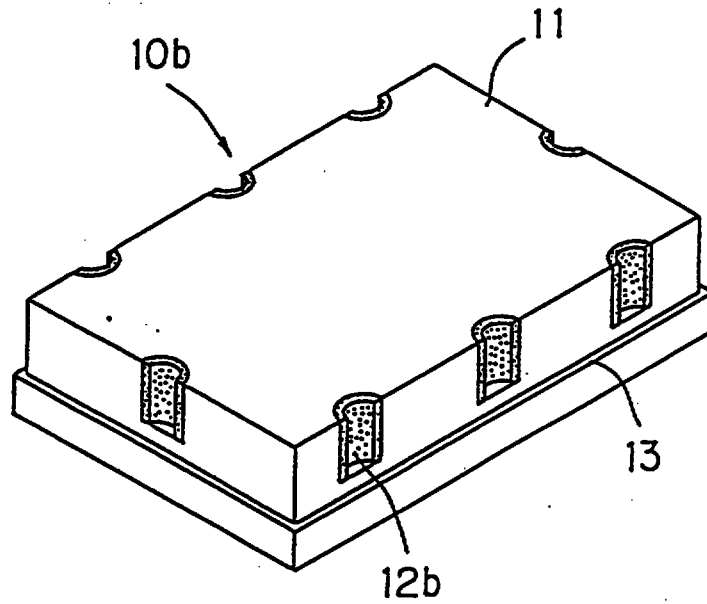
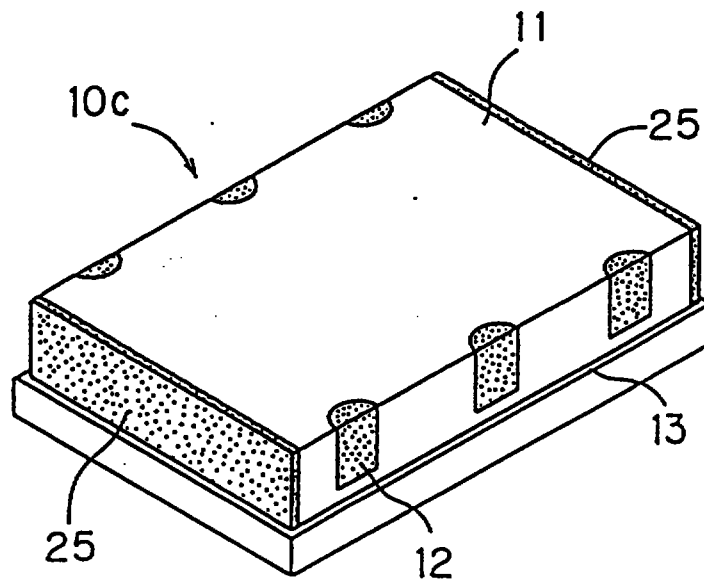


