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KAMO et al.

(54) **INDUCTOR COMPONENT**

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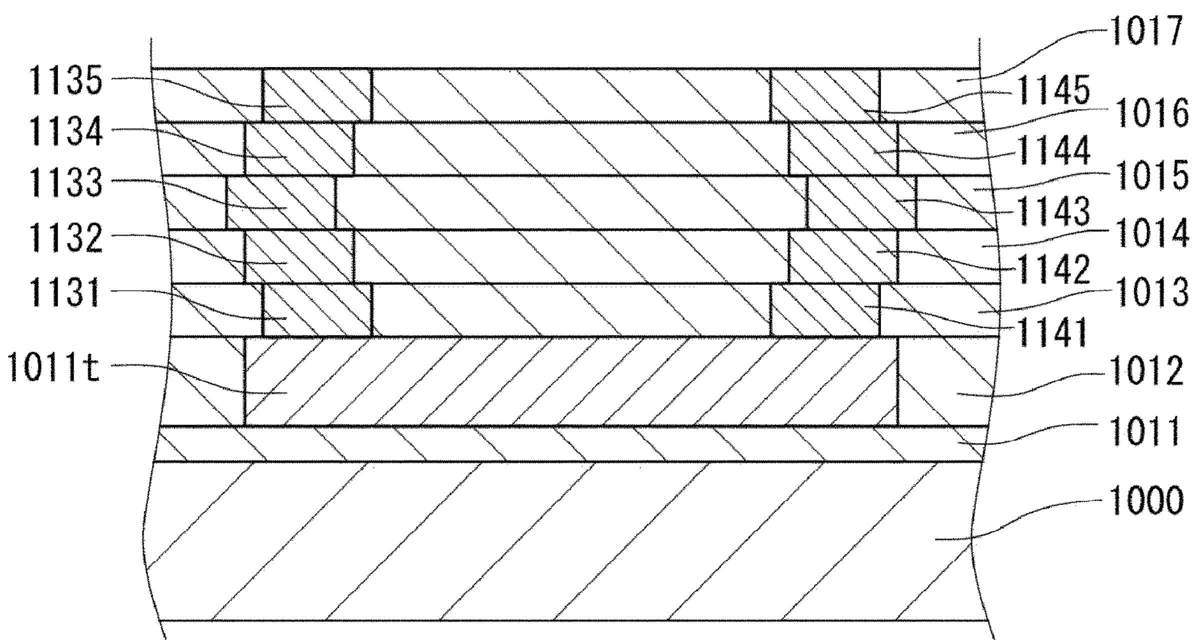
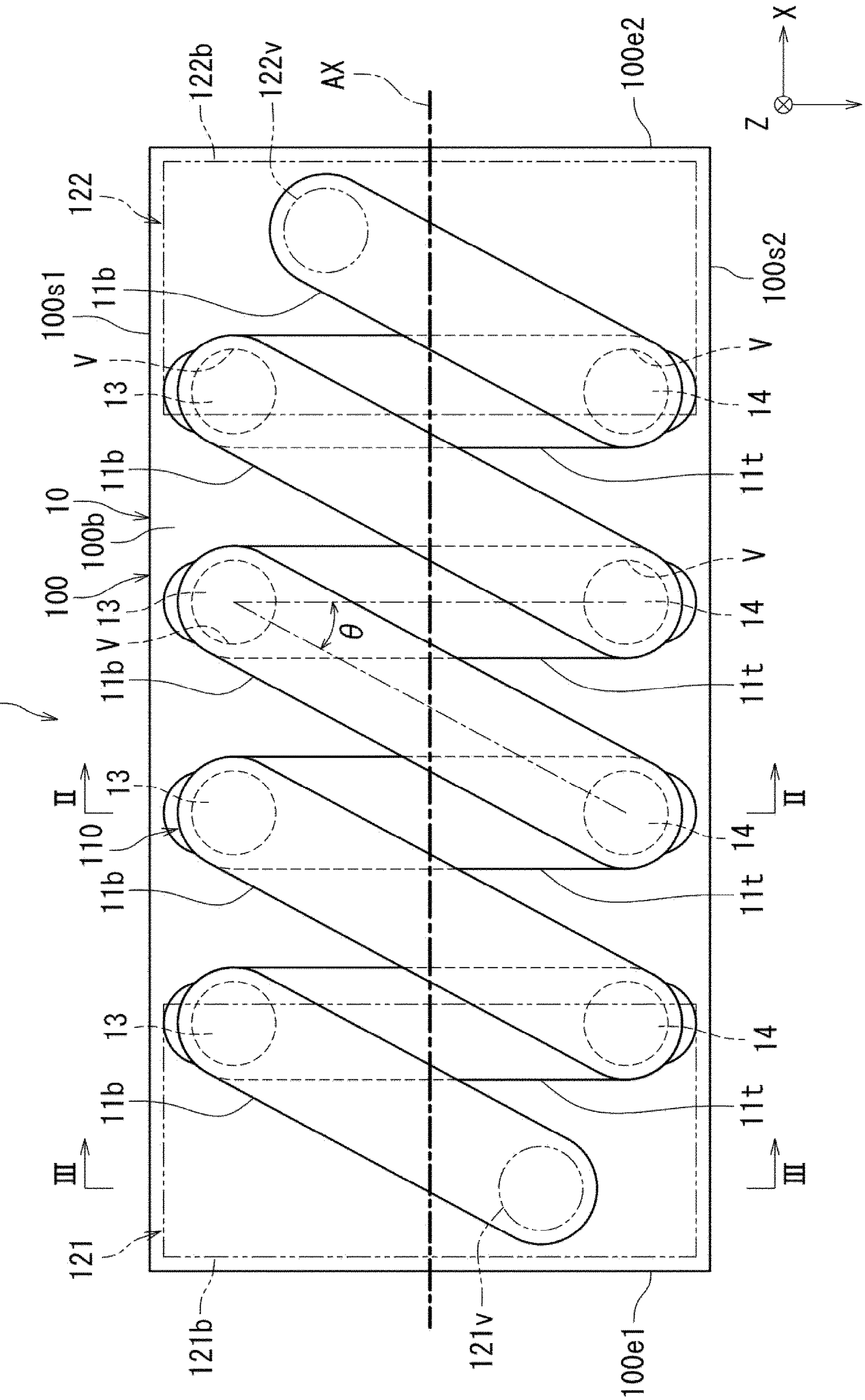
(57) **ABSTRACT**

An inductor component includes an element body having first and second principal surfaces opposite to each other; a coil that is in the element body and is wound in a spiral shape along an axis; and first and second external electrodes that are provided on the element body and are electrically connected to the coil. The axis of the coil is parallel to the first principal surface. The coil includes first coil wirings which are on the first principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the first principal surface, second coil wirings which are on the second principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the second principal surface.

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11b
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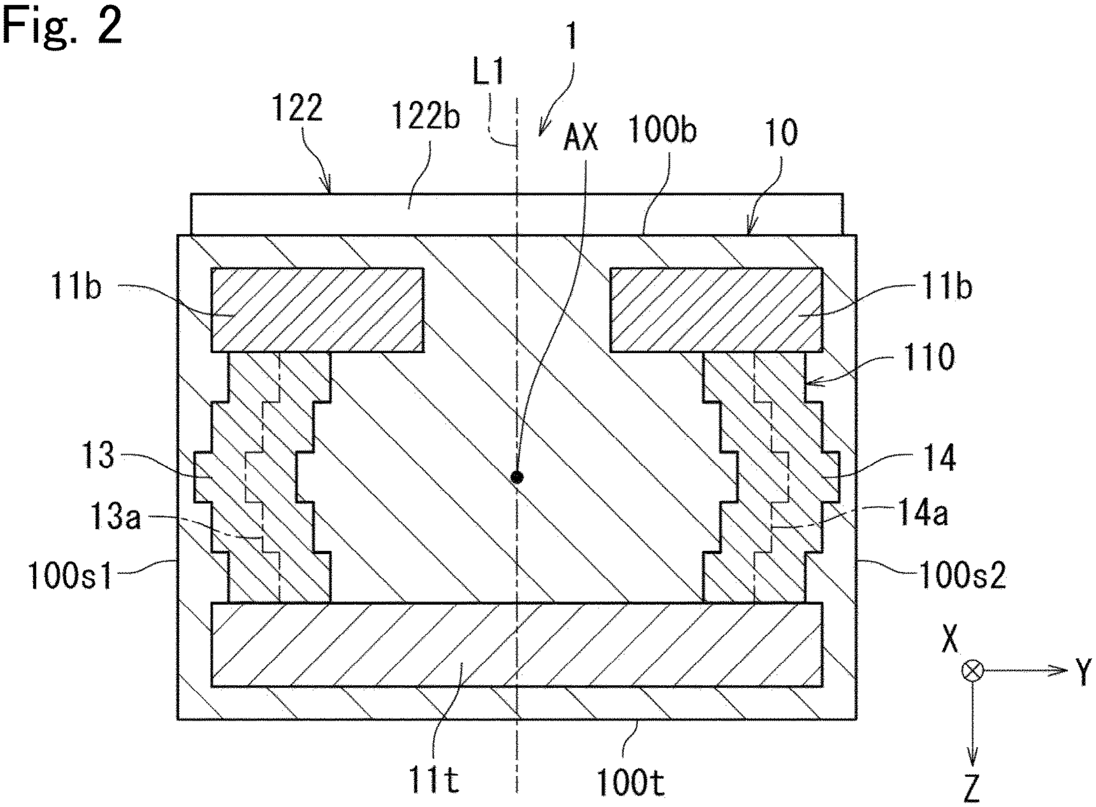
121v
122
122b
122v
II
III
X
Z

Fig. 1

Fig. 2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11t
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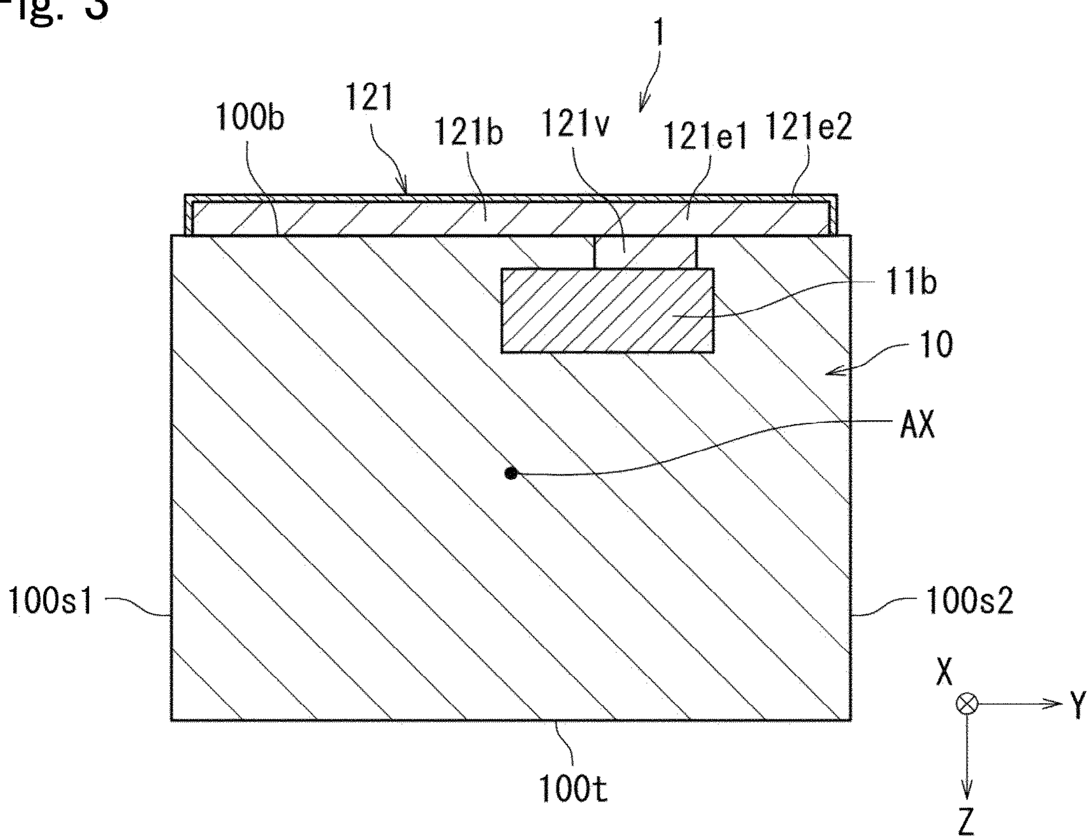
Fig. 3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AX
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Fig. 4

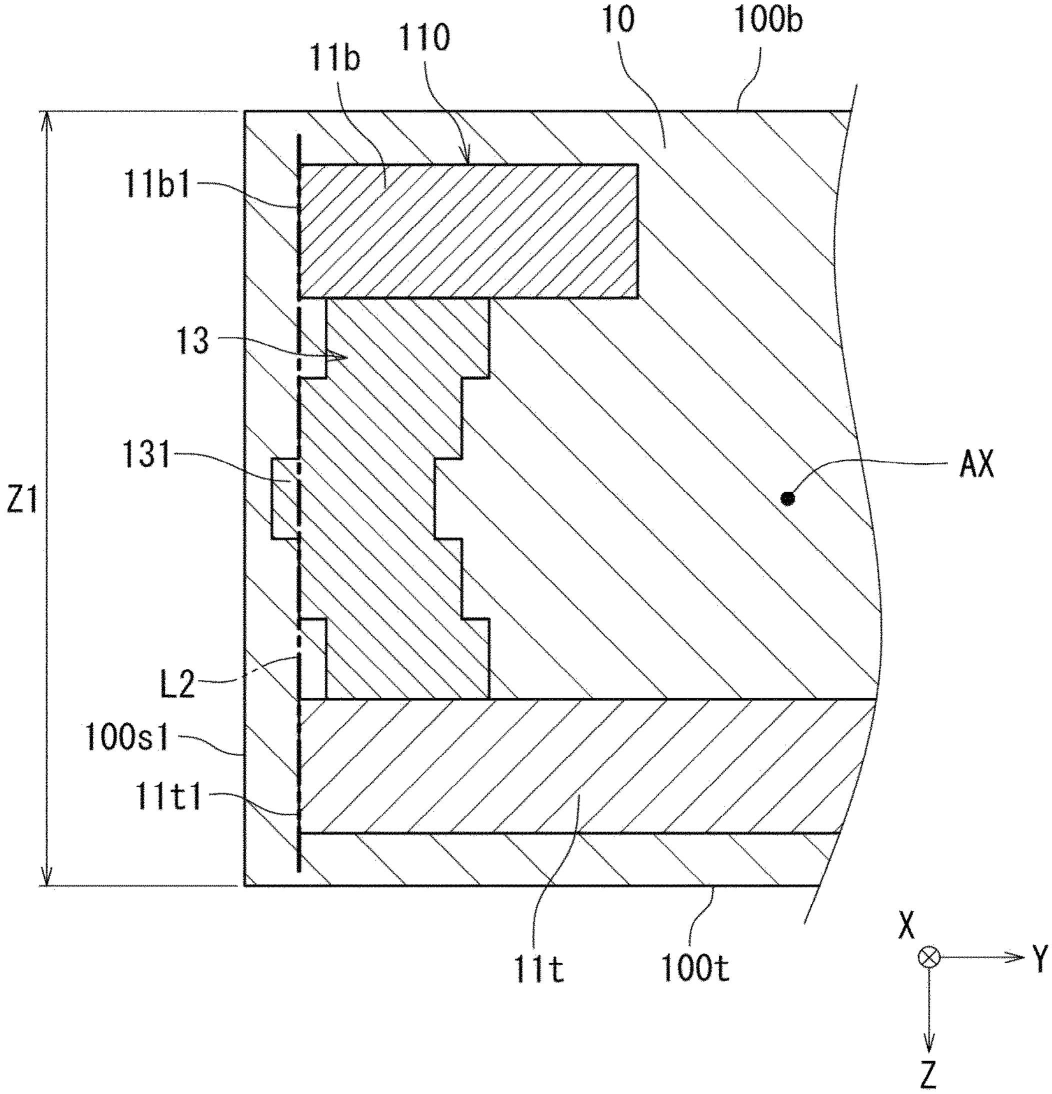
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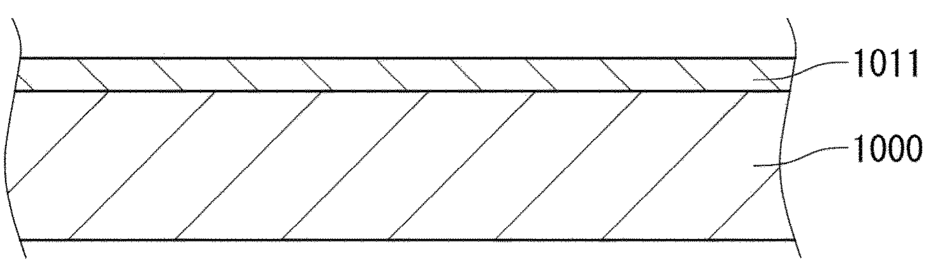
Fig. 5A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1000

