(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 089 302 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.04.2001 Bulletin 2001/14

(51) Int. Cl.[7]: **H01F 17/00**, H01F 41/04, H01L 23/64

(21) Application number: **00121450.1**

(22) Date of filing: **29.09.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **30.09.1999 JP 28007999**

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(54) Substrate-mounted common mode choke coil and method of manufacture thereof

(57) A common mode choke coil has first and second spiral conductive layer elements electrically insulated from each other at a base. The base is made of a magnetic material or a dielectric material. at least one of the first and the second spiral conductive layer elements is formed in close contact with a surface of the base. The common mode choke coil has two spiral conductor layer elements at a base. Therefore, the common mode choke coil may be easily and economically provided that has high Q-characteristics or high impedance at a common mode and little fluctuation of resonance frequencies and inductance.

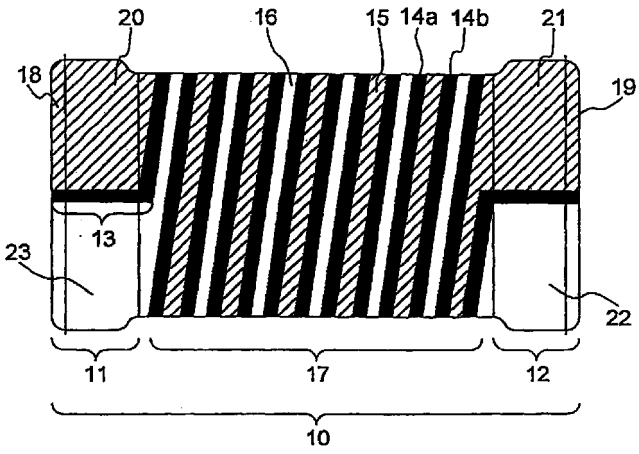

FIG. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a noise filter so as to restrain electromagnetic noise, and particularly to a substrate-mounted common mode choke coil and the method of manufacture thereof.

2. Description of the Related Art

[0002] As electric equipment is reduced in size and has increased handling frequencies, the importance of measures against EMI (Electromagnetic Interference) has been increasing. Impedance elements generally shield frequency noise as impedance characteristics for the measures against EMI.

[0003] Wound type and laminated type common mode choke coils are used as electromagnetic noise filters.

[0004] The wound type is miniaturized by thinning wires or the like, thus increasing defects thereby. Additionally, pitch variations or the like causes errors in resonance frequencies and inductance, and the adjustments thereof are difficult. The manufacture thereof is also hard.

[0005] Moreover, in case of the laminated type, patterns have been predetermined, thereby causing errors in inductance due to the fluctuation in thickness or the like. Also, the manufacture thereof is difficult because of the laminated structure.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to easily and economically provide, in common mode choke coils having two mutually electrically insulated spiral conductors at a base, the common mode choke coil that has high Q-characteristics and little fluctuation of resonance frequencies and inductance.

[0007] It is another object of the present invention to easily and economically provide, in common mode choke coils having two mutually electrically insulated spiral conductors at a base, the common mode choke coil that has high impedance at a common mode and little fluctuation of resonance frequencies and inductance.

[0008] It is still another object of the present invention to provide the method of manufacturing the common mode choke coils described above.

[0009] According to an aspect of the present invention, there is provided a common mode choke coil which has first and second spiral conducive layer elements electrically insulated from each other at a base. The base is made of a magnetic or dielectric material. At least one of the first and the second spiral conductive layer elements is formed in close contact with the surface of the base.

[0010] According to another aspect of the present invention, there is provided a method of manufacturing the above-mentioned common mode choke coils. The method is characterized in that, after at least one conductive layer is formed on the surface of the base, two spiral conductors are formed by at least one processes of laser trimming, sandblast and water jet while the conductive layer is being removed to form grooves.

[0011] Moreover, according to still another aspect of the present invention, there is provided a method of manufacturing the common mode choke coils mentioned above is obtained. The method is characterized in that, after forming two spiral conductive layers and an insulating layer by screen printing, a binder is removed and baking is carried out, thus forming the coil.

[0012] Furthermore, according to yet another aspect of the present invention, there is provided a method of manufacturing any of the above-mentioned common mode choke coils is obtained. The method is characterized in that input and output terminals at a spiral conductive layer part, which is formed in close contact with the base, are formed by etching with a resist until a conductive layer constituting the spiral conductive layer part is exposed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a front view for use in explaining a common mode choke coil according to a first example of the present invention;

Fig. 2 is a view for use in explaining an end product of the common mode choke coil of Fig. 1;

Fig. 3A is a front view of a base of a common mode choke coil according to a second example of the present invention;

Fig. 3B is a side view of the base of Fig. 3A;

Fig. 4A is a front view of a base of a common mode choke coil according to a third example of the present invention;

Fig. 4B is a side view of the base of Fig. 4A;

Fig. 5 is a figure for use in explaining a double-layer spiral common mode choke coil of a sixth example of the present invention;

Fig. 6 is a figure for use in explaining a cross section of the double-layer spiral conductive part of Fig. 5;

Fig. 7 is a view for use in explaining an end product of the common mode choke coil of Fig. 5;

Fig. 8 is a perspective view for use in explaining the common mode choke coil according to a ninth example of the present invention;

Fig. 9 is a figure for use in explaining a cross section of a spiral conductive part of the common mode choke coil of Fig. 8; and

Fig. 10 is a figure for use in explaining an end prod-

uct of the common mode choke coil of Fig. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Example 1

[0014] With reference to Fig. 1 and Fig. 2, a structure of a common mode choke coil according to the first example of the present invention will be explained based on the manufacturing processes thereof.