FIG. 8



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FIG. 9

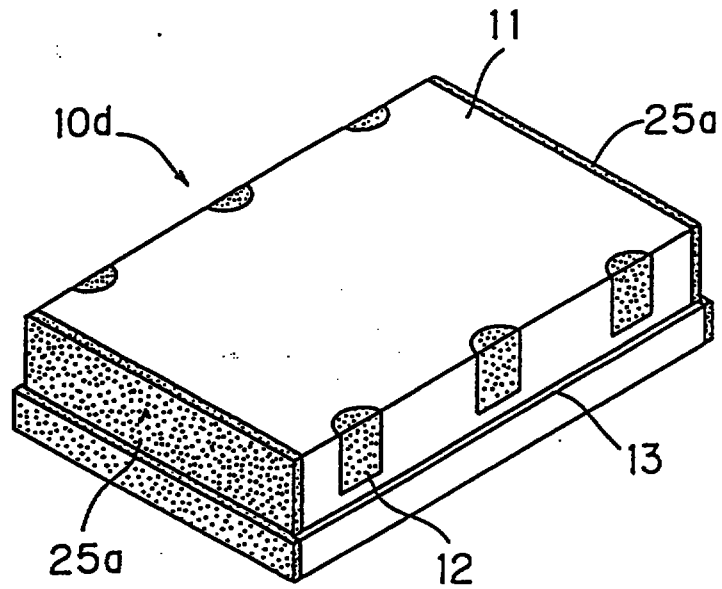
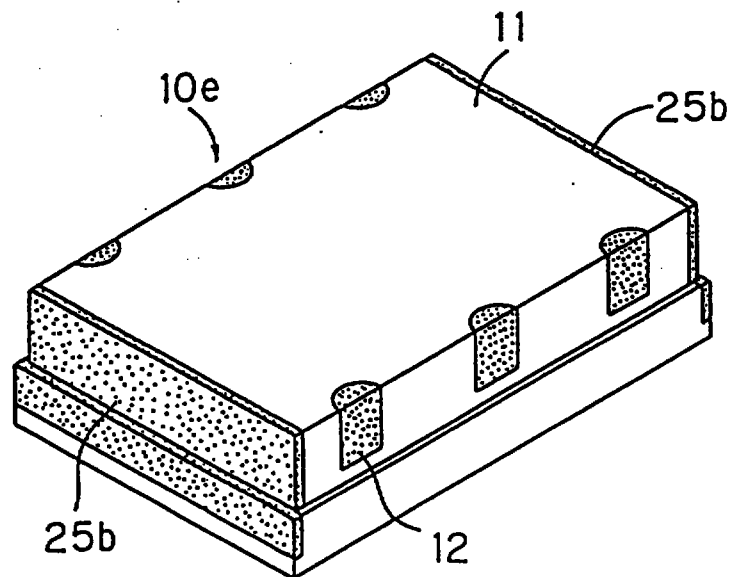


FIG. 10



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FIG. 11

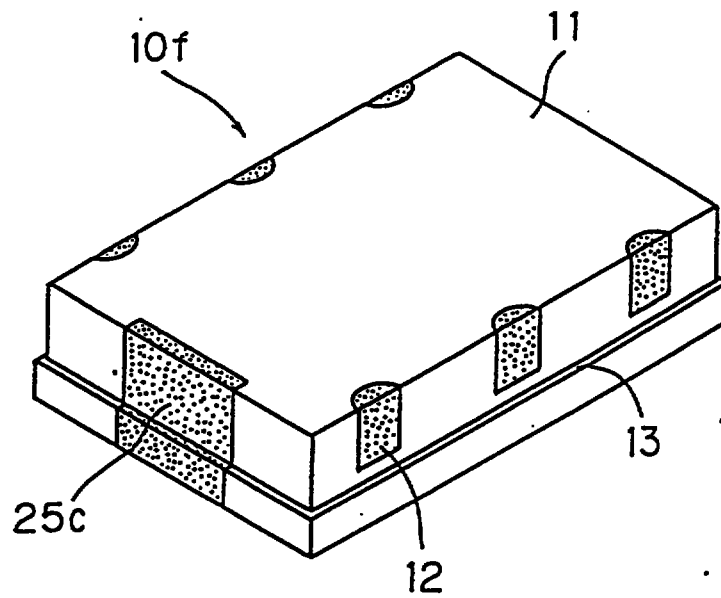
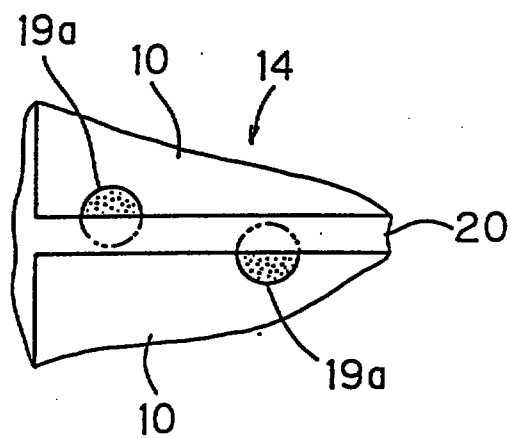