Fig. 5B

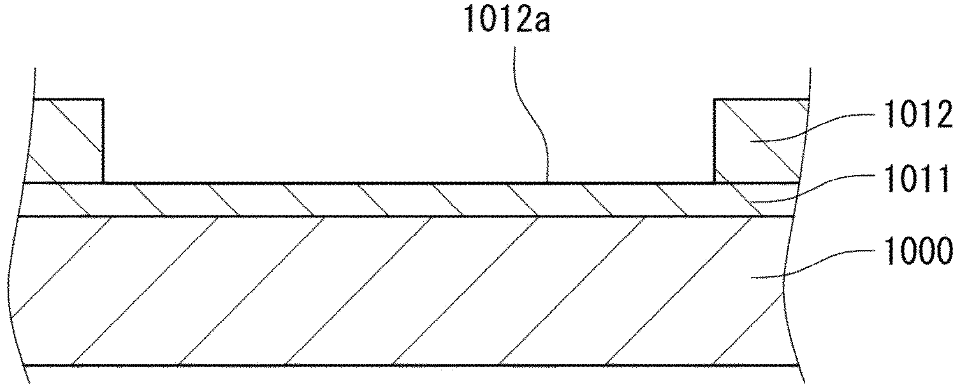


Fig. 5C

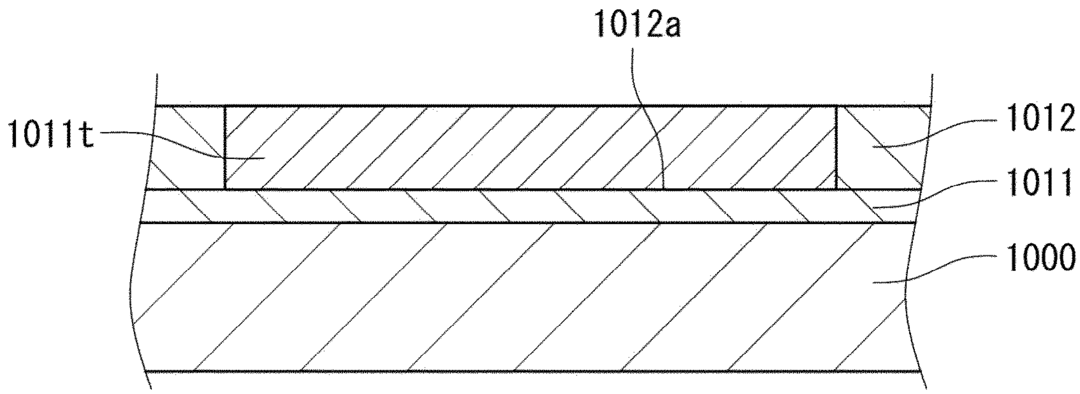


Fig. 5D

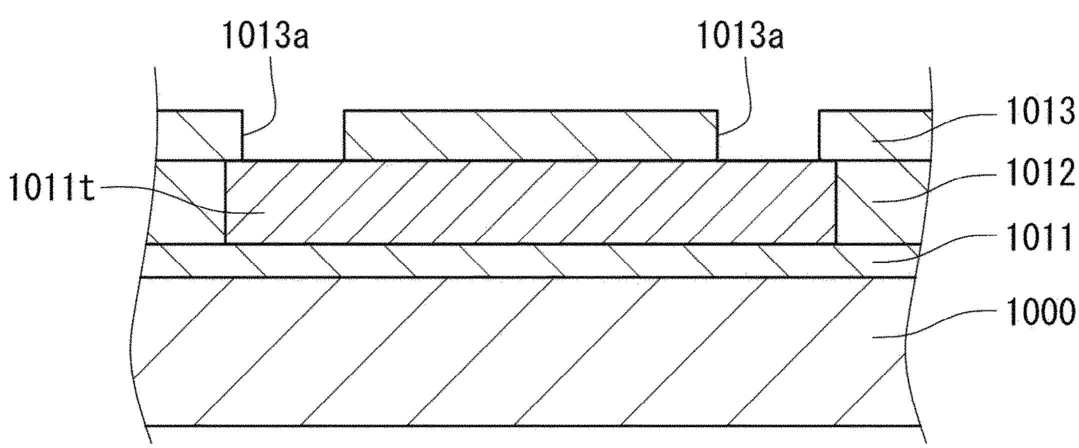
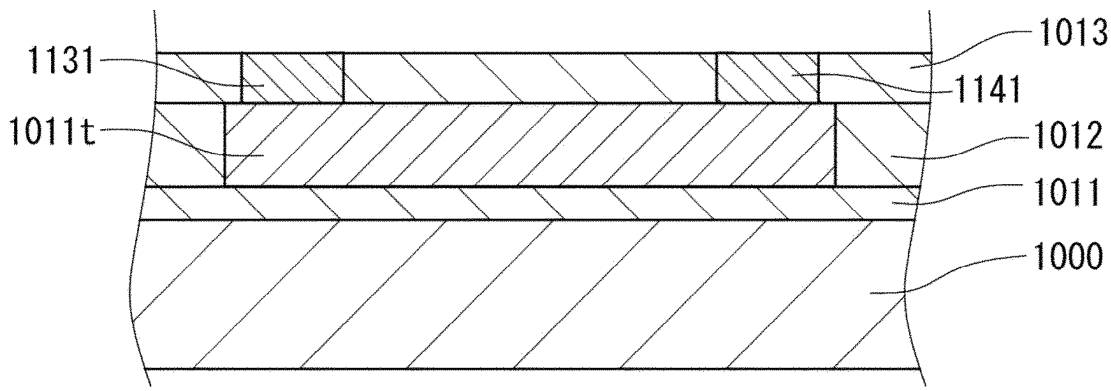


Fig. 5E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1011
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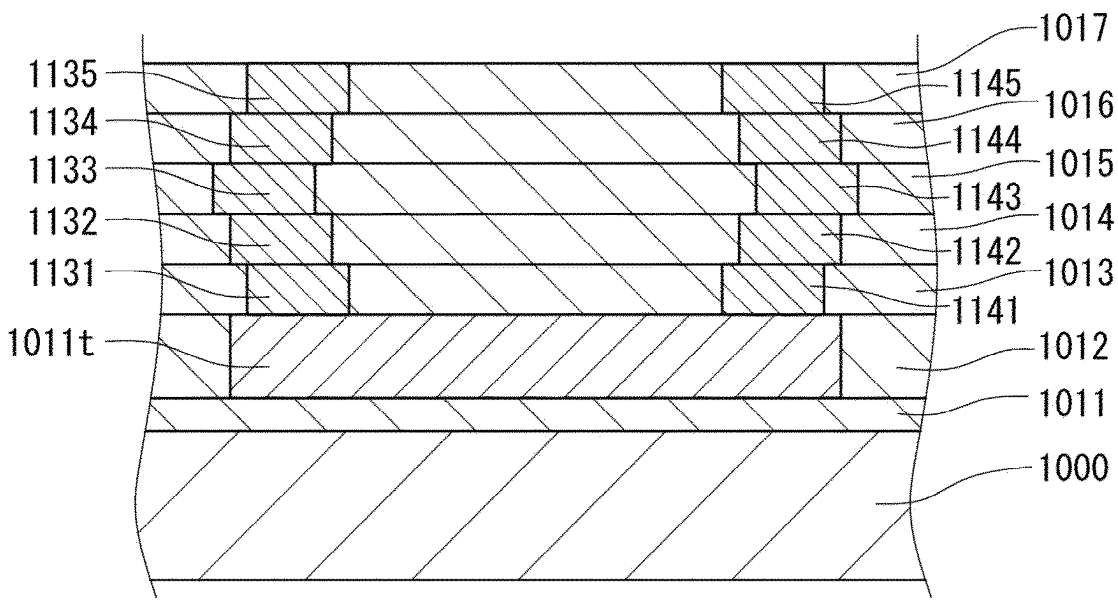
Fig. 5F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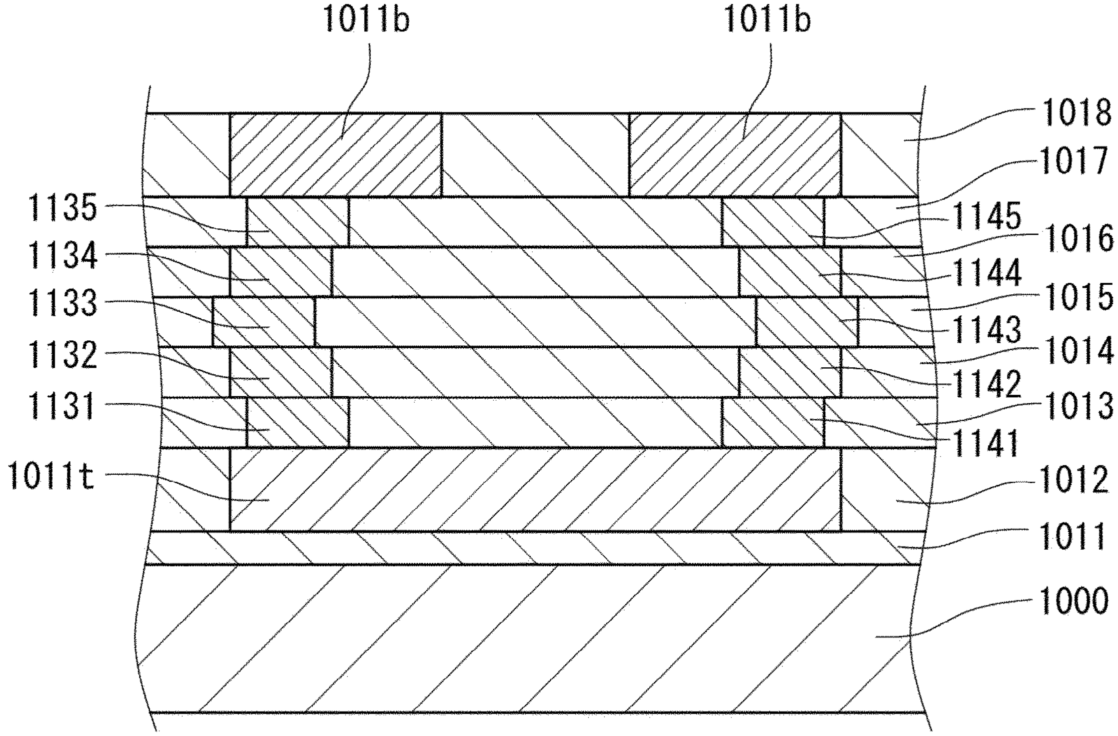
1011
1000

Fig. 5G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1011
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Fig. 5H

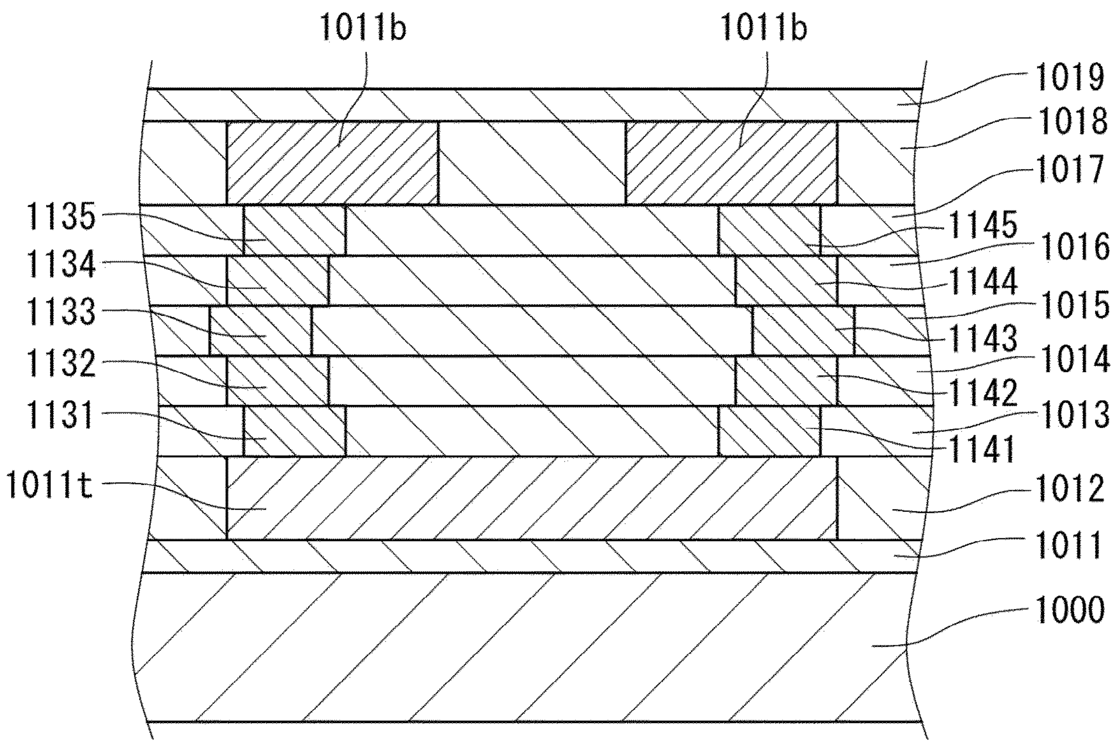
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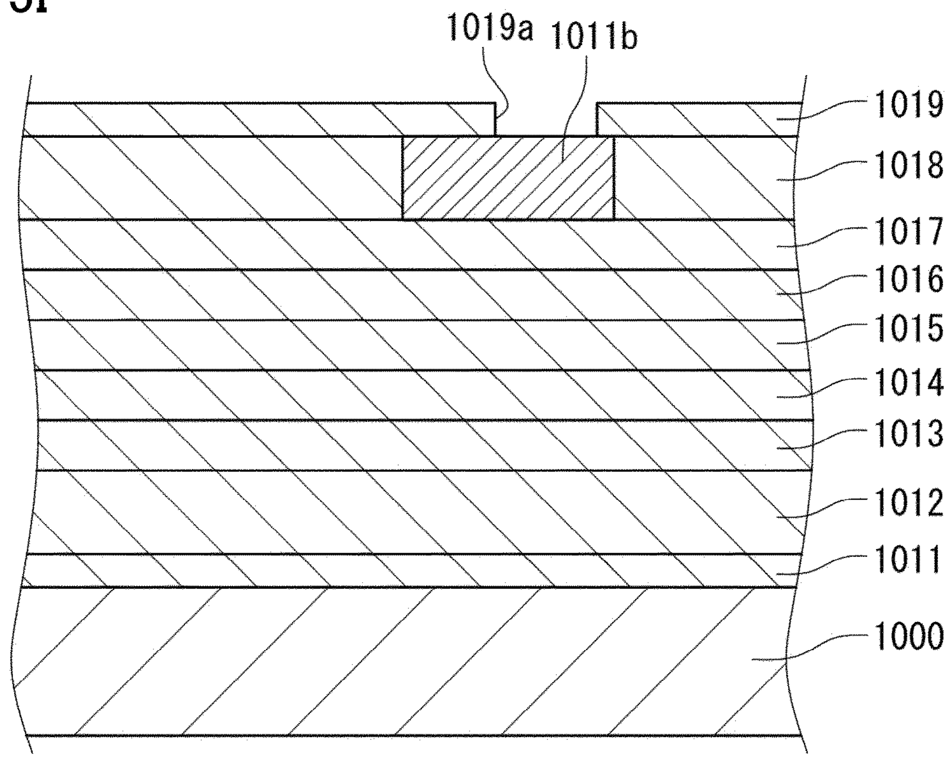
Fig. 5I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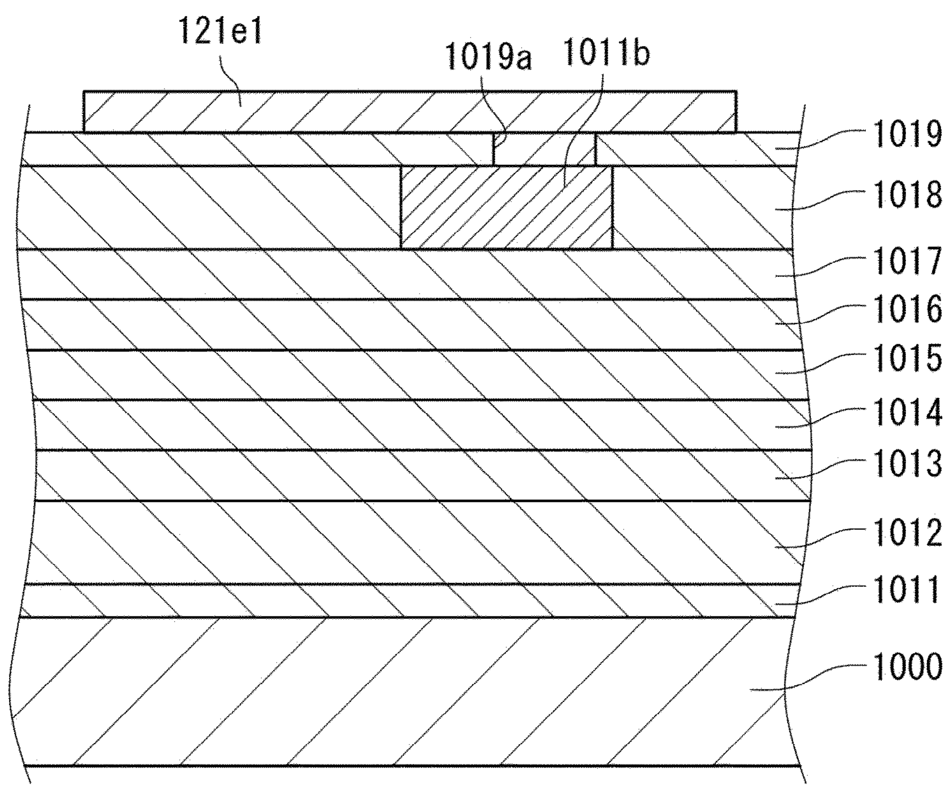
1011
1000

Fig. 5J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1011
1000

Fig. 5K

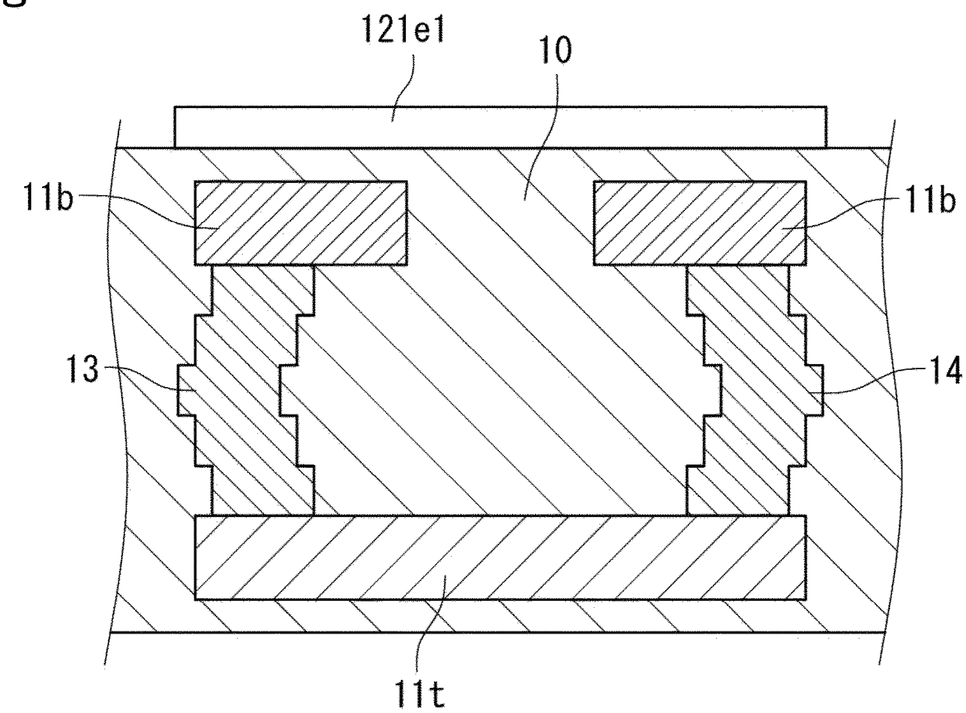
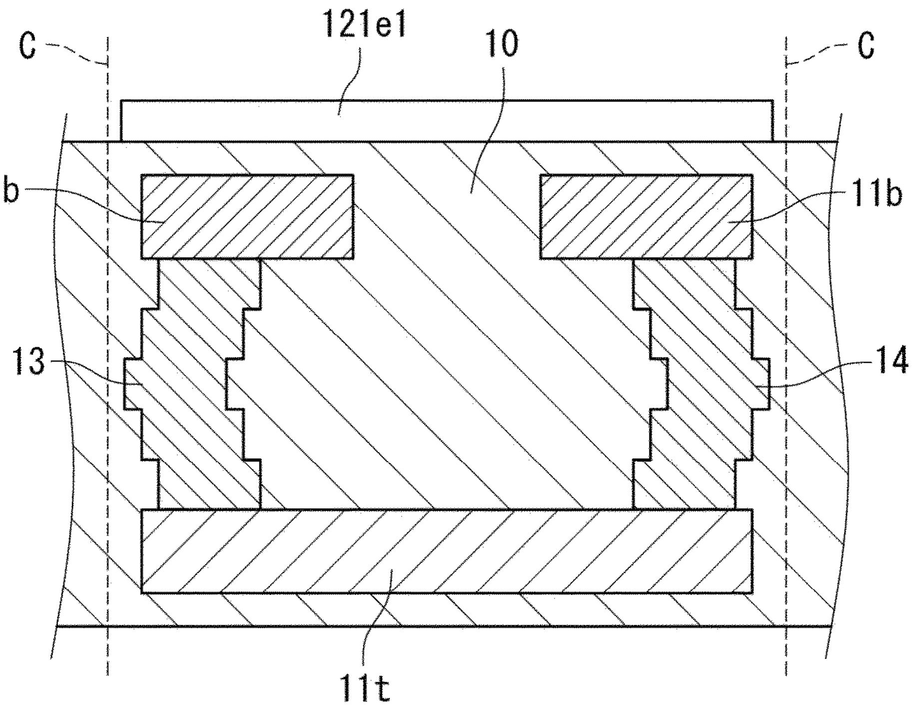