[0015] A conductive material is coated on the surface of a prismatic base 10, made of a dielectric or magnetic material. The conductive material for use may be provided by plating, sputtering or depositing copper, aluminum, silver, or the like.

[0016] The conductive material for use may also be provided by, after coating a conductive paste made of a conductive powder and a binder, removing the binder and then baking the paste.

[0017] Regarding the shape of the base 10, terminal parts 11 and 12 may be prismatic and a spiral conductive part 17 may be a polygonal pillar, cylinder or the like as explained later in the second example and the third example relating to Figs. 3A, 3B, 4A, and 4B.

[0018] In case of the prismatic shape, the edges may have R herein. As illustrated by a thick black line in Fig. 1, spiral grooves 14a, 14b are formed on these base 10 in two stages by laser trimming, sandblast or water jet, thus forming two spiral conductive layer elements 15 and 16 alternately on the surface of the base 10. One of the spiral conductive layer elements will be referred to as a first spiral conductive layer element 15 and is illustrated by a hatched portion in Fig. 1. Another of the spiral conductive layer elements will be referred to as a second spiral conductive layer element 16 and is illustrated by non hatched portion in Fig. 1.

[0019] The terminal parts 11 and 12 on both ends are divided into four terminals 20, 21, 22, and 23 by providing grooves 13.

[0020] Referring to Fig. 2, an insulating resin 24 is coated over an entire surface of the spiral conductive part 17 between the terminal parts 11 and 12. Subsequently, solder plating is carried out to the four terminals 20, 21, 22, and 23, and both ends 18 and 19 at the terminal parts are cut off from the lines at both ends in Fig. 1. As a result, a common mode choke coil 1 is provided that has mutually insulated two spiral conductive layers of the first and the second spiral conductive layer elements 15 and 16 alternately.

[0021] Subsequently, the manufacture of the common mode choke coil according to example 1 of the present invention will be explained in further detail.

[0022] A conductive layer was formed by plating copper at 15 microns on a $1.6 \times 1.0 \times 1.0$ mm prism base 10 made of a magnetic material having $\mu' = 30$. On this plated base 10, grooves 14a, 14b were formed in a spiral form by laser trimming. First, the base 10 was moved in a perpendicular direction to the laser, thus forming a groove 13 at the base terminal part 11 toward the corner of and in a longitudinal direction of the base. Subsequently, as the base 10 was being shifted, it was also rotated perpendicularly to the shifting direction. A first spiral conductive layer element 15 was formed in the base 10 thereby. The rotation was then stopped at the opposite terminal part 12 so as to cut the conductive layer. After the cut, the base 10 was rotated by 90° or 180°, thus forming a second spiral conductive layer element 16 by laser trimming as described above. Over the entire surface of the spiral conductive part 17 between the terminal parts 11 and 12, the insulating resin 24 was coated as in Fig. 2. Four terminals 20, 21, 22, and 23 were solder-plated, and both ends 18 and 19 at the terminals were cut off from the lines at both ends. The common mode choke coil was formed thereby that has the first and the second spiral conductive layer elements 15 and 16 insulated from each other alternately.

[0023] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

Example 2

[0024] Referring to Figs. 3A and 3B, a common mode choke coil of example 2 has the same structure as the common mode choke coil of example 1, except that the base has a different shape. Even if the spiral conductive part 17' of the base 30 is a polygonal pillar as shown in example 2, the coil may be formed as in examples 1 and 2. An impedance analyzer measured the impedance of the common mode choke coil of example 2 at a common mode. The impedance was 290 Ω at 500 MHz.

Example 3

[0025] A common mode choke coil of example 3 as shown in Figs. 4A and 4B has the same structure as the common mode choke coil of example 1, except that the base has a different shape. Even if the spiral conductive part 17″ of a base 30' is cylindrical as shown in example 3, the coil may be formed as in example 1. An impedance analyzer measured the impedance of the common mode choke coil of example 3 at a common mode. The impedance was 250 Ω at 500 MHz.

Example 4

[0026] The spiral conductive part was formed by laser trimming in example 1, but was formed by sandblast instead in example 4. The same common mode choke coil as in example 1 was obtained.

Example 5

[0027] The spiral conductive part was formed by laser trimming in the common mode choke coil of exam-

ple 1, but was formed by water jet instead in example 5. The same common mode choke coil as in example 1 was obtained.

