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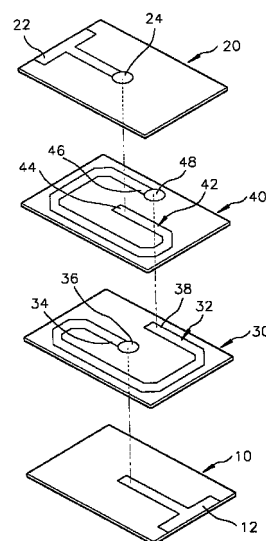
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(54) **Multilayer type chip inductor**

(57) An inventive multilayer type chip inductor includes a pair of outermost sheets having a terminal pattern, respectively, and a plurality of intermediate sheets stacked between the outermost sheets. Each of the intermediate sheets has one turned coil-shaped conductor pattern in an electric contact with the terminal pattern of the outermost sheet. Each of the conductor patterns is spirally and outwardly turned from a central portion of the intermediate sheet.

FIG. 2



EP 1 011 116 A2

Description

Field of the Invention

[0001] The present invention relates to a chip inductor; and, more particularly, to a multilayer type chip inductor employing a pair of intermediate sheets having one turned coil-shaped conductor pattern, respectively.

Background of the Invention

[0002] In general, a multilayer type chip inductor is comprised of a stack of the sheets made of a ferrite or a dielectric material, having respective coil patterned conductors formed thereon, and connected electrically by the through holes in series with each other in substantially zigzag fashion. Such a multilayer type chip inductor is used, for example, for suppressing noise or making a LC resonance circuit.

[0003] Fig. 1 shows an exploded view of the conventional multilayer type chip inductor disclosed in Japanese Laid-open Utility Model Publication No. 57-100209.

[0004] As shown, the conventional multilayer type chip inductor includes a pair of generally rectangular outermost sheets 1, 1' made of a ferrite or a dielectric material and a plurality of intermediate sheets 2 made of the ferrite or the dielectric material stacked one above the other and firmly sandwiched between the outermost sheets 1, 1'.

[0005] The outermost sheet 1 has a front surface formed with a generally L-shaped electric terminal pattern 6. The electric terminal pattern 6 has a lengthwise strip 6a extending along and adjacent to a longer side of the outermost sheet 1 and terminating at a generally intermediate portion of the longer side of the outermost sheet 1, and a lateral strip 6b continued to the lengthwise strip 6a and extending along a shorter side of the outermost sheet 1 for electric connection with an end cap or like terminal member (not shown).

[0006] Similarly, the outermost sheet 1' has at its front surface a generally L-shaped electric terminal pattern 6' composed of a lengthwise strip 6'a and a lateral strip 6'b, wherein, the terminal pattern 6' thereof is offset 180° with respect to the terminal pattern 6 on the outermost sheet 1 about an imaginary plane passing immediately between the outermost sheets 1, 1' in a widthwise direction of the stack, and the lengthwise strip 6'a has at its end a via hole 4'. The via hole 4' is formed by perforating the outermost sheet 1' across the thickness thereof so as to leave a cylindrical wall (not shown).

[0007] Each of the intermediate sheets 2 has a front and a reverse surfaces opposite to each other. The front surface of each of the intermediate sheets 2 is, respectively, formed with a generally U-shaped electric conductor pattern 3. Each of the conductor patterns 3 has a perforated end 3a formed with a via hole 4 and a non-

perforated end 3b. Similar to the above-mentioned via hole 4', the via hole 4 is formed by perforating the respective intermediate sheet 2 across the thickness thereof so as to leave a cylindrical wall (not shown). The above-mentioned cylindrical walls are filled with the conductive material.