Fig. 5L



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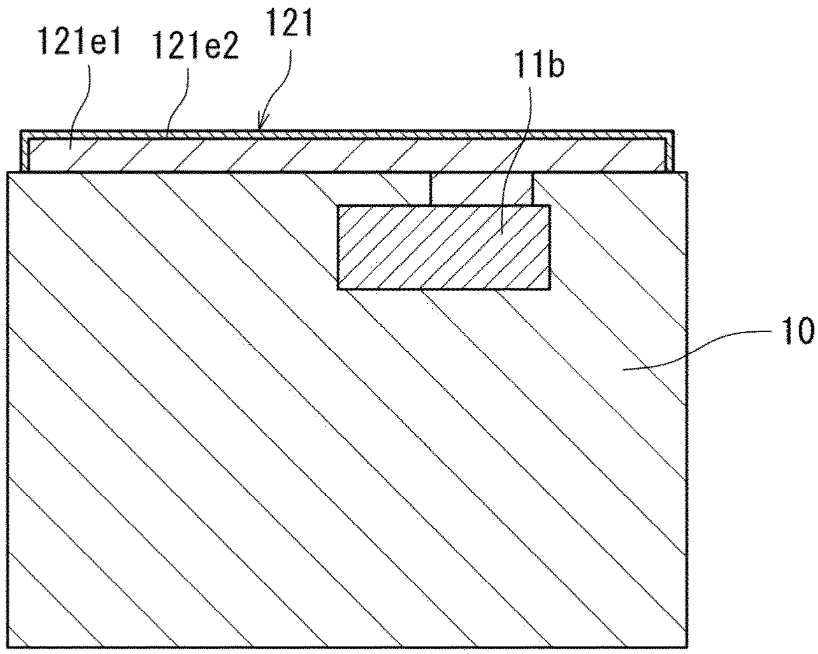

Fig. 6A

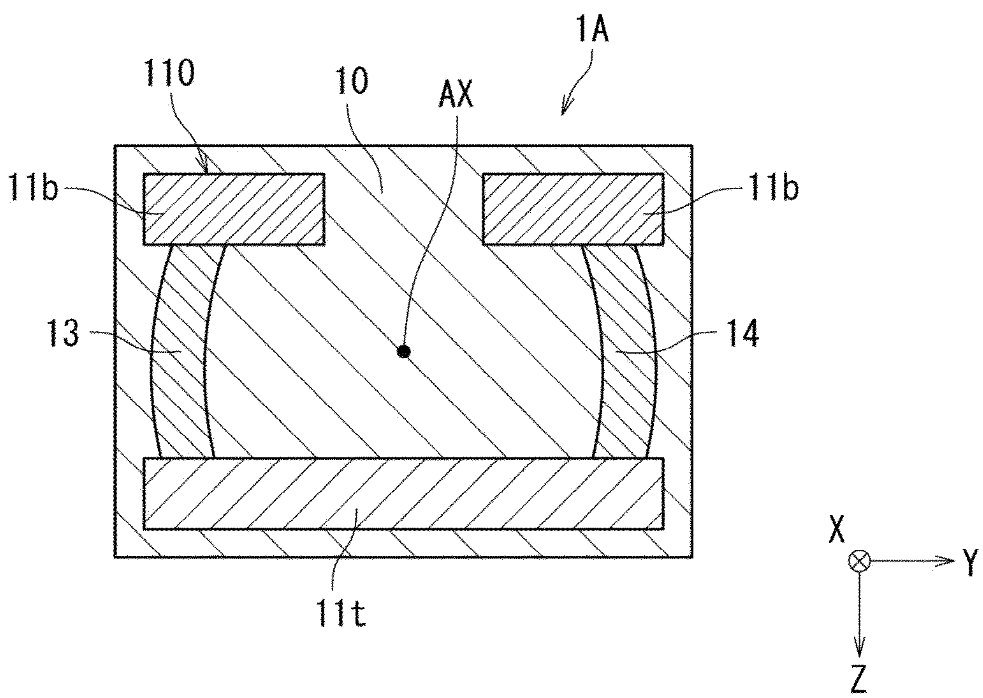

Fig. 6B

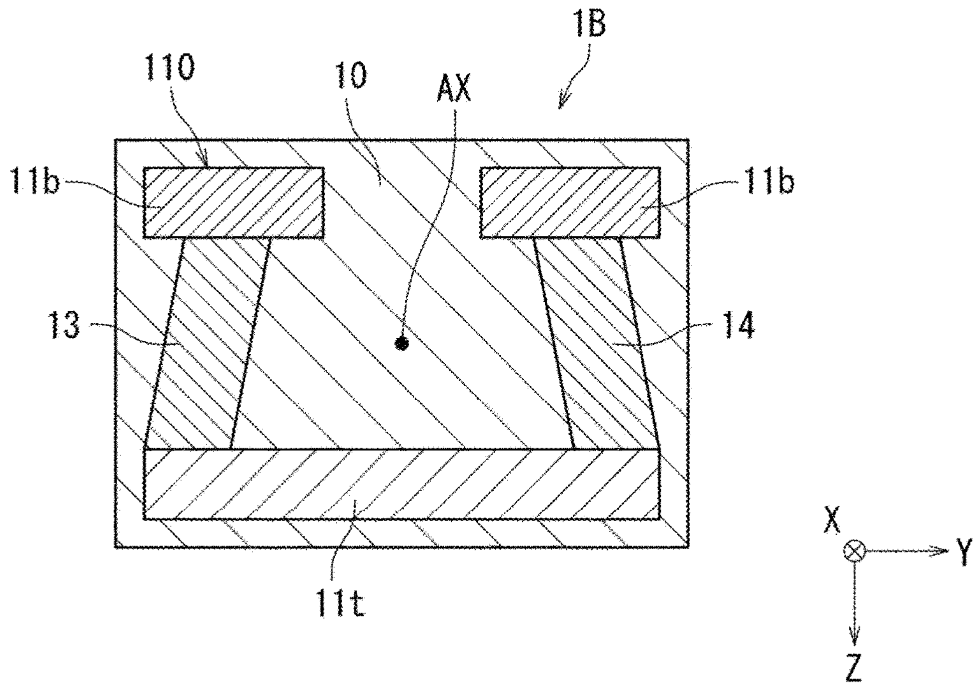
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Fig. 6C

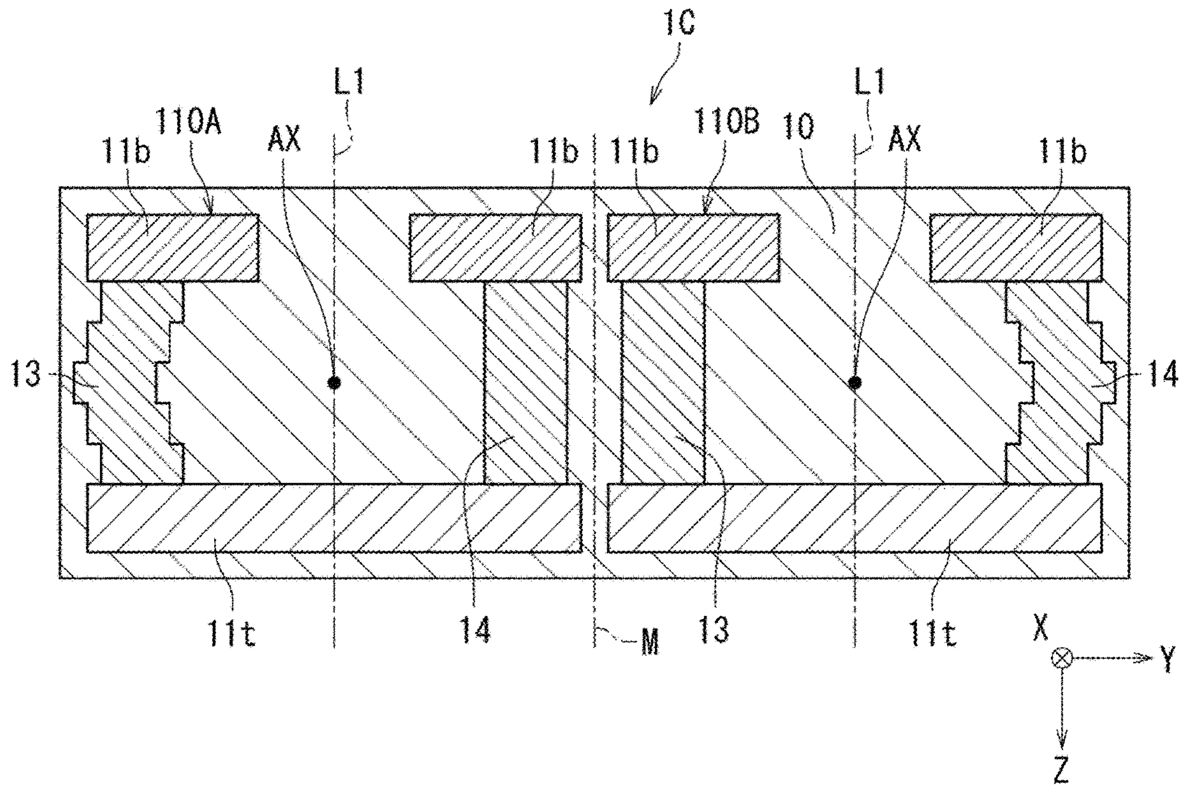
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Fig. 6D

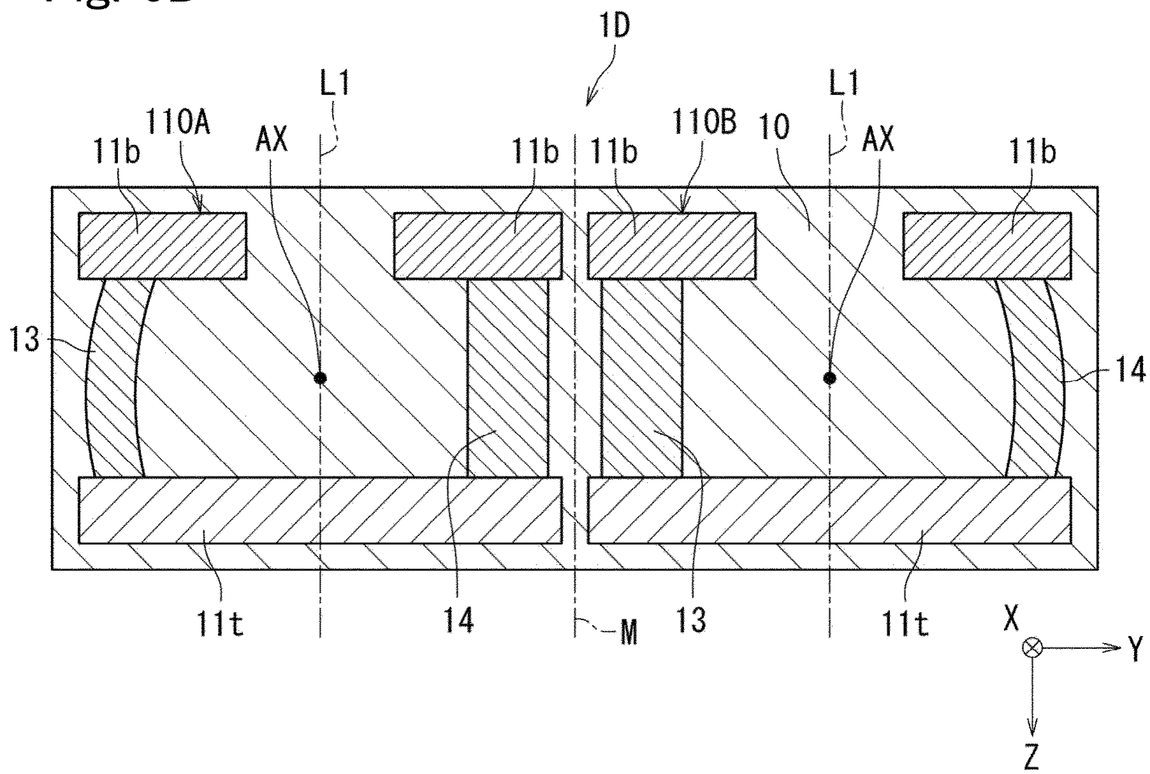
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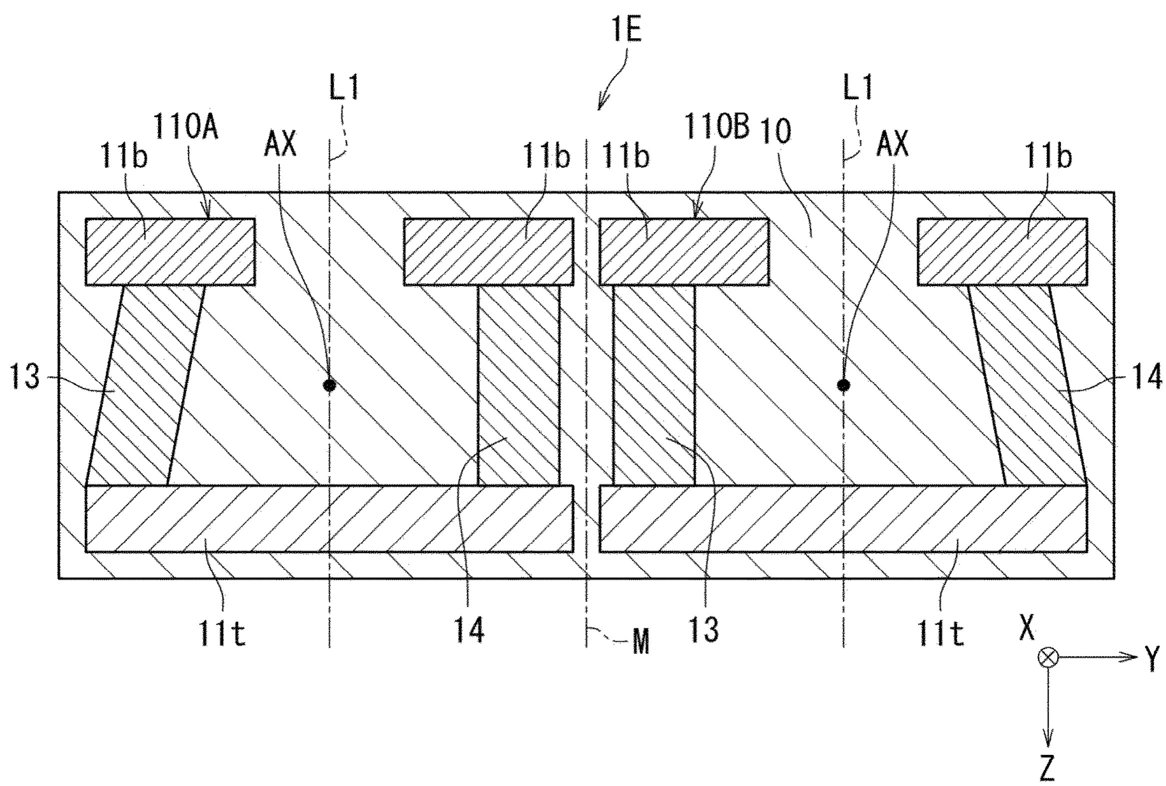
Fig. 6E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M
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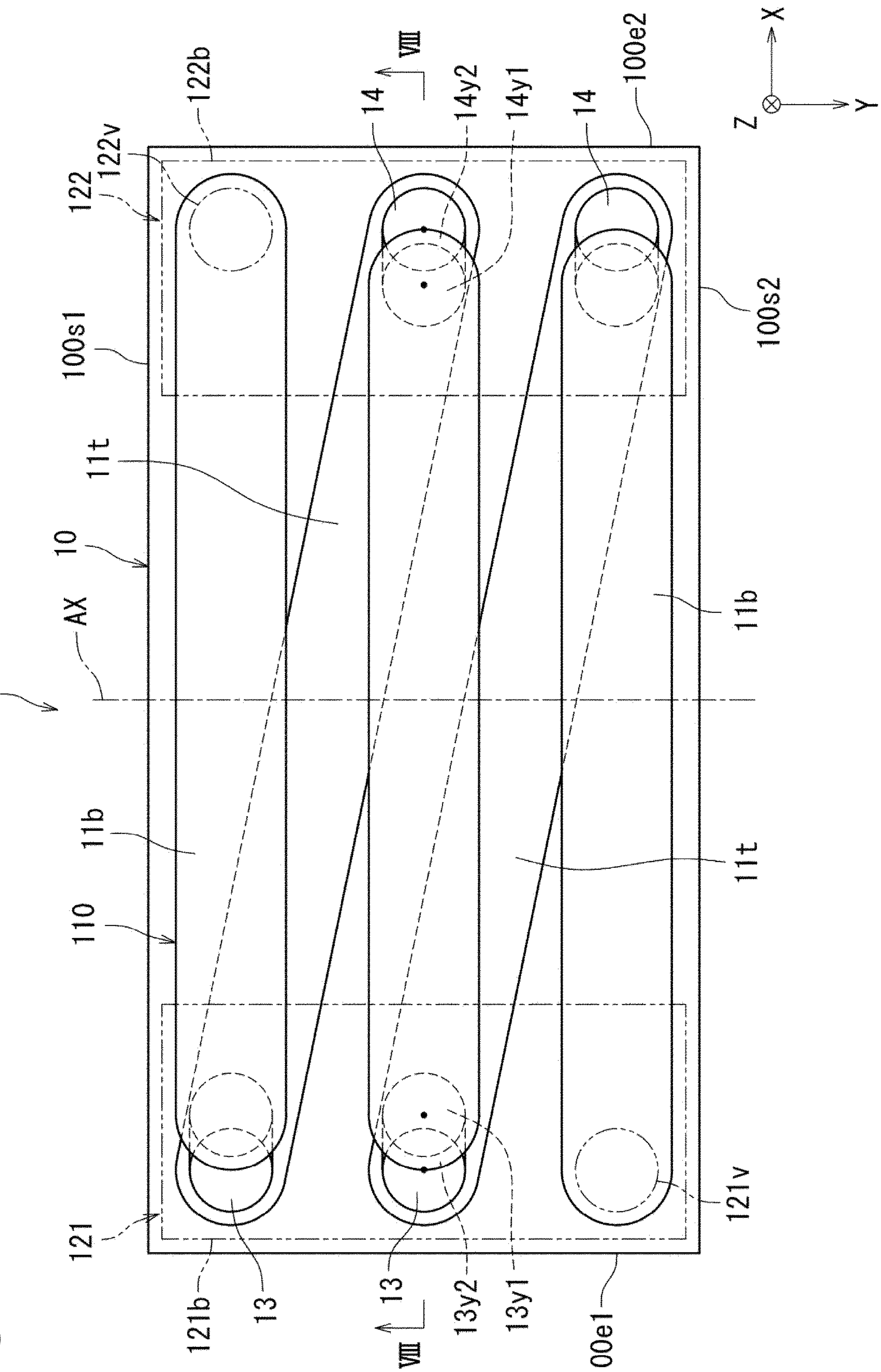
Fig. 7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VIII
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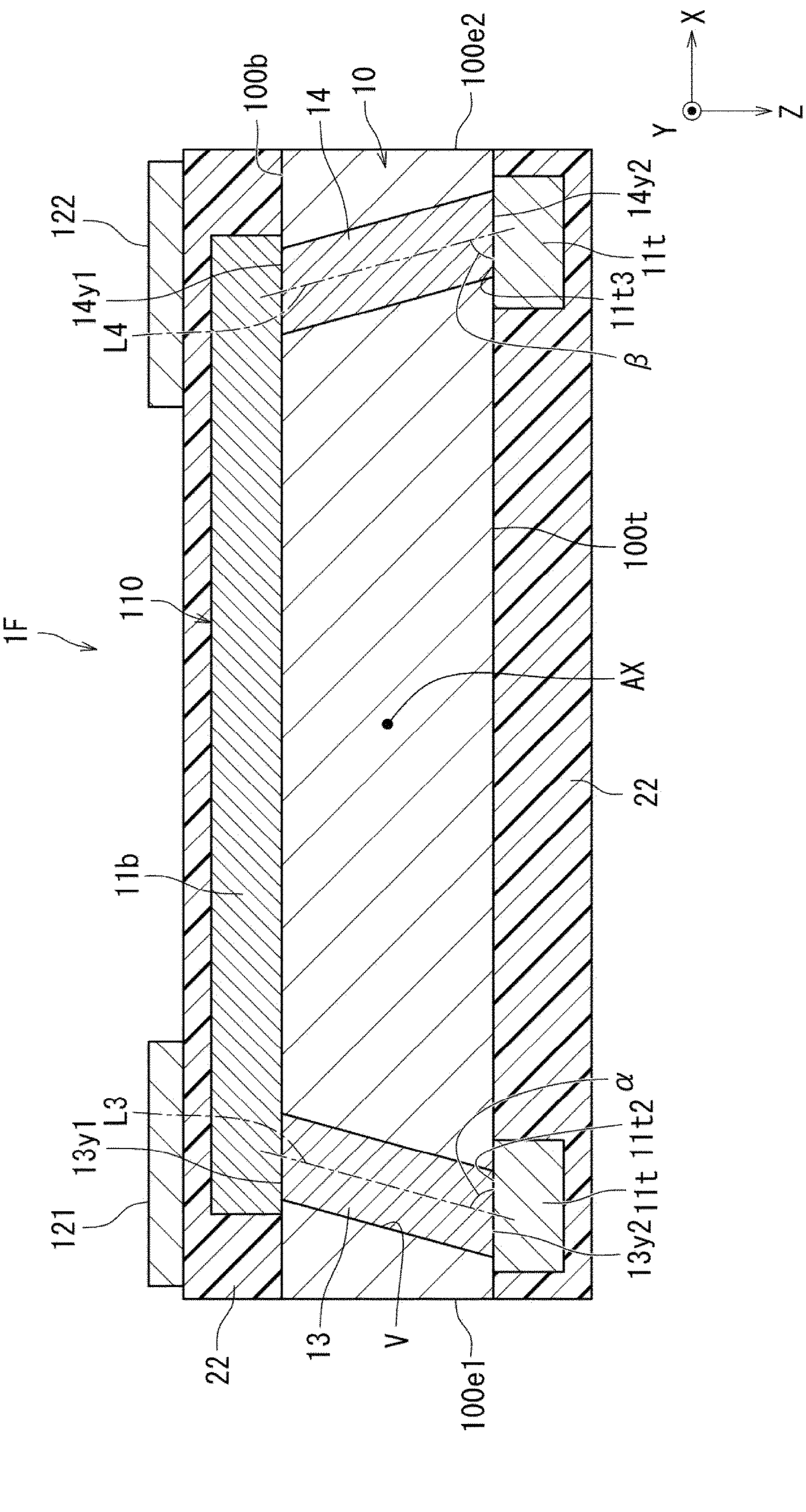
Z