[0028] In examples 5 and 6, the same base as in example 1 was used. However, when the spiral conductive part of a base is a polygonal pillar or a cylinder as in Figs. 3A, 3B or 4A, 4B as alternative examples, spiral grooves may be formed by sandblast or water jet. Clearly, the same effects can be obtained.

Example 6

[0029] A common mode choke coil of example 6 of the present invention has the same structure as the common mode choke coil of example 1 shown in Figs. 1 and 2, except that a different insulator or the like is applied. Thus, the common mode choke coil of this example will be explained by referring to Figs. 1 and 2.

[0030] In reference to Figs. 1 and 2, at a base 10 made of a dielectric or magnetic material, mutually insulated spiral electrodes are formed in close contact with the base 10. A conductive material for use may be provided by plating, sputtering or depositing copper, aluminum, silver, or the like. The conductive material for use may also be provided by, after coating a conductive paste made of a conductive powder and a binder, removing the binder and then baking the paste.

[0031] For this spiral conductive part 17, as shown in Fig. 1, an insulating layer made of a dielectric or magnetic material is formed over double spiral electrodes 15 and 16 that are two alternately formed electrodes.

[0032] This spiral conductive part 17 may be formed by laser trimming, sandblast, water jet, or the like.

[0033] In reference to Fig. 2, a resin 24 is formed by, on the surface of the spiral conductive part 17 of the base, coating and then drying a mixed resin, in which a soft magnetic material was added and then mixed with an insulating resin having a lower viscosity by dissolving it with a solvent or the like. A soft magnetic material and an organic binder are mixed, and the paste thereof is formed into a sheet by a doctor blade method, screen printing method, roll method, or the like. If no problems are found in the manufactured strength of the sheet, a coating insulating resin can be also used for the sheet.

[0034] An insulating resin is coated on this sheet, and the sheet is wound around the surface of the spiral conductive part 17, thus forming the resin 24. By these methods, the common mode choke coil is formed that contains a soft magnetic material in an insulating resin.

[0035] Subsequently, the manufacture of the common mode choke coil of example 6 of the present invention will be explained in detail.

[0036] A conductive layer was formed by plating copper at 15 microns on a $1.6 \times 1.0 \times 1.0$ mm prism base 10, made of Ni-Zn ferrite having $\mu' = 10$. On this plated base 10, six 20-micron wide groove 14a is formed in a spiral form by laser trimming. Similarly, the second spiral conductive layer elements 15 was formed by laser trimming.

[0037] Epoxy resin was prepared by dissolving it with a solvent. A slurry was prepared by mixing the epoxy resin so as to contain the Ni-Zn ferrite powder, having $\mu' = 10$, at 50% relative to the entire slurry. This slurry was coated over the spiral conductive part 17, and was dried in the open air as insulating resin 24 in Fig. 2. Solder plating was carried out on four terminals 20, 21, 22 and 23, and both ends 18 and 19 of the terminal parts were cut off from lines at both ends. An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 580 Ω at 500 MHz.

[0038] For reference, in the same method as above, the same coil as in the first example was formed without mixing a magnetic material into an insulating resin. An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

Example 7

[0039] A multi-layer spiral common mode choke coil of example 7 of the present invention will be explained by referring to Figs. 5 and 6.

[0040] At a base 10 made of a dielectric or magnetic material, mutually insulated spiral electrodes are formed in close contact with the base 10. A conductive material for use may be provided by plating, sputtering or depositing copper, aluminum, silver, or the like. The conductive material for use may also be provided by, after coating a conductive paste made of a conductive powder and a binder, removing the binder and then baking the paste.

[0041] A spiral conductive part 28 has a structure of spiral conductive portion 28' as shown in Fig. 6, in which a second conductive layer element 27 is attached on a first conductor 25 through a dielectric or magnetic body 26 therebetween.

[0042] This spiral conductive portion 28' may be formed by laser trimming, sandblast, water jet, or the like.

[0043] In reference to Fig. 5, a resin 35 is formed by, on the surface of the spiral conductive portion 28' of the base, coating and then drying a mixed resin, in which a soft magnetic material was added and then mixed with an insulating resin having a lower viscosity by dissolving it with a solvent or the like. A soft magnetic material and an organic binder are mixed, and the paste thereof is formed into a sheet by a doctor blade method, screen printing method, roll method, or the like. If no problems are found in the strength of the sheet, a coating insulating resin can also be used for the sheet.

[0044] An insulating resin is coated on this sheet, and the sheet is wound around the surface of the spiral conductive part 28', thus forming the resin 35. By these methods, the common mode choke coil is formed that

contains a soft magnetic material in an insulating resin.

[0045] The same common mode choke coil as in example 6 was formed in example 7, except that the spiral conductive part has a double-layer structure.

[0046] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 630 Ω at 500 MHz.

[0047] In the same method, a common mode choke coil was made without mixing a magnetic material into an insulating resin. An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 320 Ω at 500 MHz.