[0008] When assembling the sheets 1, 2 and 1' together to provide a substantially complete multilayer type chip inductor, the intermediate sheets 2 are stacked one above the other in such a way that, when one intermediate sheet 2 is turned 180° on an imaginary plane parallel thereto, the perforated end 3a and the non-perforated end 3b thereof are, respectively, contacted with the non-perforated end 3b and the perforated end 3a of the neighboring intermediate sheet 2 thereabove or therebelow, whereby the intermediate sheets 2 can be electrically connected with each other through the via holes 4. With respect to the outermost sheets 1, 1', the outermost sheet 1 is positioned below the lowermost intermediate sheet 2 in such a way that the lengthwise strip 6a thereof comes into contact with the perforated end 3a of the lowermost intermediate sheet 2 through the via hole 4, and the outermost sheet 1' is positioned above the uppermost intermediate sheet 2 in such a way that the lengthwise strip 6'a thereof comes into contact with the non-perforated end 3b of the uppermost intermediate sheet 2 through the via hole 4' thereof, whereby the conductor patterns 3 on the intermediate sheets 2 and the terminal patterns 6, 6' on the outermost sheets 1, 1' are electrically connected with each other through the via holes 4, 4'.

[0009] In such a multilayer type chip conductor, since the outermost sheets are, respectively, formed with the semicircular conductor patterns, there is a limit on increasing of the inductance.

Summary of the Invention

[0010] It is, therefore, a primary object of the present invention to provide a multilayer type chip inductor having an increased inductance by employing at least one intermediate sheet having one turned conductor pattern.

[0011] In accordance with one aspect of the present invention, there is provided a multilayer type chip inductor comprising a first outermost sheet having a first terminal pattern, a second outermost sheet having an identical second terminal pattern as that of the first outermost sheet and a first via hole filled with a conductive material at the second terminal pattern, wherein the second outermost sheet is arranged in such a way that, when the second outermost sheet is turned 180° on an imaginary plane parallel thereto, the first and the second terminal patterns are allowed to be overlapped with the each other, a first intermediate sheet having a first one turned coil-shaped conductor pattern, the first conductor pattern having at a central portion of the first intermediate sheet a first starting end formed with a

second via hole filled with a conductive material and a first finished end positioned at a location which the first conductor pattern spirally and outwardly turned from the first starting end terminates at, wherein the first intermediate sheet is positioned above the first outermost sheet in such a way that the first starting end thereof comes in contact with the first terminal pattern of the first outermost sheet through the second via hole thereof, and a second intermediate sheet having a second one turned coil-shaped conductor pattern, the second conductor pattern having a second starting end and a second finished end, the second starting end being positioned at a central portion of the second intermediate sheet and the second finished end being positioned at a location which the second conductor pattern spirally and outwardly turned from the second starting end terminates at and being formed with a third via hole filled with a conductive material, wherein the second intermediate sheet is positioned between the first intermediate sheet and the second outermost sheet in such a way that the second starting end thereof is contacted with second terminal pattern of the second outermost sheet through the first via hole of the second outermost sheet and the second finished end thereof is contacted with the first finished end of the first intermediate sheet through the third via hole of the second intermediate sheet.

[0012] In accordance with another aspect of the present invention, there is provided a multilayer type chip inductor comprising a first outermost sheet having a first terminal pattern, a second outermost sheet having an identical second terminal pattern as that of the first outermost sheet and a first via hole filled with a conductive material at the second terminal pattern, wherein the second outermost sheet is arranged so as to have a parallel relationship with respect to the first outermost sheet, a first intermediate sheet having a first one turned coil-shaped conductor pattern, the first conductor pattern having at a central portion of the first intermediate sheet a first starting end, and a first finished end formed with a second via hole filled with a conductive material and positioned at a location which the first conductor pattern spirally and outwardly turned from the first starting end terminates at, wherein the first intermediate sheet is positioned above the first outermost sheet in such a way that the first finished end thereof comes in contact with the first terminal pattern of the first outermost sheet through the second via hole thereof and a second intermediate sheet having a second one turned coil-shaped conductor pattern, the second conductor pattern having a second starting end and a second finished end, the second starting end being positioned at a central portion of the second intermediate sheet and being formed with a third via hole filled with a conductive material, and the second finished end being positioned at a location which the second conductor pattern spirally and outwardly turned from the second starting end terminates at, wherein the second intermediate sheet is positioned between the first intermediate sheet and the

second outermost sheet in such a way that the second starting end thereof is contacted with the first starting end of the first intermediate sheet through the third via hole thereof and the second finished end thereof is contacted with the second terminal pattern of the second outermost sheet through the first via hole of the second outermost sheet.