Fig. 8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V
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Fig. 9

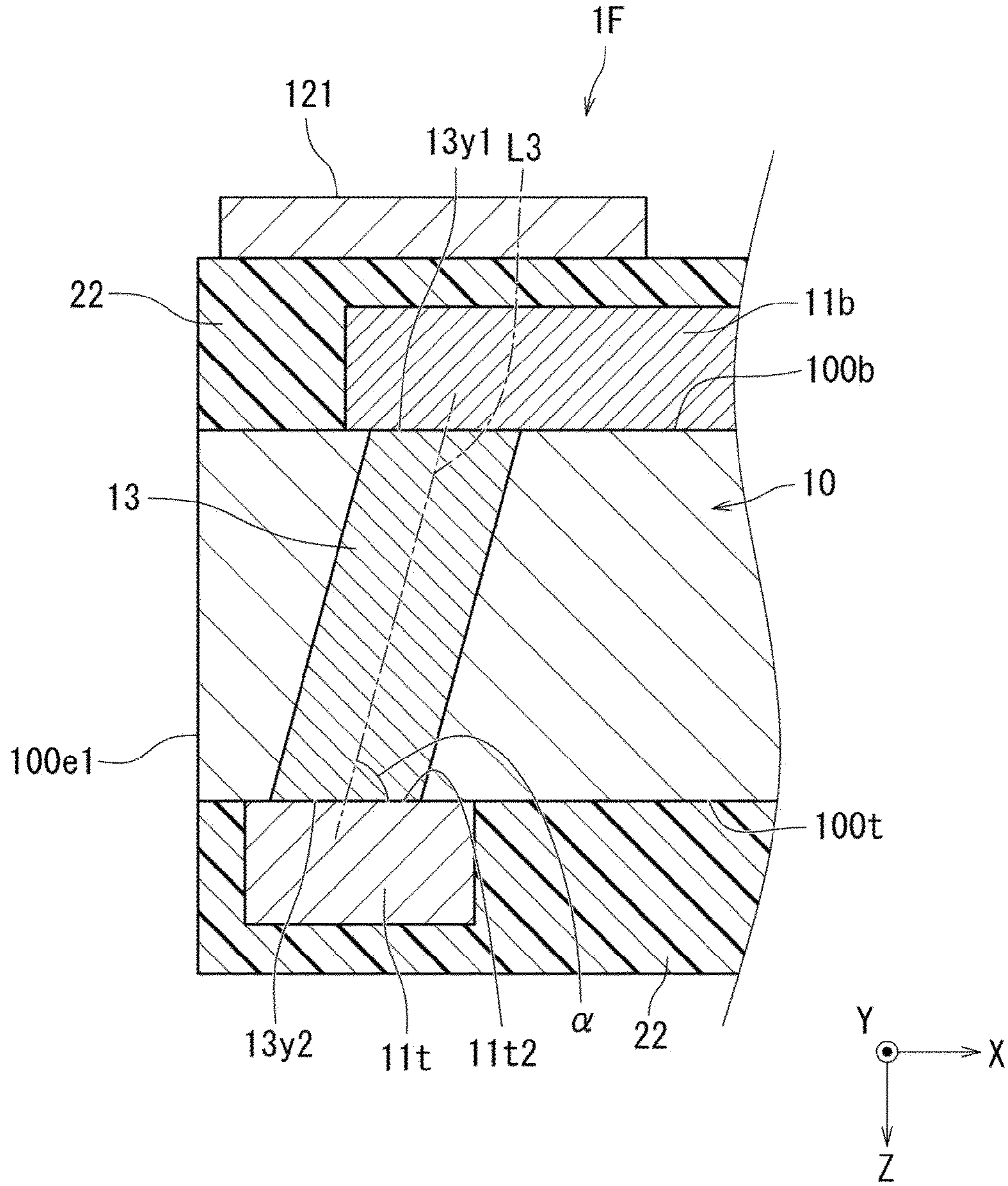
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Fig. 10A