Example 8

[0048] A common mode choke coil according to example 8 has the same structure as the common mode choke coil of example 1, except that the material of an insulating layer or the like is different. Thus, the coil of this example will be explained by referring to Fig. 1.

[0049] PVB was added to Ni-Zn ferrite powder at 5 wt. % relative to the powder, and a mixed solvent of ethyl cellosolve and buthyl carbinol was added thereto, which was subsequently kneaded by a planetary mixer. This paste was formed into a sheet form at 10 microns by a doctor blade method. This sheet was cut into an appropriate size, and was wound around the spiral conductive part 17 after coating epoxy resin over the surface.

[0050] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 580 Ω at 500 MHz.

[0051] In the same method, a common mode choke coil was made without mixing a magnetic material into an insulating resin. An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

[0052] Although the base was cylindrical at both ends and at the center in example 6 to example 8 described above, the polygonal pillar base shown in Figs. 3 and the cylindrical base shown in Figs. 4 may be used. In case of the spiral conductive part of a base being either a polygonal pillar or a cylinder, the same effects may be clearly obtained. Moreover, even with a different soft magnetic material or insulating resin, the same effects may be obtained.

Example 9

[0053] Referring to Figs. 8 and 9, a first conductive layer element 41 is coated on a prismatic base made of a dielectric or magnetic material. A conductor in use may be provided by soldering, sputtering or depositing copper, aluminum, silver, or the like. The conductor for use may also be provided by, after coating a conductive paste made of a conductive powder and a binder, removing the binder and then baking the paste.

[0054] A second conductive layer element 43 is coated on the surface of this first conductive layer element 41 through an insulating layer 42. The insulating layer 42 and the second conductive layer element 43 may be formed like the first conductive layer element 41. In this base, a spiral groove 44 is formed as illustrated by a black thick line in Fig. 8. Laser trimming, or sandblast or water jet forms this groove 44. Subsequently, a portion of electrodes 45 and 46 is etched down to the first conductive layer 41, thus forming terminals 48 and 49 as illustrated by hatched portions. For the shape of the base 40, the terminal parts 45 and 46 may be prismatic, and a spiral conductive part 47 may be a polygonal pillar, cylinder, or the like. In case of the prismatic shape, the edges may have R. As in Fig. 10, an insulating resin 24 is coated over the entire surface of the conductive layer between the terminal parts, and four electrodes 51, 52, 53 and 54 are solder-plated. Accordingly, the common mode choke coil is formed that has the first and the second spiral conductive layer elements 41 and 43 insulated from each other. Regarding the shape of the base 40, the terminal parts 45 and 46 may be prismatic, and the spiral conductive part 47 may be a polygonal pillar, cylinder, or the like.

[0055] Moreover, as another method, the above-noted paste of a conductive powder and a binder is printed by screen printing onto the base so as to form two spiral conductive layer elements 41 and 43 and the insulating layer 42. The binder is removed, and the paste is baked, thus forming the common mode choke coil.

[0056] Subsequently, the manufacture of the common mode choke coil of the example 6 of the present invention will be explained.

[0057] Copper was plated at 15 microns on a 1.6 × 1.0 × 1.0 mm prism base 40 made of a magnetic body having $\mu' = 30$ as shown in Fig. 8. On this plated base 40, furthermore, alumina was plated at 15 microns and copper was then plated at 15 microns as shown in Fig. 9. A groove 44 was formed in this base 40 by laser trimming. The groove 44 is formed in a spiral form by shifting the base 40 in the perpendicular direction to the rotation of the base 40 while rotating the base 40. Subsequently, a portion of the electrodes 45 and 46 were etched down to the first conductive layer 41, thus forming the terminals 48 and 49. Over the entire surface of the conductive layer between the terminal parts 45 and 46, the insulating resin 55 was coated as in Fig. 10. Four terminals 51, 52, 53 and 54 were solder-plated. The terminals 53 and 54 are illustrated as hatched portions in Fig. 10. Accordingly, the common mode choke coil 3 is formed that has two mutually insulating spiral conductive layers 41 and 43.

[0058] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

Example 10

[0059] Referring to Figs. 3a and 3b, a common mode choke coil of example 10 has the same structure as the common mode choke coil of the ninth example, except that the spiral conductive part of the base is a polygonal pillar. An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

[0060] Accordingly, the same results as in example 9 were obtained in example 10.

Example 11

[0061] A common mode choke coil of example 11 as shown in Figs. 4a and 4b has the same structure as the common mode choke coil of example 9, except that the spiral conductive part of the base 30 is cylindrical.

[0062] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 290 Q at 500 MHz.

[0063] Accordingly, the same results as in example 9 were obtained in example 11.

Example 12

[0064] In the common mode choke coil shown in example 9, the groove 44 is formed to make the spiral conductive portion 47' with laser trimming. However, in example 12, a common mode choke coil was made by sandblast. The same results as in example 9 were also obtained in example 12.

Example 13

[0065] In the common mode choke coil shown in example 9, the spiral conductive part was formed by laser trimming. However, in example 13, a common mode choke coil was made by water jet. The same results as in example 9 were also obtained in example 13.