FIG. 12



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FIG. 13

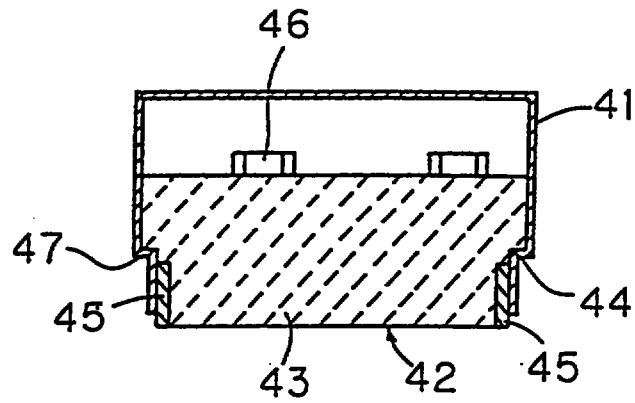
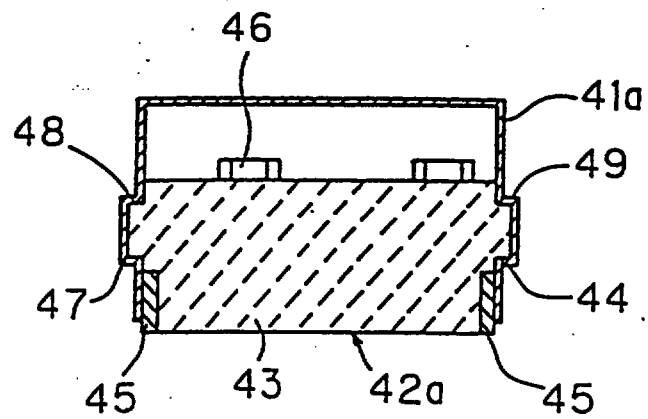


FIG. 14



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FIG. 15

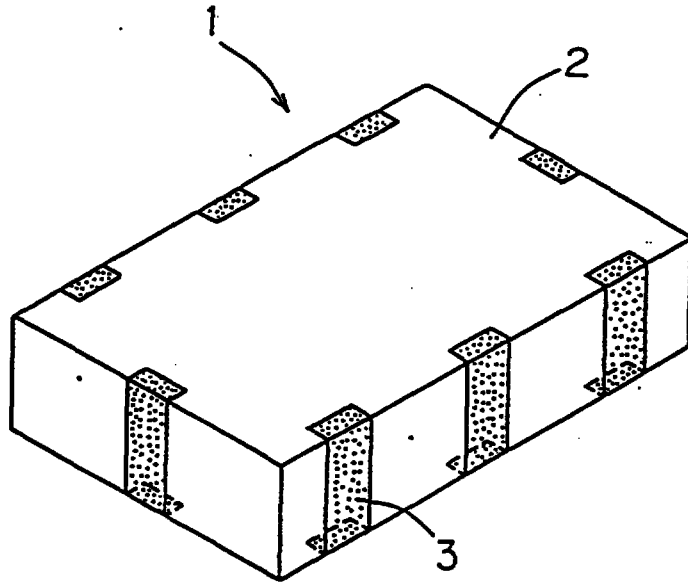
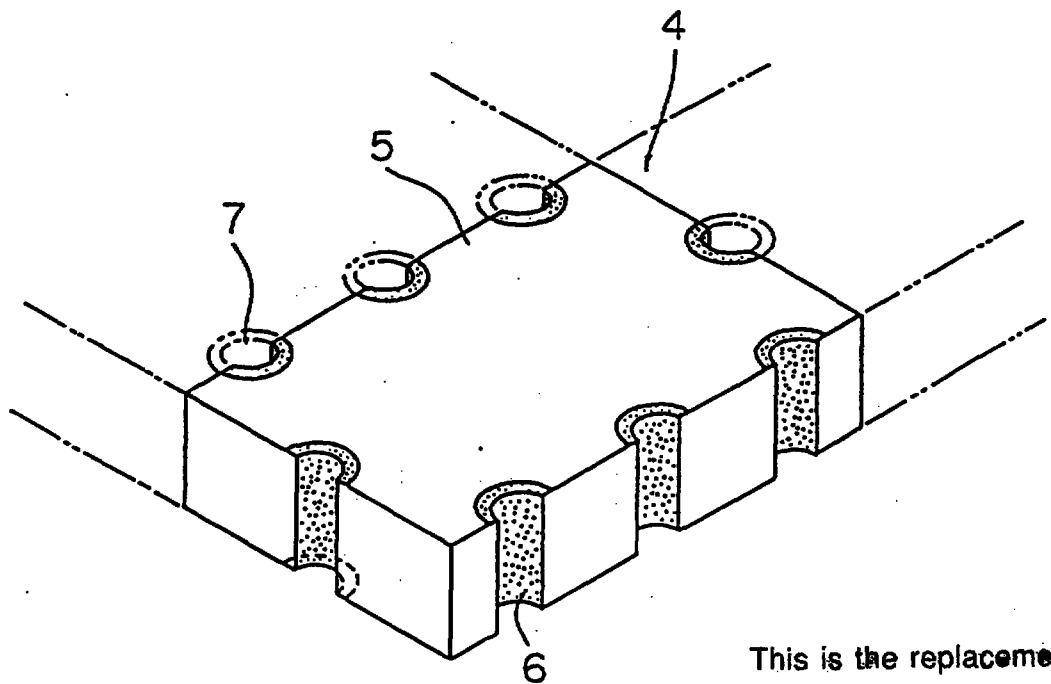