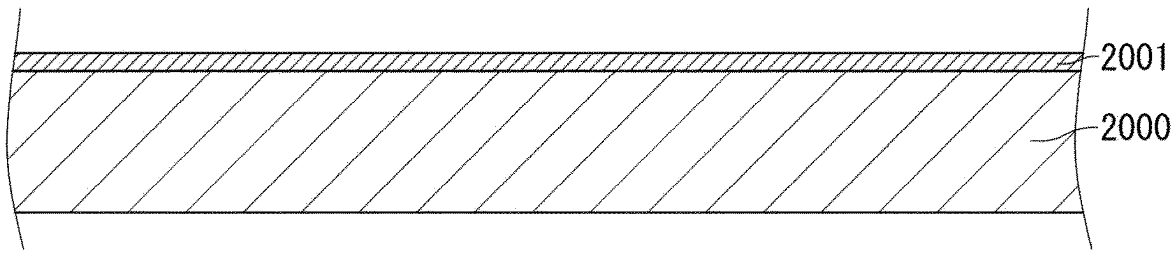


Fig. 10B

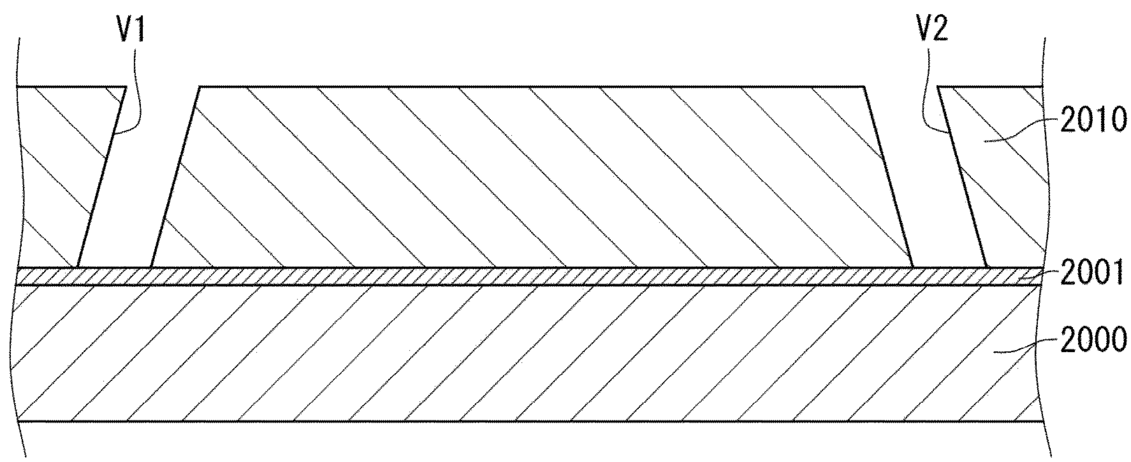


Fig. 10C

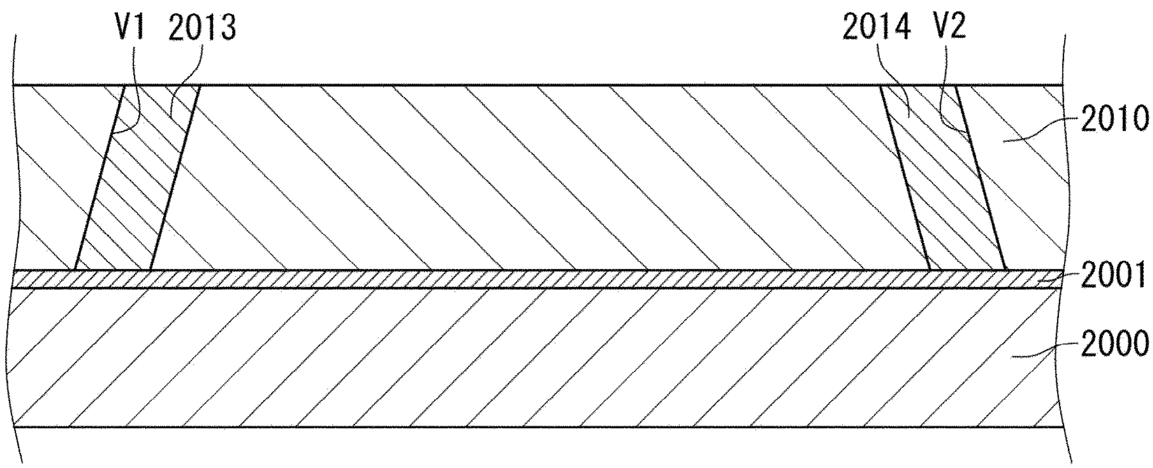


Fig. 10D

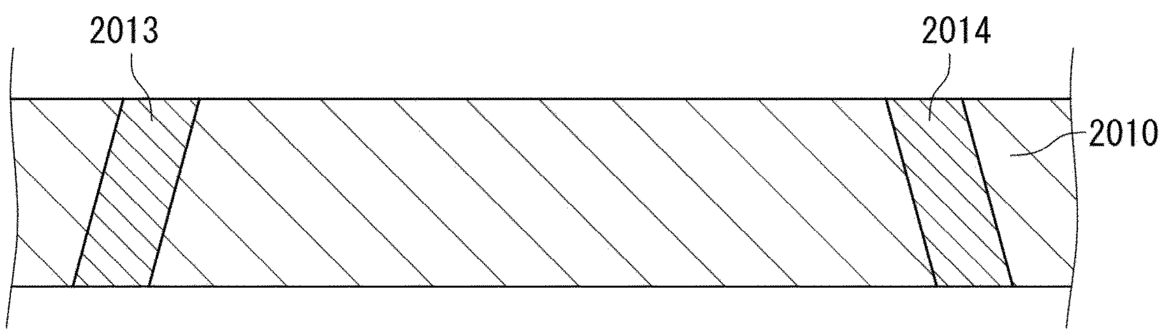


Fig. 10E

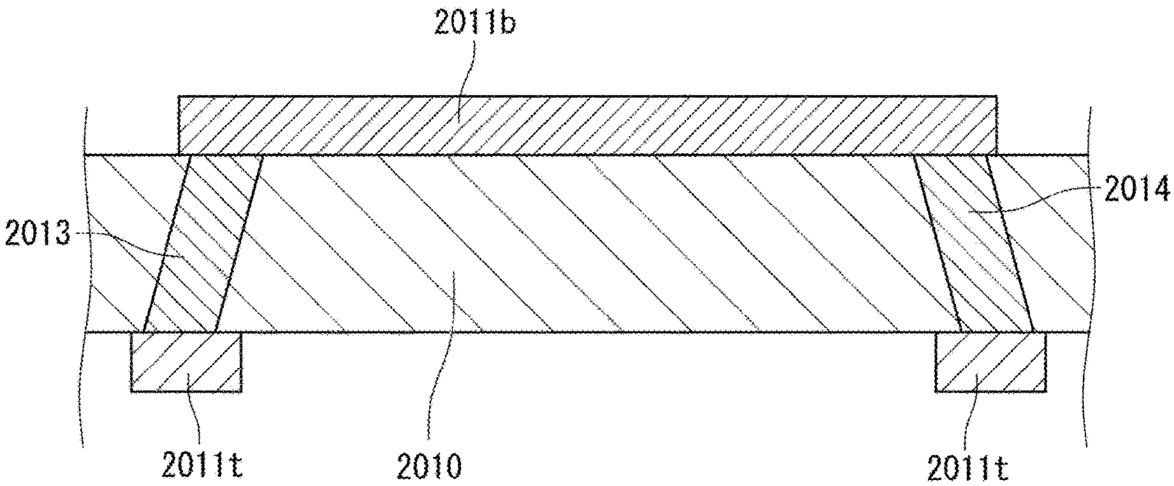


Fig. 10F

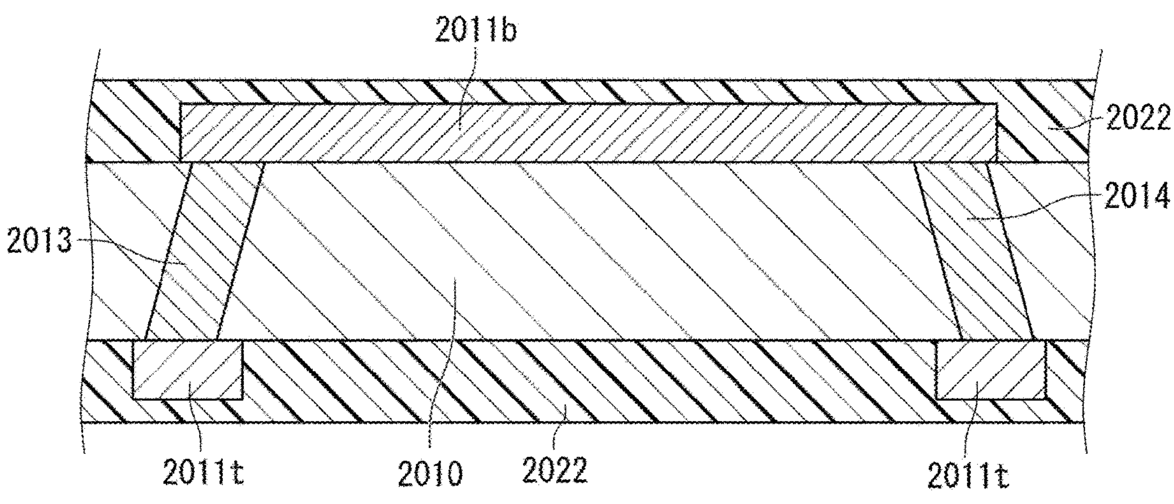


Fig. 10G

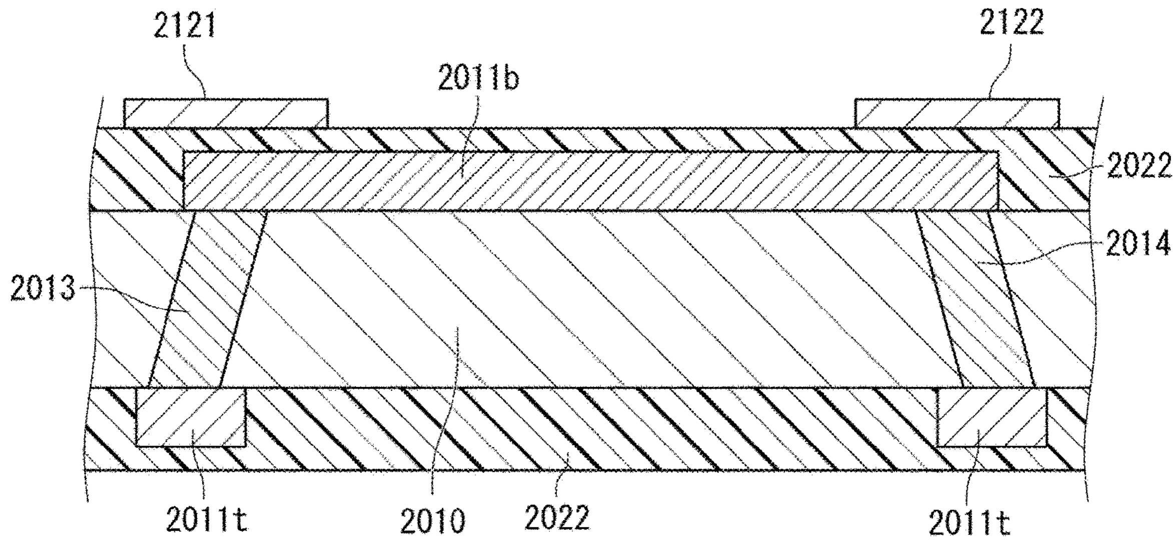


Fig. 10H

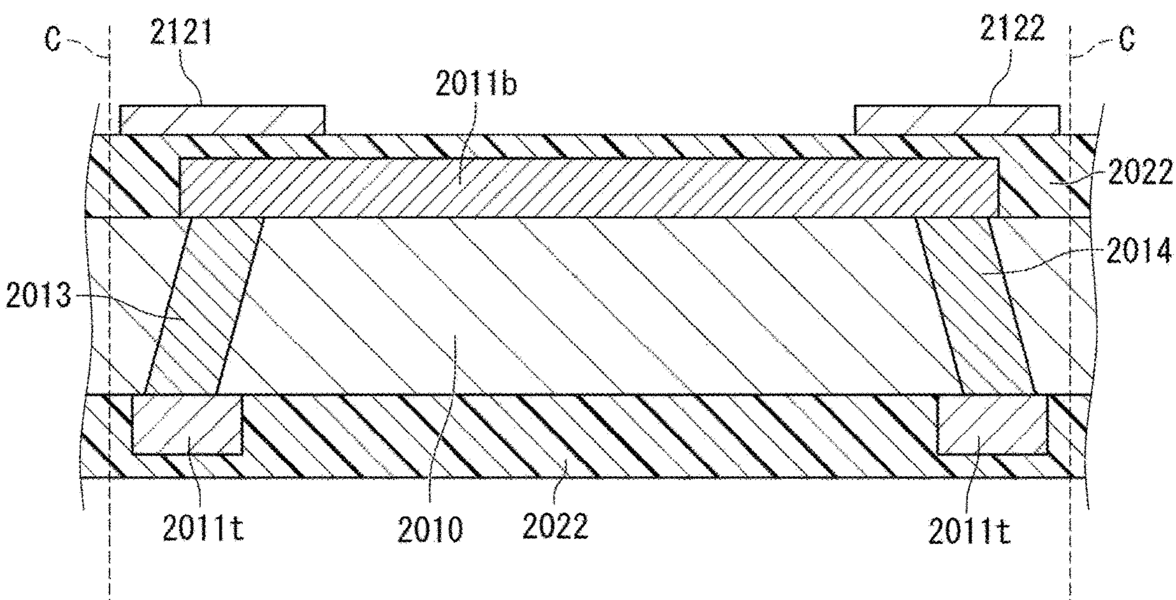


Fig. 11A

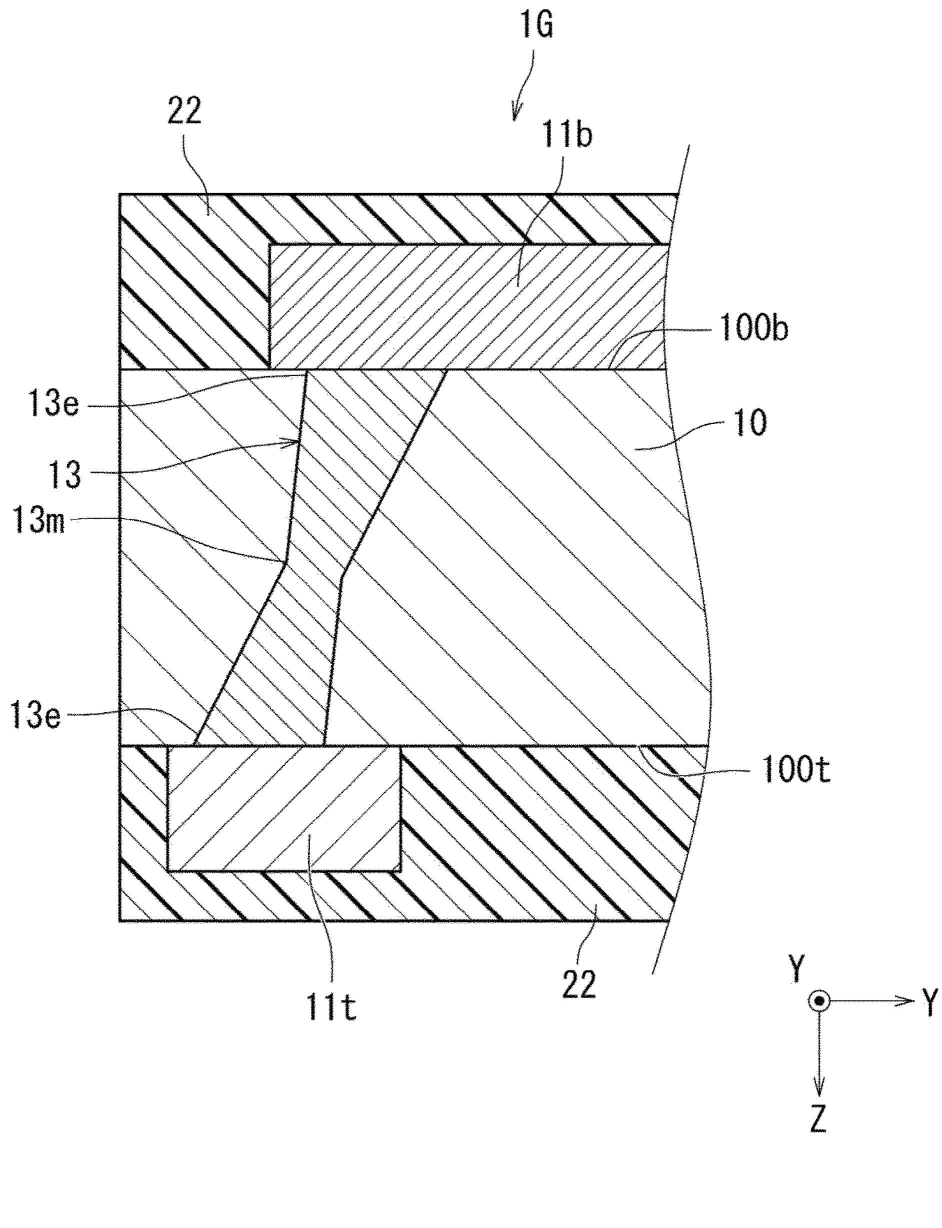
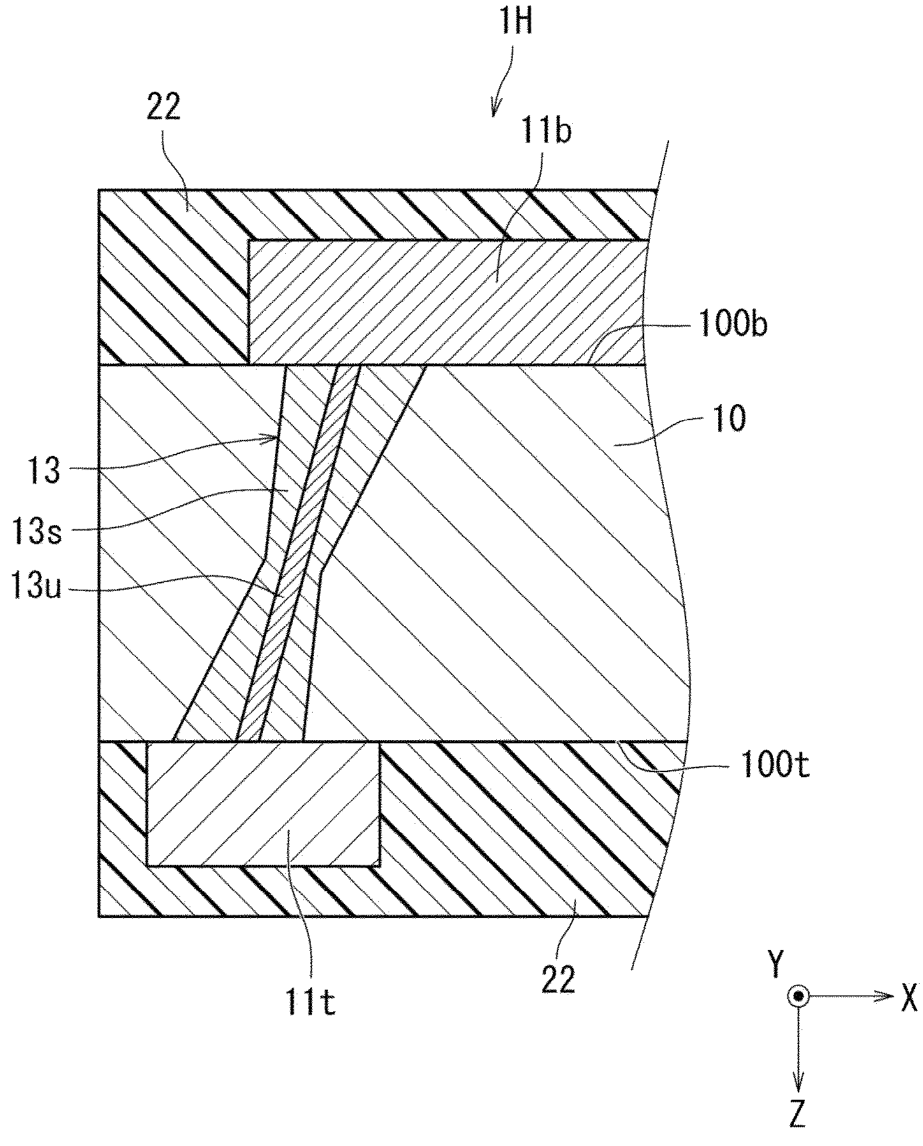


Fig. 11B



INDUCTOR COMPONENT

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims benefit of priority to International Patent Application No. PCT/JP2023/030259, filed Aug. 23, 2023, and to Japanese Patent Application 2022-176449 filed Nov. 2, 2022, the entire content of each are incorporated herein by reference.

BACKGROUND

Technical Field

[0002] The present disclosure relates to an inductor component.

Background Art

[0003] Conventionally, as an inductor component, there is an inductor component described in Japanese Patent No. 6652280. The inductor component includes an element body, a coil that is provided in the element body and is wound along an axial direction, and a first external electrode and a second external electrode that are provided on the element body and are electrically connected to the coil.

[0004] The coil has a plurality of coil patterns layered along an axis. The coil patterns adjacent to each other in the axial direction are connected via a conductive via. Each coil pattern includes a wiring portion extending in a direction orthogonal to the axis and a pad portion that is provided at an end portion of the wiring portion and is connected to the conductive via. A width of the pad portion is wider than a width of the wiring portion in order to improve the connectivity between the pad portion and the conductive via.

SUMMARY

[0005] Incidentally, in the conventional inductor component, since the width of the pad portion is wider than the width of the wiring portion, a part of the pad portion is positioned on an inner side in a radial direction of the coil with respect to the wiring portion. Therefore, an inner diameter of the coil becomes small, and the efficiency of acquisition of inductance is not necessarily high.

[0006] In this regard, the present disclosure provides an inductor component capable of increasing the efficiency of acquisition of inductance.

[0007] Accordingly, one aspect of the present disclosure provides an inductor component comprising an element body having a first principal surface and a second principal surface opposite to each other; a coil that is provided in the element body and is wound in a spiral shape along an axis; and a first external electrode and a second external electrode that are provided on the element body and are electrically connected to the coil. The axis of the coil is disposed parallel to the first principal surface. The coil includes a plurality of first coil wirings which are provided on the first principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the first principal surface, a plurality of second coil wirings which are provided on the second principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the second principal surface, a plurality of first penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings and are arranged along the axis, and a plurality of second penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings, are provided on a side opposite to the respective first penetration wirings with respect to the axis, and are arranged along the axis. Each of the first coil wirings, each of the first penetration wirings, each of the second coil wirings, and each of the second penetration wirings form at least a part of the spiral shape by being connected in this order, and the first penetration wirings and the second penetration wirings are not parallel to each other when viewed in the axial direction.

[0008] In this specification, the "axis" indicates an intersection line of a first plane passing through centers between the first coil wirings and the second coil wirings and a second plane passing through centers between the first penetration wirings and the second penetration wirings. That "the first penetration wirings and the second penetration wirings are not parallel to each other when viewed in the axial direction" indicates that a center line of the first penetration wiring and a center line of the second penetration wiring are not parallel to each other when viewed from the axial direction. Note that the center lines of the first penetration wiring and the second penetration wiring are lines passing through a center on a plane orthogonal to extending directions of the respective penetration wirings. That "the external electrode is provided on the element body" specifically indicates that the external electrode is provided on an outer surface side of the element body. For example, this includes a case where the external electrode is provided immediately on an outer surface of the element body, a case where the external electrode is provided on an outer side of the element body via an additional member on the element body, and a case where the external electrode is provided on the outer surface of the external electrode in a state where a part of the external electrode is embedded in the element body.

[0009] According to the aspect, since the coil includes the first coil wirings, the first penetration wirings, the second coil wirings, and the second penetration wirings, and each of the first coil wirings, each of the first penetration wirings, each of the second coil wirings, and each of the second penetration wirings form at least a part of the spiral shape by being connected in this order, it is possible to increase an inner diameter of the coil such that it is possible to increase the efficiency of acquisition of inductance. In addition, a Q value can be increased by increasing the efficiency of acquisition of inductance. Further, since the first penetration wirings and the second penetration wirings are not parallel to each other when viewed in the axial direction, it is possible to improve a degree of freedom in designing the first penetration wirings and the second penetration wirings, and for example, it is possible to increase the Q value or it is possible to increase the self-resonant frequency.

[0010] Preferably, in an embodiment of the inductor component, the first penetration wirings and the second penetration wirings are linearly symmetric with respect to the axis when viewed in a direction orthogonal to the first principal surface.

[0011] According to the embodiment, it is possible to secure symmetry with respect to the axis of the coil, and it is possible to easily design the coil.

[0012] Preferably, in the embodiment of the inductor component, the first penetration wirings and the second penetration wirings are linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

[0013] According to the embodiment, it is possible to secure symmetry with respect to the axis of the coil, and it is possible to easily design the coil.

[0014] Preferably, in the embodiment of the inductor component, a line edge roughness of the first penetration wirings is higher than a line edge roughness of the first coil wirings.

[0015] Here, the line edge roughness of the first penetration wirings indicates the line edge roughness of a side surface on an inner diameter side of the coil, of side surfaces of each first penetration wiring, on a cross section orthogonal to the axis of the coil and including the center line of the first penetration wiring. The line edge roughness of the first coil wirings indicates the line edge roughness of a side surface of each first coil wiring on the cross section orthogonal to the first principal surface and including the center line of each first coil wiring.

[0016] According to the embodiment, adhesiveness between the first penetration wirings and the element body is improved by the anchor effect.

[0017] Preferably, in the embodiment of the inductor component, a line edge roughness of the first penetration wirings is equal to or lower than a line edge roughness of the first coil wirings.

[0018] According to the embodiment, since the side surfaces of the first penetration wirings are smooth, it is possible to reduce an increase in resistance at a high frequency due to a skin effect and to improve the Q value.

[0019] Preferably, in the embodiment of the inductor component, a width of each of the first penetration wirings is different from a width of each of the second penetration wirings.

[0020] Here, the width of the first penetration wiring is an equivalent circle diameter obtained from a cross-sectional area of the first penetration wiring on a cross section including a center of the first penetration wiring in the extending direction thereof and parallel to the first principal surface. The width of the second penetration wiring is an equivalent circle diameter obtained from a cross-sectional area of the second penetration wiring on a cross section including a center of the second penetration wiring in the extending direction thereof and parallel to the first principal surface.

[0021] According to the embodiment, it is possible to improve the degree of freedom in designing the first penetration wirings and the second penetration wirings.

[0022] Preferably, in the embodiment of the inductor component, the first penetration wirings have respective outer circumferential parts positioned on an outer side with respect to the first coil wirings and the second coil wirings in a radial direction of the coil when viewed in the axial direction, and the outer circumferential parts are disposed between 0.3 or more and 0.7 or less (i.e., from between 0.3 and 0.7) of a height of the element body with the first principal surface as a reference in the direction orthogonal to the first principal surface.

[0023] Here, being positioned on the outer side with respect to the first coil wirings and the second coil wirings in the radial direction of the coil indicates being positioned on an outer side with respect to a tangent line in the radial direction of the coil. The tangent line is in contact with an end surface of the first coil wiring positioned in the direction parallel to the first principal surface and an end surface of the second coil wiring positioned in the direction parallel to the first principal surface, when viewed in the axial direction.

[0024] According to the embodiment, since the first penetration wiring has the outer circumferential part, it is possible to increase the inner diameter of the coil such that it is possible to improve the Q value. In addition, since the outer circumferential part is disposed between 0.3 and 0.7 of the height of the element body, it is possible to provide the outer circumferential part only in a part of the height of the element body, thereby enabling a likelihood that the first penetration wiring will be exposed from the element body at the time of division into individual components to be decreased.

[0025] Preferably, the embodiment of the inductor component further comprises a second coil that is provided in the element body and is wound in a spiral shape along a second axis parallel to the axis; and a third external electrode and a fourth external electrode that are provided on the element body and are electrically connected to the second coil. The second coil includes a plurality of third coil wirings which are provided on the first principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the first principal surface, a plurality of fourth coil wirings which are provided on the second principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the second principal surface, a plurality of third penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings and are arranged along the second axis, and a plurality of fourth penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings, are provided on a side opposite to the respective third penetration wirings with respect to the second axis, and are arranged along the second axis. Each of the third coil wirings, each of the third penetration wirings, each of the fourth coil wirings, and each of the fourth penetration wirings form at least a part of a spiral shape of the second coil by being connected in this order, and the second penetration wirings and the third penetration wirings are adjacent to each other.

[0026] According to the embodiment, similarly to the coil, it is possible to increase the efficiency of acquisition of inductance and to improve the degree of freedom in design for the second coil.

[0027] Preferably, in the embodiment of the inductor component, the first penetration wirings and the second penetration wirings, and the third penetration wirings and the fourth penetration wirings are linearly symmetric with respect to a center line between the first coil and the second coil when viewed in the axial direction of the coil.

[0028] According to the embodiment, it is possible to easily obtain the first coil and the second coil having similar characteristics.

[0029] Preferably, in the embodiment of the inductor component, the second penetration wirings and the third penetration wirings are arranged parallel to each other, when viewed in the axial direction of the coil.

[0030] According to the embodiment, since the second penetration wirings and the third penetration wirings are arranged parallel to each other, it is possible to decrease a distance between the coil and the second coil adjacent to each other such that it is possible to decrease the size of the inductor component.

[0031] Preferably, in the embodiment of the inductor component, the first penetration wirings and the second penetration wirings are not linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

[0032] According to the embodiment, since, in the first coil, the first penetration wirings and the second penetration wirings are not linearly symmetric with respect to the straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction, it is possible to further improve the degree of freedom in designing the first penetration wirings and the second penetration wirings.

[0033] Preferably, in the embodiment of the inductor component, the third penetration wirings and the fourth penetration wirings are not parallel to each other when viewed in the second axial direction.

[0034] According to the embodiment, it is possible to increase a distance between each of the third penetration wirings and each of the fourth penetration wirings, and it is possible to increase an inner diameter of the second coil such that it is possible to improve the Q value.

[0035] Preferably, in the embodiment of the inductor component, the first penetration wirings have respective first connection surfaces connected to the respective first coil wirings and respective second connection surfaces connected to the respective second coil wirings. The first external electrode is provided on the first principal surface side, and overlaps at least a part of each of the first connection surfaces when viewed in the direction orthogonal to the first principal surface. Also, when viewed in the axial direction, an inclination angle on the axial side formed by a straight line connecting a center of each of the first connection surfaces and a center of each of the second connection surfaces and a connection surface of each of the second coil wirings connected to each of the first penetration wirings is 60° or larger and smaller than 90° (i.e., from 60° to smaller than 90°).

[0036] According to the embodiment, since the inclination angle is smaller than 90°, it is possible to decrease an area of the first coil wiring overlapping the first external electrode when viewed in the direction orthogonal to the first principal surface. Consequently, it is possible to decrease the parasitic capacitance between the first external electrode and the first coil wiring such that it is possible to increase the self-resonant frequency. In addition, since the inclination angle is 60° or larger, it is possible to secure the inner diameter of the coil such that it is possible to secure the Q value.

[0037] Preferably, in the embodiment of the inductor component, a part of each of the first connection surfaces and a part of each of the second connection surfaces overlap each other when viewed in the direction orthogonal to the first principal surface.

[0038] According to the embodiment, since a part of the first connection surface and a part of the second connection surface overlap each other when viewed in the direction orthogonal to the first principal surface, it is easy to form a seed layer in a case where a through-hole is formed in the element body, the seed layer is provided on an inner surface of the through-hole, and the first penetration wiring is formed on the seed layer by electrolytic plating.

[0039] Preferably, in the embodiment of the inductor component, the center of each of the first connection surfaces is closer to the axis than the center of each of the second connection surfaces is when viewed in the direction orthogonal to the first principal surface.