[0066] As an alternative example of example 13, moreover, spiral grooves may be formed by sandblast or water jet when the spiral conductive part of the base is a polygonal pillar or a cylinder. Clearly, similar results can be obtained.

Example 14

[0067] A conductive paste was prepared by using a mixed solvent of ethyl cellosolve and butyl carbinol, copper powder and PVB. In this case, the ratio of copper powder to PVD was 95:5. This paste was printed on a $1.6 \times 1.0 \times 1.0$ mm prismatic base, made of a magnetic body having $\mu' = 30$, as shown in Fig. 1 by using a stainless mesh screen, thus printing a first spiral conductor at 15 microns, and was then dried. Successively, by using a separately prepared alumina paste, an alumina layer was printed on the surface of the first conductor and was then dried, thus printing and drying a second conductor. The alumina paste has the same composition as the copper paste. After the second conductor was dried, a binder was removed and the paste was baked. As shown in Fig. 10, a common mode choke coil is formed by coating the insulating resin 55 and solder plating the terminal parts.

[0068] An impedance analyzer measured the impedance of this common mode choke coil at a common mode. The impedance was 300 Ω at 500 MHz.

[0069] Even when the spiral conductive part of the base is a polygonal pillar or a cylinder as an alternative example of example 14, the same results may be clearly obtained.

[0070] As explained above, in the examples of the present invention, a base made of a magnetic or dielectric body has two mutually electrically insulated spiral conductors, and the conductive layer thereof is trimmed by laser or the like. Thus, the common mode choke coil may be easily and economically provided that has high Q-characteristics and little fluctuation of resonance frequencies and inductance.

[0071] Moreover, according to the examples of the present invention, binding increases by mixing a magnetic material to an insulating resin, so that the common mode choke coil may be easily and economically provided that has high impedance at a common mode in a high frequency range.

[0072] Furthermore, according to the examples of the present invention, a base made of a magnetic or dielectric material has two mutually electrically insulated laminated spiral conductors. The conductive layers are formed by trimming with laser or the like or screen printing, so that the common mode choke coil may be easily and economically provided that has high Q-characteristics and little fluctuation of resonance frequencies and inductance.

Claims

1. A common mode choke coil comprising first and second spiral conductive layer elements electrically insulated from each other at a base, said base consisting of a magnetic material or a dielectric material, wherein at least one of the first and the second spiral conductive layer elements is formed in contact with a surface of the base.

2. The common mode choke coil according to claim 1, wherein said base has a spiral conductive layer part comprises the first and the second spiral conductive layer elements alternately wound in a longitudinal direction of said spiral conductive layer part and having roughly an identical electric length, both of the first and the second spiral conductive layer elements being formed in contact with a surface of the base.

3. The common mode choke coil according to claim 1, wherein the first and the second conductive layer elements are formed by winding and laminating two spiral conductive layer elements having roughly an identical electric length, one of the first and second spiral conductive layer elements being attached to another spiral conductive layer element through an insulating layer.

4. The common mode choke coil according to claim 1, wherein at least one of the first and the second spiral conductive layer elements is covered by an insulating layer at its surface, the insulating layer being formed of an insulating resin containing a soft magnetic powder.

5. The common mode choke coil according to claim 1, wherein at least one of the first and the second spiral conductive layer elements is covered by an insulating layer at its surface, the insulating layer being formed of only an insulating resin.

6. The common mode choke coil according to claim 3, wherein the insulating layer is formed between the first and the second spiral conductive elements by winding an insulating resin sheet, said resin sheet containing an organic binder and a soft magnetic powder.

7. The common mode choke coil according to claim 1, wherein each of the first and the second spiral conductive layer elements has an input terminal and an output terminal at both of ends thereof, respectively.

8. The common mode choke coil according to claim 1, wherein said at least one of first and second spiral conductive layer portions is provided by plating, sputtering or depositing.

9. The common mode choke coil according to claim 1, wherein said at least one of first and second spiral conductive layer elements is formed by coating a conductive paste consisting of a conductive powder and a binder, thereafter removing the binder, and then baking the paste.

10. The common mode choke coil according to claim 1, wherein the base has a rotation-symmetrical pillar shape.

11. The common mode choke coil according to claim 9, wherein the base has a prismatic shape.

12. The common mode choke coil according to claim 1, wherein the base has prismatic terminal parts at both ends, and a spiral conductive layer part between both ends, said spiral conductive layer part having a shape of a rotation-symmetrical polygonal pillar or cylinder.

13. The common mode choke coil according to claim 1, wherein electrodes are formed for terminals at both ends of the base.

14. The common mode choke coil according to claim 13, said electrodes are divided to form four terminals.

15. The common mode choke coil according to claim 3, wherein the insulating layer has internal resistance of $10^8\Omega \cdot m$ or more.

16. The common mode choke coil according to claim 3, wherein the insulating layer between two conductors has internal resistance of $10^8\Omega \cdot m$ or more.