FIG. 16



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REPLACED SHEETS SG

☐ Description : paged to paged
☐ Claim(s) : paged to paged
☐ Drawing(s) : paged to paged
☒ Abstract : paged 31 to paged

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REPLACEMENT SHEETS SG

☐ Description : paged to paged
☐ Claim(s) : paged to paged
☐ Drawing(s) : paged to paged
☒ Abstract : paged 31 to paged

DATE OF RECEIPT 25 FEB 1998

MULTILAYER ELECTRONIC COMPONENT, METHOD OF MANUFACTURING THE SAME AND METHOD OF MEASURING CHARACTERISTICS THEREOF

ABSTRACT OF THE DISCLOSURE

In order to provide a multilayer electronic component (10) which can reduce arrangement pitches for external electrodes (12), via holes (19) filled up with conductive materials (18) are provided in a mother laminate (14), which is obtained by stacking a plurality of insulating sheets (16, 17) with interposition of conductor films (23, 24), in positions parted by cutting. The conductive materials (18) define external electrodes (12) of individual multilayer electronic components (10) which are obtained by cutting the mother laminate (14). No specific step is required for forming the external electrodes (12), and characteristics of each multilayer electronic component (10) can be efficiently measured in the state of the mother laminate (14).

FIGURE 3.

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REPLACEMENT SHEETS	
☒ Description	: paged 1 to 2 & paged 5
☒ Claim(s)	: paged 23 to 27
☐ Drawing(s)	: paged 1 to 1
☒ Abstract	: paged 28 to 1
DATE OF RECEIPT 15 AUG 1998	

**MULTILAYER ELECTRONIC COMPONENT, METHOD OF
MANUFACTURING THE SAME AND METHOD OF MEASURING
CHARACTERISTICS THEREOF**

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a multilayer electronic component having internal circuit elements arranged therein, a method of manufacturing the same and a method of measuring characteristics thereof, and more particularly, it relates to an improvement in a mode of forming external electrodes in a multilayer electronic component.

Description of the Background Art

A multilayer electronic component, which is represented by a multilayer capacitor, a multilayer inductor, a multilayer circuit board or a multilayer composite electronic component, for example, comprises a laminate which is obtained by stacking a plurality of insulating sheets with interposition of internal circuit elements such as conductor films and/or resistors films. The insulating sheets are typically prepared from ceramic sheets.