[0040] According to the embodiment, the first connection surface is disposed on an inner side with respect to the second connection surface of the coil when viewed in the direction orthogonal to the first principal surface. Consequently, it is possible to decrease the area of the first coil wiring overlapping the first external electrode when viewed in the direction orthogonal to the first principal surface, and it is possible to reduce the parasitic capacitance between the first external electrode and the first coil wiring such that it is possible to increase the self-resonant frequency.

[0041] Preferably, in the embodiment of the inductor component, each of the first penetration wirings includes a conductive layer positioned on an outer circumferential side when viewed in an extending direction of the first penetration wirings, and a non-conductive layer positioned inside the conductive layer.

[0042] According to the embodiment, since a current mainly flows in a surface of the first penetration wirings due to a skin effect in the case of use in a high frequency band, the Q value is not decreased by providing the conductive layer on the outer circumferential side. In addition, by providing the non-conductive layer inside, stress can be alleviated, and manufacturing costs can be reduced by using no conductor.

[0043] Preferably, in the embodiment of the inductor component, a cross-sectional area of at least one of both end portions of each of the first penetration wirings in the extending direction is larger than a cross-sectional area of a central portion of each of the first penetration wirings in the extending direction.

[0044] According to the embodiment, it is possible to increase the cross-sectional area of the end portion of the first penetration wiring such that connectivity between the first penetration wiring and at least one of the first coil wiring and the second coil wiring can be improved. In addition, when a hole portion is formed in the element body, the hole portion is filled with a conductive material by fill plating or the like, and the first penetration wiring is formed in the hole portion of the element body, it is easy to fill the hole portion on an opening side with the conductive material. Since the cross-sectional area of the end portion of the first penetration wiring is large, and the cross-sectional area of the central portion of the first penetration wiring is small, the first penetration wiring is easily formed.

[0045] Preferably, in the embodiment of the inductor component, the inductor component has a thickness of 200 μm or smaller.

[0046] According to the embodiment, it is possible to decrease a thickness of the inductor component.

[0047] Preferably, in the embodiment of the inductor component, when viewed in the direction orthogonal to the first principal surface, the first external electrode and the second external electrode are positioned on an inner side with respect to an outer surface of the element body.

[0048] According to the configuration, since the first external electrode and the second external electrode are not in contact with the outer surfaces of the element body, loads applied to the first external electrode and the second external electrode can be decreased, and deformation and peeling of the first external electrode and the second external electrode can be reduced, when division into individual inductor components is performed. Therefore, even if the inductor component has a small size, it is possible to prevent the first external electrode and the second external electrode from being deformed or peeled off.

[0049] Preferably, the embodiment of the inductor component further comprises an organic insulating body provided on the first principal surface. The element body is an inorganic insulating body, and the organic insulating body is positioned on an inner side with respect to an outer surface of the inorganic insulating body when viewed in the direction orthogonal to the first principal surface.

[0050] According to the embodiment, since the organic insulating body is provided, the organic insulating body easily imparts flowability, the organic insulating body easily fills a space between the first coil wirings adjacent to each other and enables insulating properties to be improved, in a case where the first coil wirings are covered with the organic insulating body. In addition, since the organic insulating body is not in contact with the outer surface of the inorganic insulating body, it is possible to decrease a load applied to the organic insulating body and reduce deformation and peeling of the organic insulating body when division into individual inductor components is performed.

[0051] According to the inductor component which is the one aspect of the present disclosure, it is possible to increase the efficiency of acquisition of inductance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] FIG. **1** is a schematic bottom view of an inductor component from a bottom surface side according to a first embodiment;

[0053] FIG. **2** is a cross-sectional view taken along line II-II in FIG. **1**;

[0054] FIG. **3** is a cross-sectional view taken along line III-III in FIG. **1**;

[0055] FIG. **4** is an enlarged view of a part of FIG. **2**;

[0056] FIG. **5**A is a schematic cross-sectional view illustrating a method for manufacturing an inductor component;

[0057] FIG. **5**B is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0058] FIG. **5**C is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0059] FIG. **5**D is a schematic cross-sectional view for illustrating the method for manufacturing an inductor component;

[0060] FIG. **5**E is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0061] FIG. **5**F is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0062] FIG. **5**G is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0063] FIG. **5**H is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0064] FIG. **5**I is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0065] FIG. **5**J is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0066] FIG. **5**K is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0067] FIG. **5**L is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0068] FIG. **5**M is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0069] FIG. **6**A is a cross-sectional view showing a first modification example of the inductor component;

[0070] FIG. **6**B is a cross-sectional view showing a second modification example of the inductor component;

[0071] FIG. **6**C is a cross-sectional view showing a third modification example of the inductor component;

[0072] FIG. **6**D is a cross-sectional view showing a fourth modification example of the inductor component;

[0073] FIG. **6**E is a cross-sectional view showing a fifth modification example of the inductor component;

[0074] FIG. **7** is a schematic bottom view of an inductor component from a bottom surface side according to a second embodiment;

[0075] FIG. **8** is a cross-sectional view taken along line VIII-VIII in FIG. **7**;

[0076] FIG. **9** is a partially enlarged view of FIG. **8**;

[0077] FIG. **10**A is a schematic cross-sectional view illustrating a method for manufacturing an inductor component;

[0078] FIG. **10**B is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0079] FIG. **10**C is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0080] FIG. **10**D is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0081] FIG. **10**E is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0082] FIG. **10**F is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0083] FIG. **10**G is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0084] FIG. **10**H is a schematic cross-sectional view illustrating the method for manufacturing an inductor component;

[0085] FIG. **11**A is a cross-sectional view showing a first modification example of the inductor component;

[0086] FIG. **11**B is a cross-sectional view showing a second modification example of the inductor component;

DETAILED DESCRIPTION

[0087] Hereinafter, an inductor component which is the one aspect of the present disclosure will be described in detail with reference to embodiments shown in the drawings. Note that the drawings include some schematic drawings, and may not reflect actual dimensions and ratios.

First Embodiment

[0088] An inductor component **1** according to the first embodiment will be described below. FIG. **1** shows a schematic bottom view of the inductor component **1** from a bottom surface side thereof. FIG. **2** is a cross-sectional view taken along line II-II in FIG. **1**. FIG. **3** is a cross-sectional view taken along line III-III in FIG. **1**. Note that, in FIG. **1**, an external electrode is drawn by a two-dot chain line for convenience. In addition, in FIG. **1**, an element body **10** is drawn transparently so that a structure thereof can be easily understood, but may be translucent or opaque.

1. GENERAL CONFIGURATION

[0089] A general configuration of the inductor component **1** will be described. The inductor component **1** is, for example, a surface mount inductor component that is used in a high-frequency signal transmission circuit. As shown in FIGS. **1**, **2**, and **3**, the inductor component **1** includes the element body **10**, a coil **110** that is provided in the element body **10** and is wound in a spiral shape along an axis AX, and a first external electrode **121** and a second external electrode **122** that are provided on the element body **10** and are electrically connected to the coil **110**.

[0090] The element body **10** has a length, a width, and a height. The element body **10** has a first end surface **100*e*1** and a second end surface **100*e*2** on both end sides in a length direction, a first side surface **100*s*1** and a second side surface **100*s*2** on both end sides in a width direction, and a bottom surface **100*b*** and a top surface **100*t*** on both end sides in a height direction. That is, outer surfaces **100** of the element body **10** include the first end surface **100*e*1** and the second end surface **100*e*2**, the first side surface **100*s*1** and the second side surface **100*s*2**, and the bottom surface **100*b*** and the top surface **100*t***. The bottom surface **100*b*** corresponds to an example of a "first principal surface" described in CLAIMS, and the top surface **100*t*** corresponds to an example of a "second principal surface" described in CLAIMS.

[0091] As shown in the drawings, hereinafter, for convenience of description, a direction that is the length direction (longitudinal direction) of the element body **10** and is from the first end surface **100*e*1** toward the second end surface **100*e*2** is referred to as an X direction. In addition, a direction that is the width direction of the element body **10** and is from the first side surface **100*s*1** toward the second side surface **100*s*2** is referred to as a Y direction. In addition, a direction that is the height direction of the element body **10** and is from the bottom surface **100*b*** toward the top surface **100*t*** is referred to as a Z direction. The X direction, the Y direction, and the Z direction are directions orthogonal to each other and form a right-handed system when arranged in an order of X, Y, and Z.

[0092] In this specification, the "outer surfaces **100** of the element body" including the first end surface **100*e*1**, the second end surface **100*e*2**, the first side surface **100*s*1**, the second side surface **100*s*2**, the bottom surface **100*b***, and the top surface **100*t*** of the element body **10** do not simply mean surfaces of the element body **10** toward the outer circumferential sides of the element body **10**, but are surfaces serving as a boundary between an outside and an inside of the element body **10**. In addition, "above the outer surfaces **100** of the element body **10**" does not indicate an absolute direction such as a vertical upward direction defined in the direction of gravity, but indicates a direction toward the outside with the outer surfaces **100** as a reference, of the outside and inside with the outer surfaces **100** as the boundary therebetween. Hence, "above the outer surfaces **100**" indicates a relative direction determined depending on an orientation of the outer surfaces **100**. In addition, "above" with respect to a certain element means not only above from the corresponding element, that is, an upper position via another object on the corresponding element or an upper position apart from the corresponding element at an interval, but also a position immediately on the corresponding element to be in contact with the corresponding element.

[0093] The axis AX of the coil **110** is disposed parallel to the bottom surface **100*b***. The coil **110** includes a plurality of bottom surface wirings **11*b*** which are provided on the bottom surface **100*b*** side with respect to the axis AX and are arranged along the axis AX on a plane parallel to the bottom surface **100*b***, a plurality of top surface wirings **11*t*** which are provided on the top surface **100*t*** side with respect to the axis AX and are arranged along the axis AX on a plane parallel to the top surface **100*t***, a plurality of first penetration wirings **13** which extend from the respective bottom surface wirings **11*b*** toward the respective top surface wirings **11*t***, and are arranged along the axis AX, and a plurality of second penetration wirings **14** which extend from the respective bottom surface wirings **11*b*** toward the respective top surface wirings **11*t***, are provided on a side opposite to the respective first penetration wirings **13** with respect to the axis AX, and are arranged along the axis AX. Each of the bottom surface wirings **11*b***, each of the first penetration wirings **13**, each of the top surface wirings **11*t***, and each of the second penetration wirings **14** form at least a part of a spiral shape by being connected in this order.

[0094] The bottom surface wiring **11*b*** corresponds to an example of a "first coil wiring" described in CLAIMS, and the top surface wiring **11*t*** corresponds to an example of a "second coil wiring" described in CLAIMS. The axis AX indicates an intersection line of a first plane passing through centers between the bottom surface wirings **11*b*** and the top surface wirings **11*t*** and a second plane passing through centers between the first penetration wirings **13** and the second penetration wirings **14**. That is, the axis AX is a straight line passing through a center of an inner diameter portion of the coil **110**. The axis AX of the coil **110** does not have a dimension in a direction orthogonal to the axis AX.

[0095] According to the configuration described above, since the coil **110** includes the bottom surface wirings **11*b***, the first penetration wirings **13**, the top surface wirings **11*t***, and the second penetration wirings **14**, and each of the bottom surface wirings **11*b***, each of the first penetration wirings **13**, each of the top surface wirings **11*t***, and each of the second penetration wirings **14** form at least a part of the spiral shape by being connected in this order, it is possible to increase an inner diameter of the coil **110** such that it is possible to increase the efficiency of acquisition of inductance. In addition, a Q value can be increased by increasing the efficiency of acquisition of inductance.

[0096] To be more specific, since pad portions of a conventional inductor component or the bottom surface wirings **11*b*** and the top surface wirings **11*t*** of the present embodiment are "reception portions" of wirings (conductive vias of the conventional inductor component or the first penetration wirings **13** and the second penetration wirings **14** of the present embodiment) which penetrate an element body, the pad portions and the bottom and top surface wirings have a shape expanding perpendicularly to a direction in which to penetrate the element body. Here, in a configuration of the conventional inductor component, since the conductive vias extend in a direction parallel to an axis of a coil, the pad portions are expanded in a direction perpendicular to the axis of the coil and are likely to have a structure in which magnetic flux generated in an axial direction of the coil is blocked.

[0097] On the other hand, in the present embodiment, since the first penetration wiring **13** and the second penetration wiring **14** extend in a direction perpendicular to the axis AX of the coil **110**, the bottom surface wiring **11***b* and the top surface wiring **11***t* are expanded in a direction parallel to the axis AX of the coil **110**. Accordingly, it is difficult for the bottom surface wiring **11***b* and the top surface wiring **11***t* to have a structure in which magnetic flux generated in an axis AX direction is blocked. That is, according to the present embodiment, it is possible to have the structure in which it is difficult to block the magnetic flux such that it is possible to improve the efficiency of acquisition of inductance and the Q value.

[0098] As shown in FIG. **2**, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. That is, a center line **13***a* of the first penetration wiring **13** and a center line **14***a* of the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction.

[0099] According to the configuration described above, since the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction, it is possible to improve the degree of freedom in designing the first penetration wiring **13** and the second penetration wiring **14**, and for example, it is possible to increase the Q value or it is possible to increase the self-resonant frequency. To be more specific, it is possible to increase a distance between the first penetration wiring **13** and the second penetration wiring **14**, and it is possible to increase the inner diameter of the coil **110** such that it is possible to improve the Q value.

[0100] Note that it is preferable that all the first penetration wirings **13** and all the second penetration wirings **14** are not parallel to each other when viewed in the axis AX direction. At least one first penetration wiring **13** and at least one second penetration wiring **14** may not be parallel to each other when viewed in the axis AX direction. It is preferable that the first penetration wirings **13** and the second penetration wirings **14** intersecting the same plane orthogonal to the axis AX are not parallel to each other when viewed in the axis AX direction. In addition, although all the first penetration wirings **13** overlap each other when viewed in the axis AX direction, of all the first penetration wirings **13**, some first penetration wirings **13** that do not overlap when viewed in the axis AX direction may be provided. The same applies to the second penetration wirings **14**.

2. CONFIGURATIONS OF RESPECTIVE UNITS

(Inductor Component 1)

[0101] A volume of the inductor component **1** is 0.08 mm^3 or smaller, and a size of a long side of the inductor component **1** is 0.65 mm or smaller. The size of the long side of the inductor component **1** indicates the largest value of a length, a width, and a height of the inductor component **1**, and in this embodiment, indicates the length in the X direction. According to the configuration described above, since the volume of the inductor component **1** is small and the long side of the inductor component **1** is short, a weight of the inductor component **1** is reduced. Therefore, even if the external electrodes **121** and **122** are small, necessary mounting strength can be obtained. In addition, a thickness of the inductor component **1** is preferably 200 μm or smaller. This enables a thin inductor component **1** to be obtained.

[0102] To be more specific, the size (length (X direction)×width (Y direction)×height (Z direction)) of the inductor component **1** is 0.6 mm×0.3 mm×0.3 mm, 0.4 mm×0.2 mm×0.2 mm, 0.25 mm×0.125 mm×0.120 mm, or the like. In addition, the width and the height may not be equal, and may be, for example, 0.4 mm×0.2 mm×0.3 mm.

(Element Body 10)

[0103] The element body **10** contains SiO_2. This enables insulation properties and stiffness to be imparted to the element body **10**. The element body **10** is made of, for example, a glass sintered body. The glass sintered body may contain alumina, and the strength of the element body can be further increased.

[0104] The glass sintered body is formed by, for example, layering insulating layers containing a plurality of types of glass. A layering direction of the plurality of insulating layers is the Z direction. That is, the insulating layer has a layer shape having a principal surface expanding on an X-Y plane. Note that, in the element body **10**, an interface between the plurality of insulating layers may not be distinct due to firing or the like.

[0105] Note that the element body **10** may include, for example, a glass substrate. The glass substrate may be a single-layer glass substrate, and since most of the element body is made of glass, it is possible to reduce a loss such as an eddy current loss at a high frequency.

(Coil 110)

[0106] The coil **110** includes the plurality of bottom surface wirings **11***b*, the plurality of top surface wirings **11***t*, the plurality of first penetration wirings **13**, and the plurality of second penetration wirings **14**. The bottom surface wirings **11***b*, the first penetration wirings **13**, the top surface wirings **11***t*, and the second penetration wirings **14** are connected in this order, respectively, to constitute at least a part of the coil **110** wound in the axis AX direction.

[0107] According to the configuration described above, since the coil **110** is a so-called helical coil **110**, in a cross section orthogonal to the axis AX, it is possible to reduce a region where the bottom surface wiring **11***b*, the top surface wiring **11***t*, the first penetration wiring **13**, and the second penetration wiring **14** are laid out parallel to each other in a winding direction of the coil **110**, and it is possible to reduce stray capacitance in the coil **110**.

[0108] Here, the helical shape indicates a shape in which the number of turns of the entire coil is more than one turn, and the number of turns of the coil in the cross section orthogonal to the axis is less than one turn. One or more turns indicate a state in which the wirings of the coil have, on the cross section orthogonal to the axis, parts that are adjacent to each other in a radial direction and are laid out parallel to each other in the winding direction when viewed in an axial direction, and less than one turn indicates a state in which the wirings of the coil does not have, on the cross section orthogonal to the axis, parts that are adjacent to each other in the radial direction and are laid out parallel to each other in the winding direction when viewed in the axial direction.

[0109] The bottom surface wirings **11***b* extend only in one direction. To be more specific, the bottom surface wirings **11***b* slightly tilt in the X direction and extend in the Y direction. All the bottom surface wirings **11***b* are arranged parallel to each other in the X direction. Here, in a photolithography process, when deformed illumination such as annular illumination or dipole illumination is used, pattern resolution in a specific direction can be enhanced to form a finer pattern. According to the configuration described above, since the bottom surface wirings **11***b* extend only in one direction and all the bottom surface wirings **11***b* are arranged parallel to each other, it is possible to form the fine bottom surface wirings **11***b* and reduce the size of the inductor component **1** by using, for example, modified illumination in a photolithography process.

[0110] The top surface wirings **11***t* extend only in one direction. To be more specific, the top surface wirings **11***t* have a shape extending in the Y direction. All the top surface wirings **11***t* are arranged parallel to each other in the X direction. According to the configuration described above, since the top surface wirings **11***t* extend only in one direction and all the top surface wirings **11***t* are arranged parallel to each other, it is possible to form the fine top surface wirings **11***t* and reduce the size of the inductor component **1** by using, for example, modified illumination in a photolithography process.

[0111] The bottom surface wirings **11***b* and the top surface wirings **11***t* are made of a good conductor material such as copper, silver, gold, or an alloy thereof. The bottom surface wirings **11***b* and the top surface wirings **11***t* may be a metal film formed by plating, vapor deposition, sputtering, or the like, or may be a metal sintered body obtained by applying and sintering a conductor paste. In addition, the bottom surface wirings **11***b* and the top surface wirings **11***t* may have a multilayer structure in which a plurality of metal layers are layered. The bottom surface wirings **11***b* and the top surface wirings **11***t* have a thickness of preferably 5 μm or more and 50 μm or less (i.e., from 5 μm to 50 μm).

[0112] The first penetration wirings **13** are disposed in through-holes V of the element body **10** on the first side surface **100***s***1** side with respect to the axis AX, and the second penetration wirings **14** are disposed in the other through-holes V of the element body **10** on the second side surface **100***s***2** side with respect to the axis AX. Each of the first penetration wirings **13** and the second penetration wirings **14** extends in a direction orthogonal to the bottom surface **100***b* and the top surface **100***t*. This enables lengths of the first penetration wirings **13** and the second penetration wirings **14** to be shortened, thus enabling the direct current resistance (Rdc) to be reduced. The first penetration wirings **13** and the second penetration wirings **14** are all arranged parallel to each other in the X direction.