17. The common mode choke coil according to claim 3, wherein the insulating layer is provided between the first and the second spiral conductive layer elements by coating an insulating paste consisting of an insulating powder and a binder, thereafter removing the binder ,and then baking the paste.

18. The common mode choke coil according to claim 1, wherein said at least one of the first and the second spiral conductive layer elements has a terminal formed by etching with a resist.

19. A method of manufacturing a common mode choke coil comprising first and second spiral conductive layer elements electrically insulated from each other at a base made of a magnetic material or a dielectric material, at least one of the first and the second spiral conductive layer elements being formed in contact with a surface of the base, the method comprising the steps of:

    forming at least one conductive layer on the surface of the base; and
    forming two spiral conductors by at least one process of laser trimming, water jet and sandblast while grooves are formed by removing said conductive layer.

20. A method of manufacturing a common mode choke coil comprising first and second spiral conductive layer elements electrically insulated from each other at a base made of a magnetic material or a dielectric material, at least one of the first and the second spiral conductive layer elements being formed in contact with a surface of the base, wherein the first and the second spiral conductive layer elements and an insulating layer are formed by removing a binder and then baking after being printed in screen printing.

21. A method of manufacturing a common mode choke coil comprising first and second spiral conductive layer elements electrically insulated from each other at a base made of a magnetic material or a dielectric material, at least one of the first and the second spiral conductive layer elements being formed in contact with a surface of the base, wherein at least one of the first and the second spiral conductive layer elements has input and output terminals at both of the end formed by etching with a resist until a conductive layer constituting the spiral conductive layer is exposed.

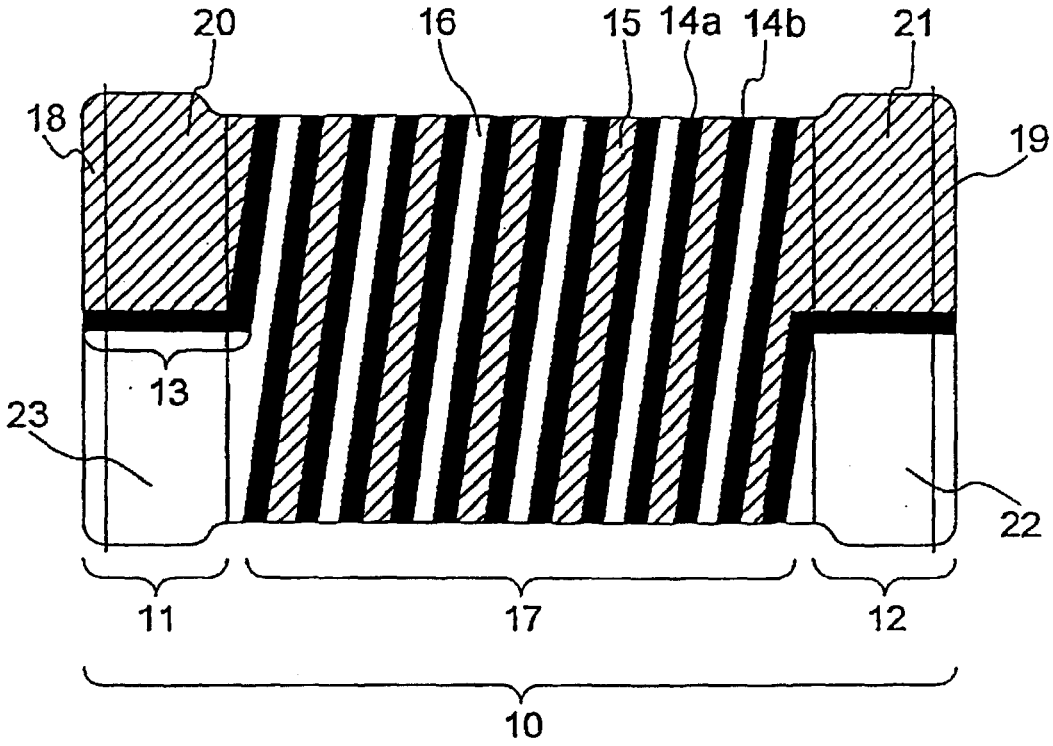
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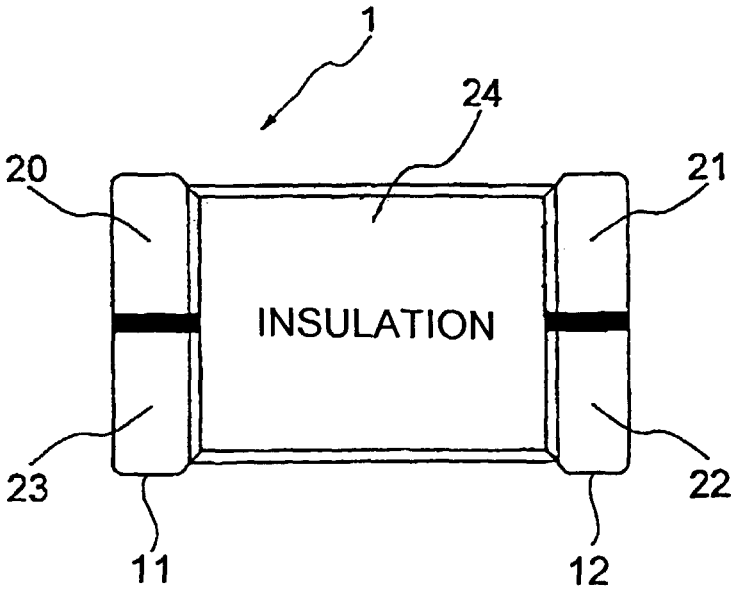
FIG. 1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INSULATION
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FIG. 2