Brief Description of the Drawings

[0013] The above and other objects and features of the present invention will become apparent from the following description of the preferred embodiments given in conjunction with the accompanying drawings, wherein:

Fig. 1 shows an exploded perspective view of the conventional multilayer type chip inductor;

Fig. 2 illustrates an exploded perspective view of the multilayer type chip inductor in accordance with a first preferred embodiment of the present invention; and

Fig. 3 describes an exploded perspective view of the multilayer type chip inductor in accordance with a second preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0014] There is provided in Fig. 2 an exploded perspective view of a multilayer type chip inductor in accordance with a first preferred embodiment of the present invention.

[0015] Referring to Fig. 2, a multilayer type chip inductor in accordance with the first embodiment of the present invention includes a first and a second outermost sheets 10, 20 and a first and a second intermediate sheets 30, 40 stacked between the first and the second outermost sheets 10, 20. The outermost and the intermediate sheets 10, 20, 30, 40 are made of a ferrite or a dielectric material.

[0016] The first and the second outermost sheets 10, 20 have a first and a second terminal patterns 12, 22, respectively, wherein the second terminal pattern 22 is formed with a first via hole 24 filled with a conductive material for establishing an electrical connection with a second conductor pattern 42 of the second intermediate sheet 40, as will be described later.

[0017] The first intermediate sheet 30 has a first one turned coil-shaped conductor pattern 32. The first conductor pattern 32 has a first starting end 34 at a central portion of the first intermediate sheet 30 and a first finished end 38 positioned at a location which the first conductor pattern 32 spirally and outwardly turned from the first starting end 34 terminates at. The first starting end 34 is formed with a second via hole 36 filled with a conductive material for establishing an electrical connection with the first terminal pattern 12 of the first out-

ermost sheet 10, as will be described later.

[0018] The second intermediate sheet 40 has an identical second one turned coil-shaped conductor pattern 42 as the first conductor pattern 32. The second conductor pattern 42 has a second starting end 44 at a central portion of the second intermediate sheet 40 and a second finished end 46 formed with a third via hole 38 filled with a conductive material for establishing an electrical connection with the first finished end 38 of the first conductor pattern 32 of the first intermediate sheet, as will be described later.

[0019] When the above-mentioned sheets 10, 20, 30, 40 are assembled together, the first outermost sheet 10 is positioned in a lowermost location. Next, the first intermediate sheet 30 is disposed above the first outermost sheet 10 in such a way that the first starting end 34 thereof is contacted with the first terminal pattern 12 of the first outermost sheet 10 through the second via hole 36 thereof.

[0020] Subsequently, the second intermediate sheet 40 is installed above the first intermediate sheet 30 in such a way that the second finished end 46 thereof is contacted with the first finished end 38 of the first intermediate sheet 30 through the third via hole 48 thereof.

[0021] Finally, the second outermost sheet 20 is arranged in such a way that, when it is turned 180° on an imaginary plane parallel thereto, its second terminal pattern 22 is offset with respect to the first terminal pattern 12 of the first outermost sheet 10, and then is mounted on the second intermediate sheet 40 in such a way that its second terminal pattern 22 is contacted with the second starting end 44 of the second intermediate sheet 40 through its first via hole 24.

[0022] The foregoing arrangement allows the outermost sheets 10, 20 and the intermediate sheets 30, 40 to be electrically connected with each other through the via holes 24, 36, 48.

[0023] A multilayer type chip inductor in accordance with a second preferred embodiment of the present invention will now be described with reference to Fig. 3.

[0024] This embodiment is similar to the first one except for intermediate sheets and a position of the first via hole of the second outermost sheet. That is, a multilayer type chip inductor in accordance with a second preferred embodiment or the present invention includes a third and a fourth intermediate sheets 130, 140.