[0113] The first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. To be more specific, the first penetration wiring **13** and the second penetration wiring **14** are bent at respective centers thereof in the Z direction such that a space therebetween is widened toward the centers. That is, each of the first penetration wiring **13** and the second penetration wiring **14** has a shape expanding outward in a radial direction of the coil **110** toward the center in the Z direction. In addition, each of the first penetration wiring **13** and the second penetration wiring **14** has a stepped shape in the Z direction. According to the configuration described above, in a case where the first penetration wiring **13** and the second penetration wiring **14** are each formed by layering a plurality of conductor layers, the first penetration wiring **13** and the second penetration wiring **14** can be easily formed in the stepped shape by shifting and layering each conductor layer.

[0114] Preferably, as shown in FIG. **1**, the first penetration wiring **13** and the second penetration wiring **14** are linearly symmetric with respect to the axis AX when viewed in the direction orthogonal to the bottom surface **100***b*. This enables symmetry with respect to the axis AX of the coil **110** to be secured, thus enabling the coil **110** to be easily designed. In addition, it is possible to decrease entry of a part of the penetration wiring into an inner side of the inner diameter of the coil **110** and improve the Q value.

[0115] Preferably, as shown in FIG. **2**, the first penetration wiring **13** and the second penetration wiring **14** are linearly symmetric with respect to a straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction. This enables symmetry with respect to the axis AX of the coil **110** to be secured, thus enabling the coil **110** to be easily designed. In addition, it is possible to decrease entry of a part of the penetration wiring into an inner side of the inner diameter of the coil **110** and improve the Q value.

[0116] Preferably, a line edge roughness (hereinafter, also referred to as LER) of the first penetration wiring **13** is higher than a line edge roughness of the bottom surface wiring **11***b*. To be more specific, the line edge roughness of the first penetration wiring **13** indicates the line edge roughness of a side surface on an inner diameter side of the coil **110**, of side surfaces of the first penetration wiring **13**, on a cross section orthogonal to the axis AX of the coil **110** and including the center line **13***a* of the first penetration wiring **13**. The line edge roughness of the bottom surface wiring **11***b* indicates the line edge roughness of a side surface of the bottom surface wiring **11***b* on a cross section orthogonal to the bottom surface **100***b* and including a center line **14***a* of the bottom surface wiring **11***b*. This causes adhesiveness between the first penetration wirings **13** and the element body **10** to be improved by the anchor effect.

[0117] The LER of the first penetration wiring **13** indicates dimensional deviations of a width of the first penetration wiring **13**. The width of the first penetration wiring **13** is a dimension in a direction orthogonal to the center line **13***a* on a cross section including the center line **13***a* of the first penetration wiring **13**. A method of measuring the LER is in accordance with the SEMI standard (SEMI Standard P47-0307, Test Method for Evaluation of Line-Edge Roughness and Line width Roughness). In the present embodiment, an SEM image (or an optical image) of the first penetration wiring **13** is acquired at a magnification at which ⅓ or more of a length of the first penetration wiring **13** in an extending direction thereof is taken, and the LER of the first penetration wiring **13** is calculated using WinROOF 2018 which is image processing software. Similarly, regarding the bottom surface wiring **11***b*, an SEM image of the bottom surface wiring **11***b* is acquired at a magnification at which ⅓ or more of a length of the bottom surface wiring **11***b* in an extending direction thereof is taken, and the LER of the bottom surface wiring **11***b* is calculated. Note that, unless otherwise specified, the LER in the present specification indicates an average value of LERs calculated at three or more points on an image acquired as described above, and the three or more calculation points include at least two points at an interval which is half or more of the acquired image.

[0118] Similarly, the line edge roughness of the first penetration wirings **13** may be higher than the line edge roughness of the top surface wirings **11***t*, and adhesiveness between the first penetration wirings **13** and the element body **10** is improved by the anchor effect. Similarly, the line edge roughness of the second penetration wirings **14** may be higher than the line edge roughness of the bottom surface wirings **11***b*, and adhesiveness between the second penetration wirings **14** and the element body **10** is improved by the anchor effect. Similarly, the line edge roughness of the second penetration wirings **14** may be higher than the line edge roughness of the top surface wirings **11***t*, and adhesiveness between the second penetration wirings **14** and the element body **10** is improved by the anchor effect.

[0119] Here, the line edge roughness of the first penetration wirings **13** may be equal to or lower than the line edge roughness of the bottom surface wirings **11***b*. This enables an increase in resistance at a high frequency due to a skin effect to be reduced and to improve the Q value since the side surfaces of the first penetration wirings **13** are smooth. Similarly, the line edge roughness of the first penetration wirings **13** may be equal to or lower than the line edge roughness of the top surface wirings **11***t*. Similarly, the line edge roughness of the second penetration wirings **14** may be equal to or lower than the line edge roughness of the bottom surface wirings **11***b*, and since the side surfaces of the second penetration wirings **14** are smooth, it is possible to reduce an increase in resistance at a high frequency due to the skin effect and to improve the Q value. Similarly, the line edge roughness of the second penetration wirings **14** may be equal to or lower than the line edge roughness of the top surface wirings **11***t*.

[0120] Preferably, the width of the first penetration wiring **13** is different from the width of the second penetration wiring **14**. The width of the first penetration wiring **13** is an equivalent circle diameter obtained from a cross-sectional area of the first penetration wiring **13** on a cross section including a center of the first penetration wiring **13** in the extending direction thereof and parallel to the bottom surface **100***b*. The width of the second penetration wiring **14** is an equivalent circle diameter obtained from a cross-sectional area of the second penetration wiring **14** on a cross section including a center of the second penetration wiring **14** in the extending direction thereof and parallel to the bottom surface **100***b*. To be more specific, the first penetration wiring **13** is divided into three equal portions of an upper portion, a middle portion, and a lower portion in a height direction thereof, and an average value of the equivalent circle diameters of cross-sectional areas of the three equal portions is defined as the width. Note that, in a case where the width of the first penetration wiring **13** and the width of the second penetration wiring **14** are relatively different by 10% or more, it is assumed that the width of the first penetration wiring **13** and the width of the second penetration wiring **14** are different.

[0121] According to the configuration described above, it is possible to improve the degree of freedom in designing the first penetration wirings **13** and the second penetration wirings **14**. For example, when a penetration wiring is inclined or curved, the DC resistance increases. Hence, a width of the penetration wiring on a side on which a line length is long is increased so that DC resistances of penetration wirings having different shapes and different line lengths are the same.

[0122] FIG. **4** is an enlarged view of a part of FIG. **2**. As shown in FIG. **4**, the first penetration wirings **13** have respective outer circumferential parts **131** positioned on an outer side with respect to the bottom surface wirings **11***b* and the top surface wirings **11***t* in a radial direction of the coil **110** when viewed in the axis AX direction. When viewed in the axis AX direction, the outer circumferential part **131** is positioned on the outer side with respect to a tangent line L**2** in the radial direction of the coil **110**. The tangent line L**2** is in contact with an end surface **11***b***1** of the bottom surface wiring **11***b* positioned in the direction parallel to the bottom surface **100***b* and an end surface **11***t***1** of the top surface wiring **11***t* positioned in the direction parallel to the bottom surface **100***b*. The outer circumferential part **131** is disposed between 0.3 or more and 0.7 or less (i.e., from 0.3 to 0.7) of a height Z**1** with the bottom surface **100***b* as a reference in the direction orthogonal to the bottom surface **100***b* of the element body **10**. The height Z**1** of the element body **10** is a distance from the bottom surface **100***b* to the top surface **100***t*. A position of 1.0 of the height Z**1** of the element body **10** corresponds to the top surface **100***t*.

[0123] According to the configuration described above, since the first penetration wiring **13** has the outer circumferential part **131**, it is possible to increase the inner diameter of the coil **110** such that it is possible to improve the Q value. In addition, since the outer circumferential part **131** is disposed between 0.3 or more and 0.7 or less (i.e., from 0.3 to 0.7) of the height Z**1** of the element body, it is possible to provide the outer circumferential part **131** only in a part of the height Z**1** of the element body **10**, thereby enabling a likelihood that the first penetration wiring **13** will be exposed from the element body **10** at the time of division into individual components to be decreased.

[0124] Similarly, the second penetration wirings **14** have respective outer circumferential parts positioned on an outer side with respect to the bottom surface wirings **11***b* and the top surface wirings **11***t* in the radial direction of the coil **110** when viewed in the axis AX direction, and the outer circumferential part is disposed between 0.3 or more and 0.7 or less (i.e., from 0.3 to 0.7) of the height Z**1** of the element body **10**. Consequently, it is possible to increase the inner diameter of the coil **110** such that it is possible to improve the Q value, and it is possible to decrease a likelihood that the second penetration wiring **14** will be exposed from the element body **10** at the time of division into individual components.

[0125] Preferably, the first penetration wirings **13** contain SiO_2. This enables a linear expansion coefficient of the first penetration wiring **13** to be equal to a linear expansion coefficient of the element body **10** in a case where the element body **10** contains SiO_2, thus enabling cracks between the first penetration wirings **13** and the element body **10** to be reduced. The first penetration wiring **13** is made of, for example, a conductive paste. A conductive material is Ag, Cu, or the like. Similarly, the second penetration wirings **14** preferably contain SiO_2.

[0126] Preferably, as shown in FIG. **2**, when viewed in the direction orthogonal to the bottom surface **100***b*, the first end portion of the bottom surface wiring **11***b* and the first end portion of the top surface wiring **11***t* overlap each other, and an angle θ formed by the bottom surface wiring **11***b* and the top surface wiring **11***t* is an acute angle. The angle θ is an angle between a center line (a chain line in FIG. **2**) of a width of the bottom surface wiring **11***b* and a center line (a chain line in FIG. **2**) of a width of the top surface wiring **11***t* when viewed in the direction orthogonal to the bottom surface **100***b*.

[0127] Preferably, as shown in FIG. **2**, when viewed in the direction orthogonal to the bottom surface **100***b*, the angle θ formed by the bottom surface wiring **11***b* and the top surface wiring **11***t* connected to the same first penetration wiring **13** is 5° or larger and 45° or smaller (i.e., from 5° to 45° or smaller). The angle θ is an angle between a center line (a chain line in FIG. **2**) of a width of the bottom surface wiring **11***b* and a center line (a chain line in FIG. **2**) of a width of the top surface wiring **11***t* when viewed in the direction orthogonal to the bottom surface **100***b*.

[0128] According to the configuration described above, since the coils **110** are densely wound, it is possible to improve the inductance. Since the angle θ is 45° or smaller, a coil length is shortened, the leakage flux is reduced, and the Q value is increased. The coil length indicates an interval between both end parts positioned on the outermost sides in the axis AX direction, among the bottom surface wirings **11***b*, the top surface wirings **11***t*, the first penetration wirings **13**, and the second penetration wirings **14**. Since the angle θ is 5° or larger, it is possible to decrease possibilities that the two first penetration wirings **13** adjacent to each other in the axis AX direction are brought into contact with each other, and it is possible to decrease possibilities that the two second penetration wirings **14** adjacent to each other in the axis AX direction are brought into contact with each other. Of all the bottom surface wirings **11***b* and the top surface wirings **11***t*, the angle θ between at least one set of the bottom surface wiring **11***b* and the top surface wiring **11***t* may be 5° or larger and 45° or smaller (i.e., from 5° to 45° or smaller).

[0129] Preferably, similarly when viewed in the direction orthogonal to the bottom surface **100***b*, the angle θ formed by the bottom surface wiring **11***b* and the top surface wiring **11***t* connected to the same second penetration wiring **14** is 5° or larger and 45° or smaller (i.e., from 5° to) 45°. Consequently, since the coils **110** are densely wound, it is possible to improve the inductance.

[0130] Preferably, at least one wiring of the bottom surface wirings **11***b*, the top surface wirings **11***t*, the first penetration wirings **13**, and the second penetration wirings **14** includes a void portion or a resin portion. This enables stress due to a difference in linear expansion coefficient between the wiring and the element body **10** to be absorbed by the void portion or the resin portion, thus enabling the stress to be alleviated. As a method of forming the void portion, for example, the void portion can be formed by sintering a wiring, by using a member which is burned into the material of the wiring by being sintered. As a method for forming the resin portion, for example, the resin portion can be formed by using a conductive paste in the material of the wiring.

[0131] Preferably, at least one wiring of the bottom surface wirings **11***b* and the top surface wirings **11***t* contains SiO_2. This enables a linear expansion coefficient of the wiring to be equal to the linear expansion coefficient of the element body **10** in a case where the element body **10** contains SiO_2, thus enabling cracks between the wiring and the element body **10** to be reduced.

(First External Electrode **121** and Second External Electrode **122**)

[0132] The first external electrode **121** is connected to the first end portion of the coil **110**, and the second external electrode **122** is connected to the second end portion of the coil **110**. The first external electrode **121** is provided on the first end surface **100***e***1** side with respect to a center of the element body **10** in the X direction to be exposed from the outer surface **100** of the element body **10**. The second external electrode **122** is provided on the second end surface **100***e***2** side with respect to a center of the element body **10** in the X direction to be exposed from the outer surface **100** of the element body **10**.

[0133] When viewed in the direction orthogonal to the bottom surface **100***b*, the first external electrode **121** and the second external electrode **122** are positioned on an inner side with respect to the outer surface **100** of the element body **10**. That is, the first external electrode **121** and the second external electrode **122** are positioned on an inner side with respect to the first end surface **100***e***1**, the second end surface **100***e***2**, the first side surface **100***s***1**, and the second side surface **100***s***2** of the element body **10**.

[0134] According to the configuration described above, since the first external electrode **121** and the second external electrode **122** are not in contact with the outer surfaces **100** of the element body **10**, loads applied to the first external electrode **121** and the second external electrode **122** can be decreased, and deformation and peeling of the first external electrode **121** and the second external electrode **122** can be reduced, when division into individual inductor components is performed. Therefore, even if the inductor component has a small size, it is possible to prevent the first external electrode **121** and the second external electrode **122** from being deformed or peeled off.

[0135] Note that the first external electrode **121** may be provided to be continuously connected to the bottom surface **100***b* and the first end surface **100***e***1**. This enables a solder fillet to be formed on the first external electrode **121** when the inductor component **1** is mounted on a mounting substrate, since the first external electrode **121** is a so-called L-shaped electrode. Similarly, the second external electrode **122** may be provided to be continuously connected to the bottom surface **100***b* and the second end surface **100***e***2**.

[0136] The first external electrode **121** has a bottom surface part **121***b* provided on the bottom surface **100***b* and a via part **121***v* embedded in the bottom surface **100***b*. The via part **121***v* is connected to the bottom surface part **121***b*. The via part **121***v* is connected to an end portion of the bottom surface wiring **11***b* positioned on the first end surface **100***e***1** side in the axis AX direction.

[0137] The second external electrode **122** has a bottom surface part **122***b* provided on the bottom surface **100***b* and a via part **122***v* embedded in the bottom surface **100***b*. The via part **122***v* is connected to the bottom surface part **122***b*. The via part **122***v* is connected to an end portion of the bottom surface wiring **11***b* positioned on the second end surface **100***e***2** side in the axis AX direction.

[0138] The first external electrode **121** has a base layer **121***e***1** and a plating layer **121***e***2** covering the base layer **121***e***1**. The base layer **121***e***1** contains, for example, a conductive material such as Ag or Cu. The plating layer **121*e*2** contains, for example, a conductive material such as Ni or Sn. A part of the bottom surface part **121*b*** and the via part **121*v*** are formed by the base layer **121*e*1**. The other part of the bottom surface part **121*b*** is formed by the plating layer **121*e*2**. Similarly, the second external electrode **122** has a base layer and a plating layer covering the base layer. Note that the first external electrode **121** and the second external electrode **122** may be made of a single-layer conductor material.

(Method for Manufacturing Inductor Component **1**)

[0139] Next, a method for manufacturing the inductor component **1** will be described with reference to FIGS. **5**A to **5**M. FIGS. **5**A to **5**H, **5**K, and **5**L are views corresponding to a cross section taken along line II-II in FIG. **1**. FIGS. **5**I, **5**J, and **5**M are views corresponding to a cross section taken along line III-III in FIG. **1**.

[0140] As shown in FIG. **5**A, a first insulating layer **1011** is printed on a base substrate **1000**. Examples of materials of the base substrate **1000** include a glass substrate, a silicon substrate, an alumina substrate, or the like, and examples of materials of the first insulating layer **1011** include a resin such as epoxy or polyimide, or an inorganic insulating film such as SiO or SiN.

[0141] As shown in FIG. **5**B, a second insulating layer **1012** is printed on the first insulating layer **1011**. A groove **1012*a*** is provided in the second insulating layer **1012**. In this case, for example, the groove **1012*a*** is formed by the photolithography process. Note that the groove may be formed as a printed pattern from the beginning.

[0142] As shown in FIG. **5**C, a top surface conductor layer **1011*t*** is printed in the groove **1012*a***. Examples of materials of the top surface conductor layer **1011*t*** include Ag, Cu, Au, Al, an alloy containing at least one of these elements, or a solder paste. In this case, for example, the top surface conductor layer **1011*t*** is formed as a printed pattern to remain only in the groove **1012*a***. Note that, after the top surface conductor layer **1011*t*** is printed on the second insulating layer **1012**, the top surface conductor layer **1011*t*** may remain only in the groove **1012*a*** by the photolithography process.

[0143] As shown in FIG. **5**D, a third insulating layer **1013** is printed on the second insulating layer **1012**. The third insulating layer **1013** has a first groove **1013*a*** and a second groove **1013*b***. The first groove **1013*a*** and the second groove **1013*b*** are formed in the same method as described in FIG. **5**B.

[0144] As shown in FIG. **5**E, a first penetration conductor layer **1131** as a first layer is printed in the first groove **1013*a***, and a second penetration conductor layer **1141** as the other first layer is printed in the second groove **1013*b***. The first penetration conductor layer **1131** as the first layer and the second penetration conductor layer **1141** as the other first layer are formed by the same method described in FIG. **5**C.

[0145] By repeating the above-described processes, as shown in FIG. **5**F, a fourth insulating layer **1014** is provided on the third insulating layer **1013**, and a first penetration conductor layer **1132** as a second layer and a second penetration conductor layer **1142** as the other second layer are provided in two respective grooves provided in the fourth insulating layer **1014**. Further, a fifth insulating layer **1015** is provided on the fourth insulating layer **1014**, and a first penetration conductor layer **1133** as a third layer and a second penetration conductor layer **1143** as the other third layer are provided in two respective grooves provided in the fifth insulating layer **1015**. Further, a sixth insulating layer **1016** is provided on the fifth insulating layer **1015**, and a first penetration conductor layer **1134** as a fourth layer and a second penetration conductor layer **1144** as the other fourth layer are provided in two respective grooves provided in the sixth insulating layer **1016**. Further, a seventh insulating layer **1017** is provided on the sixth insulating layer **1016**, and a first penetration conductor layer **1135** as a fifth layer and a second penetration conductor layer **1145** as the other fifth layer are provided in two respective grooves provided in the seventh insulating layer **1017**.