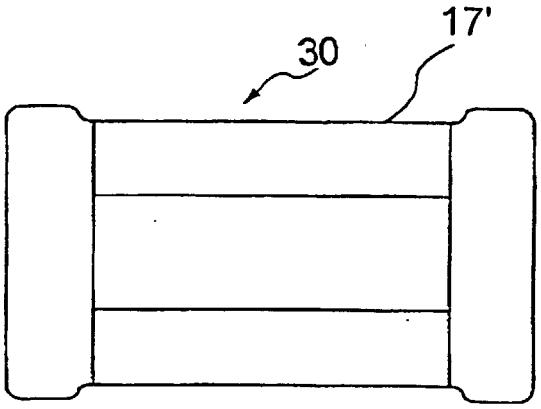

FIG. 3A

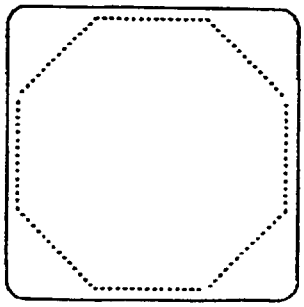

FIG. 3B

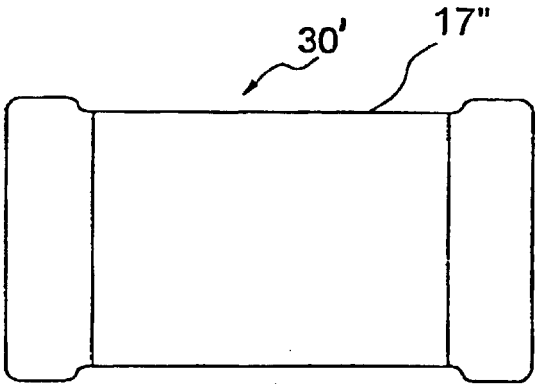

FIG. 4A

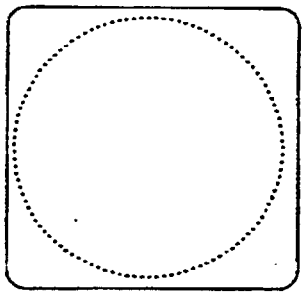

FIG. 4B

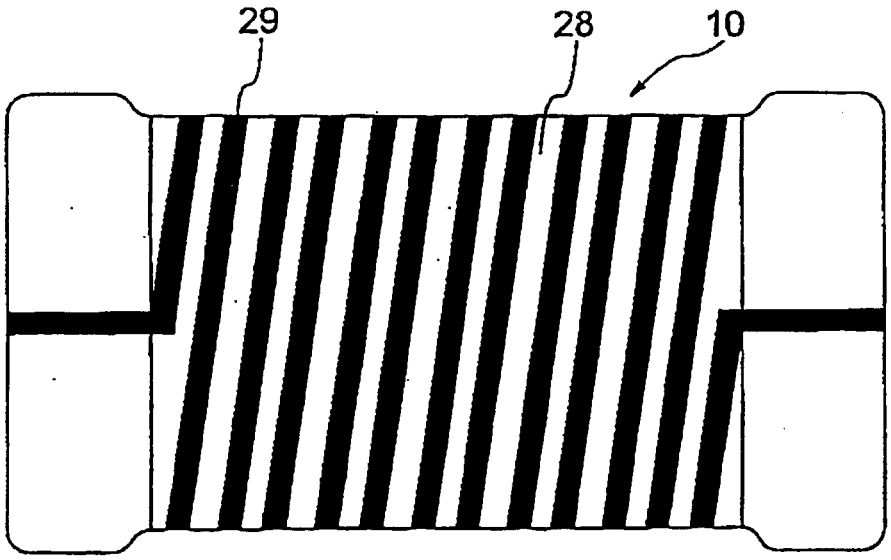

FIG. 5

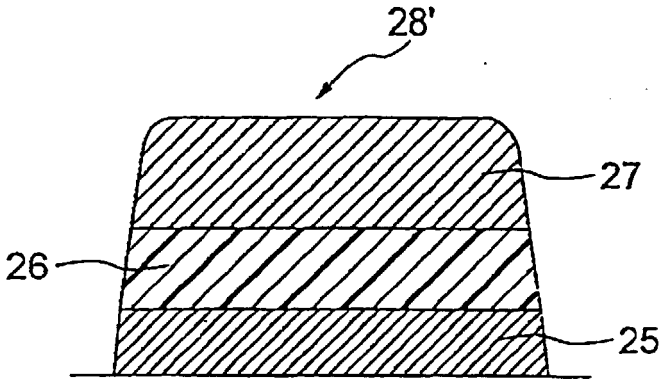

FIG. 6

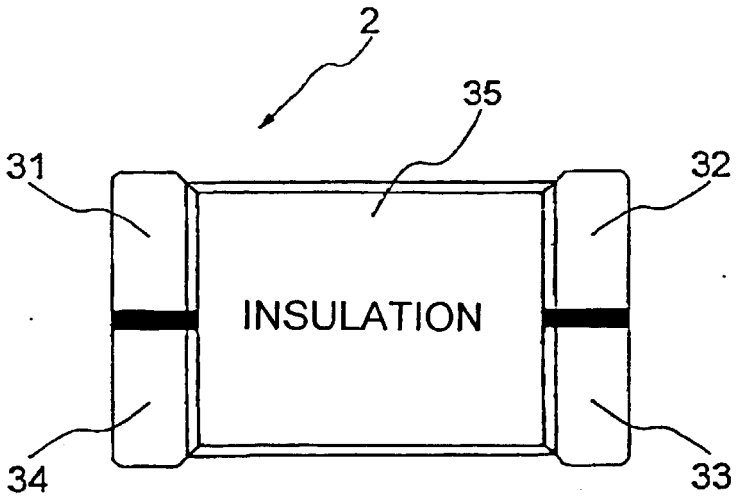

FIG. 7

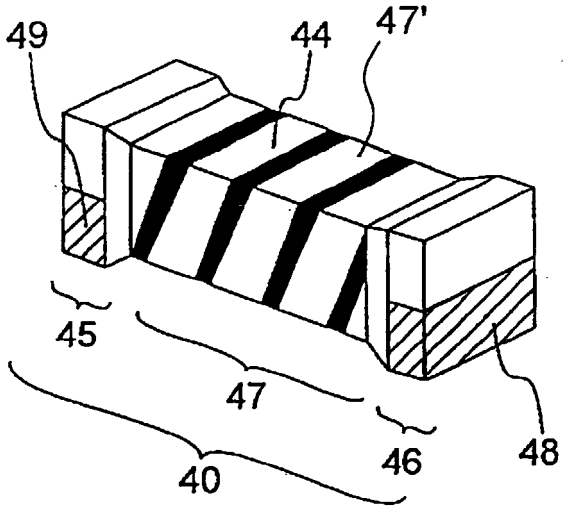