[0025] The third intermediate sheet 130 has a third one turned coil-shaped conductor pattern 132. The third conductor pattern 132 has a third starting end 134 at a central portion of the third intermediate sheet 130 and a third finished end 138 positioned at a location which the third conductor pattern 132 spirally and outwardly turned from the third starting end 134 terminates at. The third finished end 138 is formed with a fourth via hole 136 filled with a conductive material for establishing an electrical connection with the first terminal pattern 12 of the first outermost sheet 10.

[0026] The fourth intermediate sheet 140 has an identical fourth one turned coil-shaped conductor pattern 142 as the third conductor pattern 132. The fourth conductor pattern 142 has a fourth starting end 144 at a central portion of the fourth intermediate sheet 140 and a fourth finished end 146. The fourth starting end 144 is formed with a fifth via hole 148 filled with a conductive material for establishing an electrical connection with the third starting end 134 of the third conductor pattern 132 of the third intermediate sheet 130. In this case, it should be understood that the position of the first via hole of the second outermost sheet may change depending on a location of the fourth finished end of the fourth intermediate sheet.

[0027] An assembling process of the sheets 10, 130, 140, 20 is similar to that of sheets 10, 30, 40, 20 in the first embodiment except for an arrangement of the outermost sheets. That is, the first and the second outermost sheets 10, 20 are arranged so as to have a parallel relationship with respect to each other.

[0028] Although the above discussions were presented referring to a situation where the number of the intermediate sheets stacked between the outermost sheets is two, its number can be changed depending on the inductance desired.

[0029] In such a multilayer type chip inductor, since the intermediate sheet is formed with one turned coil-shaped conductor pattern, it is possible to obtain an inductor with an increased inductance.

[0030] While the present invention has been described with respect to certain preferred embodiments only, other modifications and variations may be made without departing from the scope of the present invention as set forth in the following claims.

Claims

1. In a multilayer type chip inductor equipped with a pair of outermost sheets having a terminal pattern, respectively, and a plurality of intermediate sheets stacked between the outermost sheets,

each of the intermediate sheets comprising one turned coil-shaped conductor pattern in an electric contact with the terminal pattern of the outermost sheet.

2. The multilayer type chip inductor of claim 1, wherein each of the conductor patterns is spirally and outwardly turned from a central portion of each of the intermediate sheets.

3. A multilayer type chip inductor comprising :

a first outermost sheet having a first terminal pattern;
a second outermost sheet having an identical second terminal pattern as that of the first out-

ermost sheet and a first via hole filled with a conductive material at the second terminal pattern, wherein the second outermost sheet is arranged in such a way that, when the second outermost sheet is turned 180° on an imaginary plane parallel thereto, the first and the second terminal patterns are allowed to be overlapped with the each other;

a first intermediate sheet having a first one turned coil-shaped conductor pattern, the first conductor pattern having at a central portion of the first intermediate sheet a first starting end formed with a second via hole filled with a conductive material and a first finished end positioned at a location which the first conductor pattern spirally and outwardly turned from the first starting end terminates at, wherein the first intermediate sheet is positioned above the first outermost sheet in such a way that the first starting end thereof comes in contact with the first terminal pattern of the first outermost sheet through the second via hole thereof; and a second intermediate sheet having a second one turned coil-shaped conductor pattern, the second conductor pattern having a second starting end and a second finished end, the second starting end being positioned at a central portion of the second intermediate sheet and the second finished end being positioned at a location which the second conductor pattern spirally and outwardly turned from the second starting end terminates at and being formed with a third via hole filled with a conductive material, wherein the second intermediate sheet is positioned between the first intermediate sheet and the second outermost sheet in such a way that the second starting end thereof is contacted with second terminal pattern of the second outermost sheet through the first via hole of the second outermost sheet and the second finished end thereof is contacted with the first finished end of the first intermediate sheet through the third via hole of the second intermediate sheet.

4. The multilayer type chip inductor of claim 3, wherein the first and the second conductor patterns have an identical shape.