Fig. 15 is a perspective view showing the appearance of a conventional multilayer electronic component 1 as it is, for instance, known from US-A-4 790 894. The

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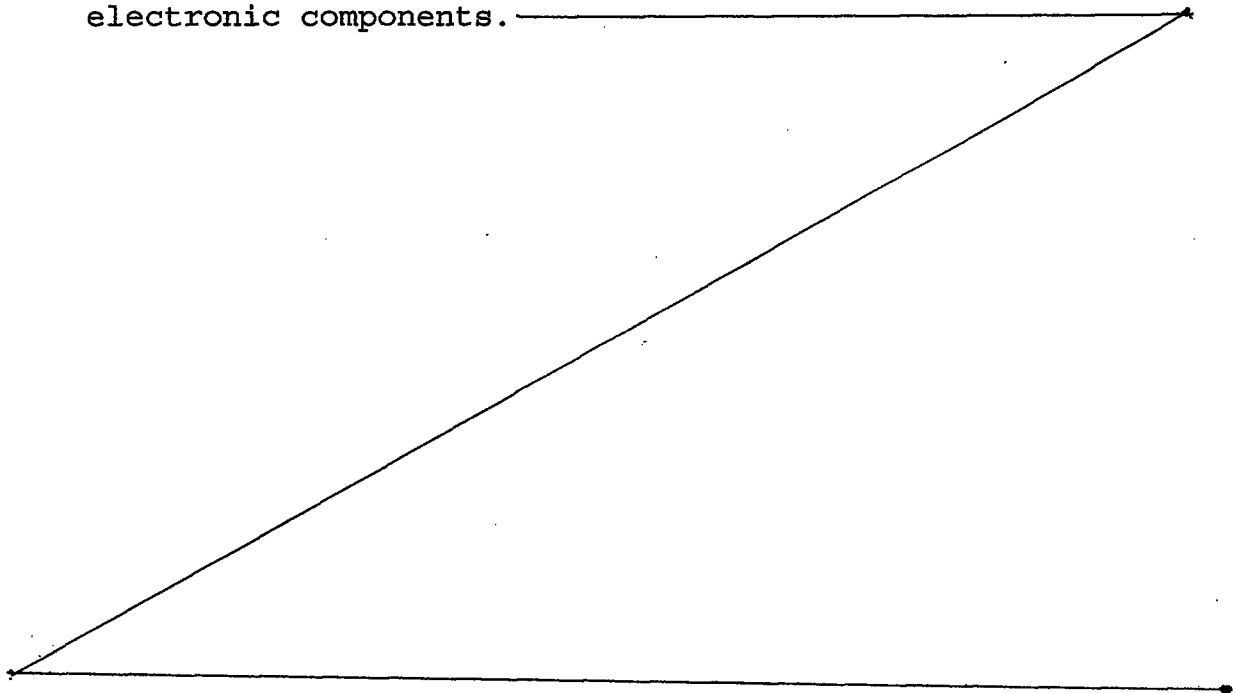
Date: 15 AUG 1998

brought into states of chips in principle. In the multilayer electronic component 1 shown in Fig. 15, measurement of the characteristics is enabled after formation of the external electrodes 3. Also in the case shown in Fig. 16, the characteristics of each multilayer electronic component 4 cannot be measured in the stage of the mother laminate. Such measurement of the characteristics is enabled only when the mother laminate is cut to divide the through holes 7.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a multilayer electronic component which can reduce arrangement pitches for external electrodes, and a method of manufacturing the same.

Another object of the present invention is to provide a characteristic measuring method which can efficiently measure characteristics of a plurality of multilayer electronic components.



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CLAIMS:

1. A multilayer electronic component comprising:

a laminate (11) comprising a stack of a first plurality of insulating sheets (16) and a stack of a second plurality of insulating sheets (17) with interposition of internal circuit elements (23, 24), said laminate having first and second opposite major surfaces and side surfaces coupling said major surfaces with each other; and

external electrodes (12) being formed on said side surfaces of said laminate (11) to be electrically connected with said internal circuit elements (23, 24),

said external electrodes (12) being formed by exposing at least side portions of via holes (19), being coated with conductive materials (18), by cutting said insulating sheets (16, 17),

characterized in that

said via holes (19) are provided only in said first plurality of insulating sheets (16).

2. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are filled up in said via holes (19).

3. A multilayer electronic component in accordance with claim 1, wherein said conductive materials (18) are layered on inner peripheral surfaces of said via holes (19).



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4. A multilayer electronic component in accordance with claim 1, further comprising a second electronic component (46) being formed on said stack of a second plurality of insulating sheets (17) of said laminate (43).

5. A multilayer electronic component in accordance with claim 1, wherein steps (13) are formed on said side surfaces of said laminate (11) in correspondence to the position of said boundary surface between said stack of a first plurality of insulating sheet and said stack of a second plurality of insulating sheets (17).

6. A multilayer electronic component in accordance with claim 4, further comprising a case (41) being so mounted on said laminate (43) as to cover said second electronic component (46).

7. A multilayer electronic component in accordance with claim 1, wherein said external electrodes are exposed on said side surfaces and said stack of a first plurality of insulating sheets (16) of said laminate.

8. A multilayer electronic component in accordance with claim 1, wherein said external electrodes (12a) are exposed only on said side surfaces of said laminate (11).

9. A method of manufacturing a multilayer electronic component, comprising the steps of:



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preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting line (45); and

cutting said mother laminate (14) along said cutting lines (15),

characterized in that

said via holes (19) are provided only in said first plurality of mother insulating sheets (16).

10. A method of manufacturing a multilayer electronic component in accordance with claim 9, wherein said step of cutting said mother laminate (14) comprises a step of forming grooves (20) in said mother laminate (14) to expose said via holes (19) on said cut surfaces, and a step of dividing said mother laminate (14), being provided with said grooves (20), in positions of said grooves (20).



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11. A method of manufacturing a multilayer electronic component in accordance with claim 9, wherein said mother insulating sheets (16, 17) are ceramic green sheets, said method further comprising a step of firing said mother laminate (14).

12. A method of measuring characteristics of a multilayer electronic component, comprising the steps of:

preparing a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via hole (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45);

characterized by the following steps:

forming grooves (20) in said mother laminate (14) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20); and

measuring characteristics of each said multilayer



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electronic component (10) while treating said via holes (19), being exposed on said inner side surfaces of said grooves (20), as external electrodes (12), wherein said via holes (19) are provided only in said first plurality of mother insulating sheets (16).

13. An assembly of multilayer electronic components, comprising:

a mother laminate (14), to be cut along prescribed cutting lines (15) for obtaining a plurality of multilayer electronic components (10), being formed by stacking a plurality of mother insulating sheets (16, 17) comprising a first plurality of mother insulating sheets (16) and a second plurality of mother insulating sheets (17) with interposition of internal circuit elements (23, 24) for respective said multilayer electronic components (10) to distribute said internal circuit elements in respective regions parted by said cutting lines (15) and having via holes (19), coated with conductive materials (18) being electrically connected with said internal circuit elements (23, 24), provided on positions to be exposed on cut surfaces by said cutting along said cutting lines (45),

characterized in that

said mother laminate (14) is formed with grooves (20) along said cutting lines (15), thereby exposing at least said via holes (19) on inner side surfaces of said grooves (20), and

said via holes (19) are provided only in said first plurality of mother insulating sheets (16).



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**MULTILAYER ELECTRONIC COMPONENT, METHOD OF
MANUFACTURING THE SAME AND METHOD OF MEASURING
CHARACTERISTICS THEREOF**

ABSTRACT OF THE DISCLOSURE

In order to provide a multilayer electrode component (10) which can reduce arrangement pitches for external electrodes (12), via holes (19) filled up with conductive materials (18) are provided in a mother laminate (14), which is obtained by stacking a plurality of insulating sheets (16, 17) with interposition of conductor films (23, 24), in positions parted by cutting. The conductive materials (18) define external electrodes (12) of individual multilayer electronic components (10) which are obtained by cutting the mother laminate (14). No specific step is required for forming the external electrodes (12), and characteristics of each multilayer electronic component (10) can be efficiently measured in the state of the mother laminate (14).

FIGURE 3.

This is the replacement sheet

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