FIG. 8

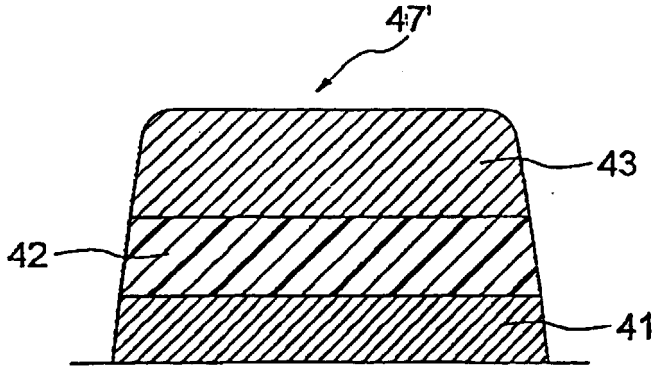

FIG. 9

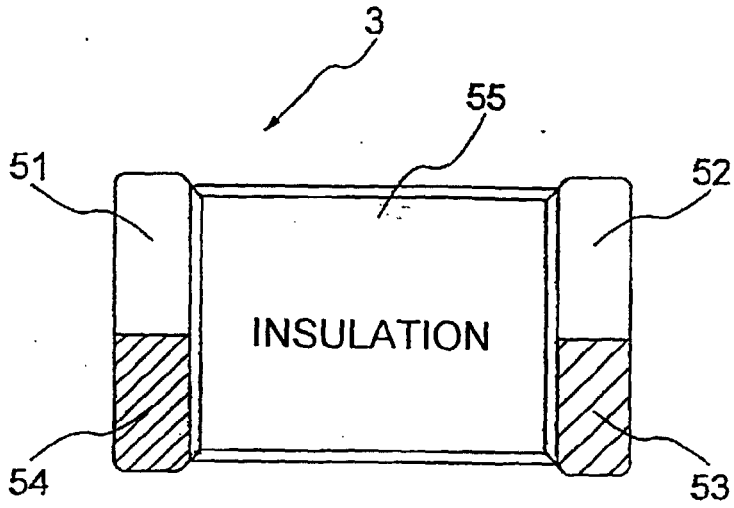

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 00 12 1450

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Place of search	Date of completion of the search	Examiner
THE HAGUE	3 November 2000	Marti Almeda, R

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