5. A multilayer type chip inductor comprising :

a first outermost sheet having a first terminal pattern;
a second outermost sheet having an identical second terminal pattern as that of the first outermost sheet and a first via hole filled with a conductive material at the second terminal pattern, wherein the second outermost sheet is

arranged so as to have a parallel relationship with respect to the first outermost sheet;

a first intermediate sheet having a first one turned coil-shaped conductor pattern, the first conductor pattern having at a central portion of the first intermediate sheet a first starting end, and a first finished end formed with a second via hole filled with a conductive material and positioned at a location which the first conductor pattern spirally and outwardly turned from the first starting end terminates at, wherein the first intermediate sheet is positioned above the first outermost sheet in such a way that the first finished end thereof comes in contact with the first terminal pattern of the first outermost sheet through the second via hole thereof; and a second intermediate sheet having a second one turned coil-shaped conductor pattern, the second conductor pattern having a second starting end and a second finished end, the second starting end being positioned at a central portion of the second intermediate sheet and being formed with a third via hole filled with a conductive material, and the second finished end being positioned at a location which the second conductor pattern spirally and outwardly turned from the second starting end terminates at, wherein the second intermediate sheet is positioned between the first intermediate sheet and the second outermost sheet in such a way that the second starting end thereof is contacted with the first starting end of the first intermediate sheet through the third via hole thereof and the second finished end thereof is contacted with the second terminal pattern of the second outermost sheet through the first via hole of the second outermost sheet.

6. The multilayer type chip inductor of claim 5, wherein the first and the second conductor patterns have an identical shape.

FIG. 1
(PRIOR ART)

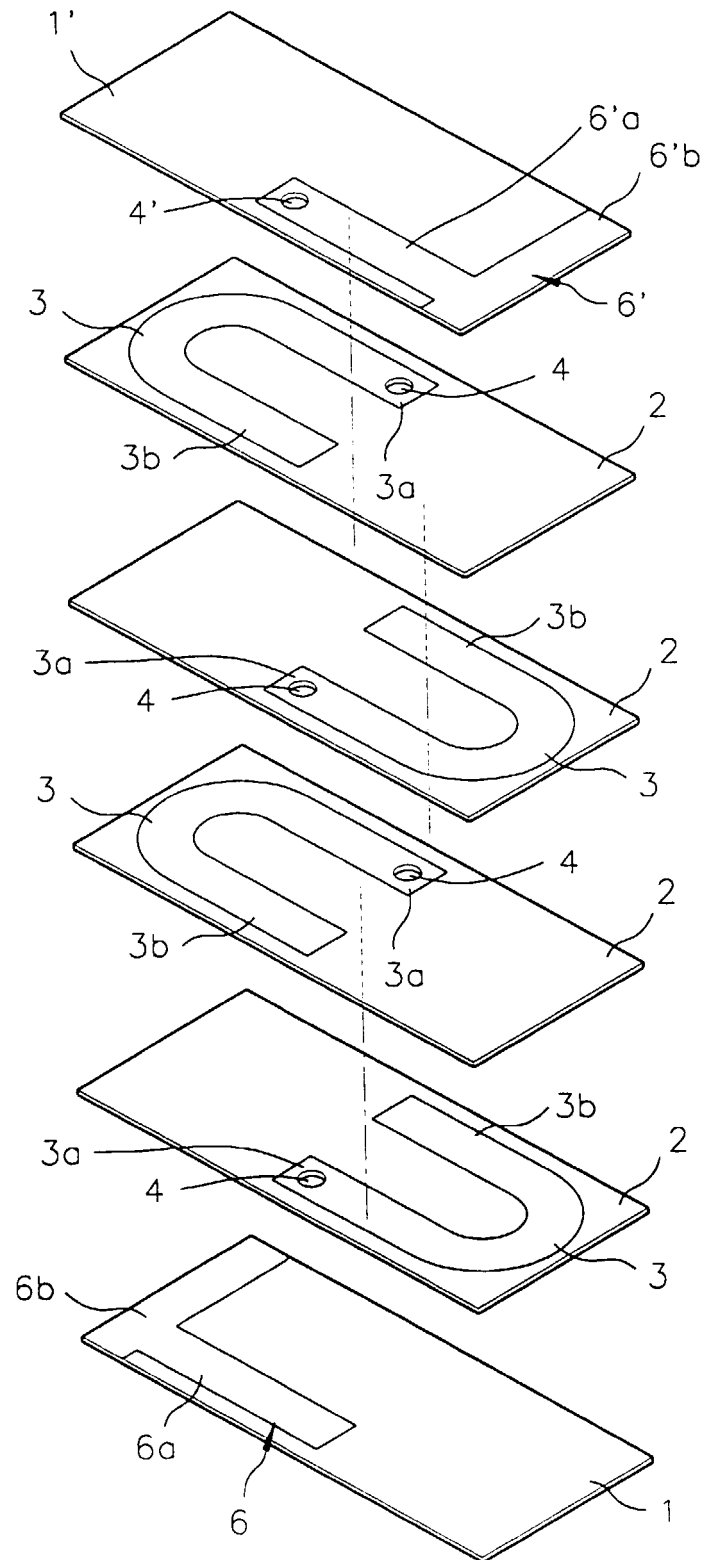


FIG. 2

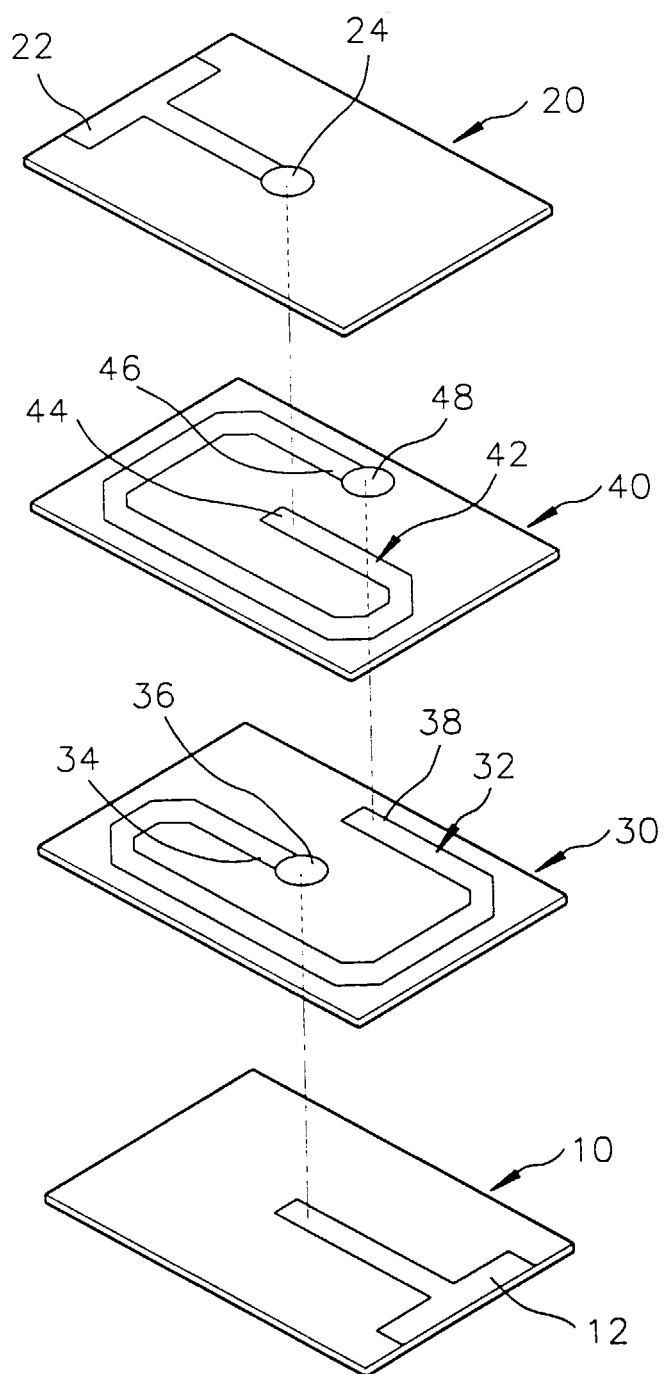


FIG. 3