[0146] In this case, the first penetration conductor layer **1131** as the first layer, the first penetration conductor layer **1132** as the second layer, and the first penetration conductor layer **1133** as the third layer are sequentially layered to be shifted outward in the radial direction of the coil, and the first penetration conductor layer **1133** as the third layer, the first penetration conductor layer **1134** as the fourth layer, and the first penetration conductor layer **1135** as the fifth layer are sequentially layered to be shifted inward in the radial direction of the coil. In this case, the second penetration conductor layer **1141** as the other first layer, the second penetration conductor layer **1142** as the other second layer, and the second penetration conductor layer **1143** as the other third layer are sequentially layered to be shifted outward in the radial direction of the coil, and the second penetration conductor layer **1143** as the other third layer, the second penetration conductor layer **1144** as the other fourth layer, and the second penetration conductor layer **1145** as the other fifth layer are sequentially layered to be shifted inward in the radial direction of the coil.

[0147] As shown in FIG. **5**G, an eighth insulating layer **1018** is provided on the seventh insulating layer **1017**, and a bottom surface conductor layer **1011*b*** is provided in a groove provided in the eighth insulating layer **1018**. A material of the bottom surface conductor layer **1011*b*** is the same as the material of the top surface conductor layer **1011*t***. As shown in FIG. **5**H, a ninth insulating layer **1019** is provided on the eighth insulating layer **1018**.

[0148] As shown in FIG. **5**I, a groove **1019*a*** is provided in the ninth insulating layer **1019** such that a part of the bottom surface conductor layer **1011*b*** is exposed. As shown in FIG. **5**J, a base conductor layer **1121*e*1** is provided on the ninth insulating layer **1019** and in the groove **1019*a***. Examples of materials of the base conductor layer **1121*e*1** include resin pastes of Ag or Cu.

[0149] As shown in FIG. **5**K, an entire layered body is sintered in a furnace at a high temperature (for example, 500° C. or higher). The first to ninth insulating layers **1011** to **1019** are sintered to form the element body **10**, the top surface conductor layer **1011*t*** is sintered to form the top surface wiring **11*t***, the bottom surface conductor layer **1011*b*** is sintered to form the bottom surface wiring **11*b***, the first penetration conductor layers **1131** to **1135** as the first to fifth layers are sintered to form the first penetration wiring **13**, the second penetration conductor layers **1141** to **1145** as the first to fifth other layers are sintered to form the second penetration wiring **14**, and the base conductor layer **1121*e*1** is sintered to form the base layer **121*e*1**. Hence, it is possible to improve the strength by sintering the insulating layers, and a resin component which does not need to be contained in the conductor layers can be volatilized by sintering the conductor layers, and a conductor material contained in the conductor layers can be fused to realize high conductivity. The base substrate **1000** may be peeled off by decomposing a surface during sintering, may be mechanically removed by performing grinding or the like before and after the sintering, or may be chemically removed by performing etching or the like before and after the sintering.

[0150] As shown in FIG. **5**L, division into individual inductor components is performed along a cutting line C. As shown in FIG. **5**M, the plating layer **121***e***2** is formed by performing barrel plating to cover the base layer **121***e***1**, and the first external electrode **121** is formed. Consequently, as shown in FIG. **2**, the inductor component **1** is manufactured.

3. MODIFICATION EXAMPLES

First Modification Example

[0151] FIG. **6**A is a view showing a first modification example of the inductor component, and the view corresponds to the cross section taken along line II-II in FIG. **1**. As shown in FIG. **6**A, in an inductor component **1**A of the first modification example, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110** to be increased such that it is possible to improve the Q value.

[0152] To be more specific, the first penetration wiring **13** and the second penetration wiring **14** are bent at respective centers thereof in the Z direction such that a space therebetween is widened toward the centers. That is, each of the first penetration wiring **13** and the second penetration wiring **14** has a shape expanding outward in a radial direction of the coil **110** toward the center in the Z direction.

[0153] In addition, each of the first penetration wiring **13** and the second penetration wiring **14** has an arc shape in the Z direction. That is, the inner-side surface of the first penetration wiring **13** has a concave curved surface, and the outer-side surface of the first penetration wiring **13** has a convex curved surface. The inner-side surface of the second penetration wiring **14** has a concave curved surface, and the outer-side surface of the second penetration wiring **14** has a convex curved surface. The inner-side surfaces of both the first penetration wiring **13** and the second penetration wiring **14** are surfaces on the inner diameter side of the coil **110**, and the outer-side surfaces of both the first penetration wiring **13** and the second penetration wiring **14** are surfaces on the outer diameter side of the coil **110**.

[0154] According to the configuration described above, the inner-side surfaces of both the first penetration wirings **13** and the second penetration wirings **14** and the outer-side surfaces of both the first penetration wirings **13** and the second penetration wirings **14** can be made smooth such that it is possible to decrease the DC resistance. In particular, since the inner-side surfaces of both the first penetration wirings **13** and the second penetration wirings **14** are smooth, it is possible to reduce an increase in resistance at a high frequency due to the skin effect and to improve the Q value.

Second Modification Example

[0155] FIG. **6**B is a view showing a second modification example of the inductor component, and the view corresponds to the cross section taken along line II-II in FIG. **1**. As shown in FIG. **6**B, in an inductor component **1**B of the second modification example, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110** to be increased such that it is possible to improve the Q value.

[0156] To be more specific, the first penetration wirings **13** and the second penetration wirings **14** are inclined such that a space therebetween is widened toward the top surface wiring **11***t* side in the Z direction. That is, each of the first penetration wirings **13** and the second penetration wirings **14** has a shape expanding outward in the radial direction of the coil **110** toward the top surface wiring **11***t* in the Z direction. As described above, the coil **110** has a trapezoidal shape when viewed from the axis AX direction.

[0157] According to the configuration described above, the first penetration wirings **13** and the second penetration wirings **14** can be linearly formed and shortened, and the DC resistance of the first penetration wirings **13** and the second penetration wirings **14** can be reduced.

Third Modification Example

[0158] FIG. **6**C is a view showing a third modification example of the inductor component, and the view corresponds to the cross section taken along line II-II in FIG. **1**. As shown in FIG. **6**C, an inductor component **1**C of the third modification example includes a first coil **110**A and a second coil **110**B as compared with the inductor component **1** shown in FIG. **2**. The first coil **110**A corresponds to the coil **110** of the inductor component **1** shown in FIG. **2**.

[0159] Similarly to the first coil **110**A, the second coil **110**B is provided in the element body **10**, is spirally wound along the axis AX (an example of a second axis), and is connected to a third external electrode and a fourth external electrode (not shown). The third external electrode and the fourth external electrode have the same configurations as those of the first external electrode **121** and the second external electrode **122** of the inductor component **1** shown in FIG. **1**.

[0160] Similarly to the first coil **110**A, the second coil **110**B includes a bottom surface wiring **11***b* (an example of a third coil wiring), a top surface wiring **11***t* (an example of a fourth coil wiring), a first penetration wiring **13** (an example of a third penetration wiring), and a second penetration wiring **14** (an example of a fourth penetration wiring).

[0161] In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**A to be increased such that it is possible to improve the Q value.

[0162] To be more specific, the first penetration wiring **13** has the same configuration as that of the first penetration wiring **13** of the inductor component **1** in FIG. **2**. Meanwhile, the second penetration wiring **14** has a linear shape parallel to the Z direction. That is, the first penetration wiring **13** is bent at a center thereof in the Z direction such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the center.

The first penetration wiring **13** has a stepped shape in the Z direction. According to the configuration described above, in a case where the first penetration wiring **13** is formed by layering a plurality of conductor layers, the first penetration wiring **13** can be easily formed in the stepped shape by shifting and layering each conductor layer.

[0163] In the second coil **110**B, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**B to be increased such that it is possible to improve the Q value.

[0164] To be more specific, the second penetration wiring **14** has the same configuration as that of the second penetration wiring **14** of the inductor component **1** in FIG. **2**. Meanwhile, the first penetration wiring **13** has a linear shape parallel to the Z direction. That is, the second penetration wiring **14** is bent at a center thereof in the Z direction such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the center. The second penetration wiring **14** has a stepped shape in the Z direction. According to the configuration described above, in a case where the second penetration wiring **14** is formed by layering a plurality of conductor layers, the second penetration wiring **14** can be easily formed in the stepped shape by shifting and layering each conductor layer.

[0165] Preferably, as illustrated in FIG. **6**C, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to a center line M between the first coil **110**A and the second coil **110**B. The center line M is a line passing through a center between the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B when viewed in an axis AX direction of the first coil **110**A. To be more specific, the first penetration wiring **13** of the first coil **110**A and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to the center line M, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are linearly symmetric with respect to the center line M. This enables the first coil **110**A and the second coil **110**B having similar characteristics to be easily obtained.

[0166] Preferably, as illustrated in FIG. **6**C, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. This enables a distance between the first coil **110**A and the second coil **110**B adjacent to each other to be decreased such that it is possible to decrease the size the inductor component **1**C, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other.

[0167] Preferably, as illustrated in FIG. **6**C, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

[0168] According to the configuration described above, it is possible to decrease a distance between the first coil **110**A and the second coil **110**B adjacent to each other such that it is possible to decrease the size the inductor component **1**C, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In addition, since, in the first coil **110**A, the first penetration wirings **13** and the second penetration wirings **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction, it is possible to further improve the degree of freedom in designing the first penetration wirings **13** and the second penetration wirings **14**. Similarly, in the second coil **110**B, the first penetration wirings **13** and the second penetration wirings **14** may not be linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

Fourth Modification Example

[0169] FIG. **6**D is a view showing a fourth modification example of the inductor component, and the view corresponds to the cross section taken along line II-II in FIG. **1**. As shown in FIG. **6**D, in an inductor component **1**D of the fourth modification example, the coil includes a first coil **110**A and a second coil **110**B as compared with the inductor component **1**A shown in FIG. **6**A.

[0170] In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**A to be increased such that it is possible to improve the Q value.

[0171] To be more specific, the first penetration wiring **13** has the same configuration as that of the first penetration wiring **13** of the inductor component **1**A in FIG. **6**A. Meanwhile, the second penetration wiring **14** has a linear shape parallel to the Z direction. That is, the first penetration wiring **13** is bent at a center thereof in the Z direction such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the center. The first penetration wiring **13** has an arc shape in the Z direction. According to the configuration described above, the side surface of the first penetration wiring **13** can be made smooth such that it is possible to decrease the DC resistance of the first penetration wiring **13**.

[0172] In the second coil **110**B, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**B to be increased such that it is possible to improve the Q value.

[0173] To be more specific, the second penetration wiring **14** has the same configuration as that of the second penetration wiring **14** of the inductor component **1**A in FIG. **6**A. Meanwhile, the first penetration wiring **13** has a linear shape parallel to the Z direction. That is, the second penetration wiring **14** is bent at a center thereof in the Z direction such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the center. The second penetration wiring **14** has an arc shape in the Z direction. According to the configuration described above, the side surface of the second penetration wiring **14** can be made smooth such that it is possible to decrease the DC resistance of the second penetration wiring **14**.

[0174] Preferably, as illustrated in FIG. **6**D, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to a center line M between the first coil **110**A and the second coil **110**B. To be more specific, the first penetration wiring **13** of the first coil **110**A and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to the center line M, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are linearly symmetric with respect to the center line M. This enables the first coil **110**A and the second coil **110**B having similar characteristics to be easily obtained.

[0175] Preferably, as illustrated in FIG. **6**D, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. This enables a distance between the first coil **110**A and the second coil **110**B adjacent to each other to be decreased such that it is possible to decrease the size the inductor component **1**D, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other.

[0176] Preferably, as illustrated in FIG. **6**D, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

[0177] According to the configuration described above, it is possible to decrease a distance between the first coil **110**A and the second coil **110**B adjacent to each other such that it is possible to decrease the size the inductor component **1**D, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In addition, since, in the first coil **110**A, the first penetration wirings **13** and the second penetration wirings **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction, it is possible to further improve the degree of freedom in designing the first penetration wirings **13** and the second penetration wirings **14**. Similarly, in the second coil **110**B, the first penetration wirings **13** and the second penetration wirings **14** may not be linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

Fifth Modification Example

[0178] FIG. **6**E is a view showing a fifth modification example of the inductor component, and the view corresponds to the cross section taken along line II-II in FIG. **1**. As shown in FIG. **6**E, an inductor component **1**E of the fifth modification example includes a first coil **110**A and a second coil **110**B as compared with the inductor component **1**B of the second modification example shown in FIG. **6**B.

[0179] In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**A to be increased such that it is possible to improve the Q value.

[0180] To be more specific, the first penetration wiring **13** has the same configuration as that of the first penetration wiring **13** of the inductor component **1**B of the second modification example. Meanwhile, the second penetration wiring **14** has a linear shape parallel to the Z direction. That is, the first penetration wiring **13** is inclined such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the top surface wiring **11***t* side in the Z direction. According to the configuration described above, the first penetration wirings **13** and the second penetration wirings **14** can be linearly formed and shortened, and the DC resistance of the first penetration wirings **13** and the second penetration wirings **14** can be reduced.

[0181] In the second coil **110**B, the first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. This enables a distance between the first penetration wiring **13** and the second penetration wiring **14** to be increased and enables the inner diameter of the coil **110**B to be increased such that it is possible to improve the Q value.

[0182] To be more specific, the second penetration wiring **14** has the same configuration as that of the second penetration wiring **14** of the inductor component **1**B of the second modification example. Meanwhile, the first penetration wiring **13** has a linear shape parallel to the Z direction. That is, the second penetration wiring **14** is inclined such that a space between the first penetration wiring **13** and the second penetration wiring **14** is widened toward the top surface wiring **11***t* side in the Z direction. According to the configuration described above, the first penetration wirings **13** and the second penetration wirings **14** can be linearly formed, and the electrical resistance of the first penetration wirings **13** and the second penetration wirings **14** can be reduced.

[0183] Preferably, as illustrated in FIG. **6**E, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to a center line M between the first coil **110**A and the second coil **110**B. To be more specific, the first penetration wiring **13** of the first coil **110**A and the second penetration wiring **14** of the second coil **110**B are linearly symmetric with respect to the center line M, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are linearly symmetric with respect to the center line M. This enables the first coil **110**A and the second coil **110**B having similar characteristics to be easily obtained.

[0184] Preferably, as illustrated in FIG. **6**E, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. This enables a distance between the first coil **110**A and the second coil **110**B adjacent to each other to be decreased such that it is possible to decrease the size of the inductor component **1**E, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other.

[0185] Preferably, as illustrated in FIG. **6**E, the axis AX of the first coil **110**A and the axis AX of the second coil **110**B are arranged parallel to each other. When viewed in the axis AX direction of the first coil **110**A, the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are adjacent to each other, and the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In the first coil **110**A, the first penetration wiring **13** and the second penetration wiring **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

[0186] According to the configuration described above, it is possible to decrease a distance between the first coil **110**A and the second coil **110**B adjacent to each other such that it is possible to decrease the size the inductor component **1**E, since the second penetration wiring **14** of the first coil **110**A and the first penetration wiring **13** of the second coil **110**B are arranged parallel to each other. In addition, since, in the first coil **110**A, the first penetration wirings **13** and the second penetration wirings **14** are not linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction, it is possible to further improve the degree of freedom in designing the first penetration wirings **13** and the second penetration wirings **14**. Similarly, in the second coil **110**B, the first penetration wirings **13** and the second penetration wirings **14** may not be linearly symmetric with respect to the straight line L**1** orthogonal to the bottom surface **100***b* and including the axis AX when viewed in the axis AX direction.

Second Embodiment

[0187] FIG. **7** is a schematic bottom view of a second embodiment of the inductor component from the bottom surface side. FIG. **8** is a cross-sectional view taken along line VIII-VIII in FIG. **7**. In FIG. **7**, for convenience, an insulating layer is omitted, and the external electrodes are drawn by two-dot chain lines. In addition, in FIG. **7**, the element body **10** is drawn transparently so that a structure thereof can be easily understood. The second embodiment differs from the first embodiment mainly in the position of the axis of the coil, the material of the element body, and providing of an insulating layer, and these different configurations will be mainly described below. The other configurations are the same as those of the first embodiment, and the description thereof will be omitted.

1. CONFIGURATIONS OF RESPECTIVE UNITS

(Inductor Component **1**F)

[0188] As shown in FIG. **7**, in an inductor component **1**F, an axis AX of a coil **110** is perpendicular to the X direction. To be more specific, the axis AX is parallel to the Y direction and passes a center of the element body **10** in the X direction. This enables interference in magnetic flux of the coil **110** by the first external electrode **121** and the second external electrode **122** to be reduced, and it is possible to improve the efficiency of acquisition of inductance.

[0189] A length of the coil **110** in the axis AX direction is shorter than an inner diameter of the coil **110**. The length of the coil **110** in the axis AX direction is also referred to as a coil length. This enables the Q value to be improved since the coil length is short and the coil inner diameter is large. The inner diameter of the coil indicates an equivalent circle diameter based on a minimum area of a region surrounded by the coil **110** when viewed therethrough in the axis AX direction.

(Element Body **10**)

[0190] The element body **10** is an inorganic insulating body. The material of the element body **10** is preferably glass, and this enables an eddy current to be reduced and enables the Q value to be increased since the glass has high insulation properties. The element body **10** preferably contains an Si element, and this enables the thermal stability of the element body **10** to be increased, thus, enabling variations in dimension or the like of the element body **10** due to heat to be reduced and enabling variations in electrical characteristics to be decreased.

[0191] The element body **10** is preferably a single-layer glass plate. This enables the strength of the element body **10** to be ensured. In addition, in the case of the single-layer glass plate, since dielectric loss is small, the Q value at a high frequency can be increased. In addition, since no sintering process for such a sintered body is performed, deformation of the element body **10** during sintering can be reduced. Hence, it is possible to reduce pattern misalignment and provide an inductor component with a small inductance tolerance.

[0192] As a material of the single-layer glass plate, a glass plate having photosensitivity represented by Foturan II (Schott AG's registered trademark) is preferable from the viewpoint of a manufacturing method. In particular, the single-layer glass plate preferably contains cerium oxide (ceria: CeO_2), and in this case, cerium oxide serves as a sensitizer, and processing by photolithography becomes easier.

[0193] However, since the single-layer glass plate can be processed by machining such as drilling or sandblasting, dry/wet etching using a photoresist/metal mask, laser processing, or the like, the single-layer glass plate may be a non-photosensitive glass plate. In addition, the single-layer glass plate may be obtained by sintering a glass paste, or may be formed by a known method such as a float process.

(Insulating Body **22**)

[0194] As shown in FIG. **8**, the inductor component **1**F includes an insulating body **22**. The insulating body **22** covers both the bottom surface **100***b* and the top surface **100***t* of the element body **10**. Note that the insulating body **22** may be provided only on the bottom surface **100***b* of the bottom and top surfaces **100***b* and **1100***t*.

[0195] The insulating body **22** is a member that protects the wirings from an external force by covering the wirings (the bottom surface wirings **11***b* and the top surface wirings **11***t*), and has a role of preventing the wirings from being damaged and a role of improving insulation properties of the wirings. The insulating body **22** is preferably an organic insulating body. For example, the insulating body **22** may be a film made of a resin such as epoxy or polyimide which is easily formed. In particular, the insulating body **22** is preferably made of a material having a low dielectric constant. Consequently, in a case where the insulating body **22** is present between the coil **110** and the external electrode **121** or **122**, it is possible to decrease the stray capacitance formed between the coil **110** and the external electrode **121** or **122**. The insulating body **22** can be formed, for example, by laminating a resin film such as ABF GX-92 (manufactured by Ajinomoto Fine-Techno Co., Inc.), applying and thermal-curing a paste-like resin, or the like. Note that the insulating body **22** may be, for example, an inorganic film made of an oxide such as silicon or hafnium, a nitride, an oxynitride, or the like, which is excellent in insulating properties and thinning.

[0196] Preferably, when the element body **10** is the inorganic insulating body, and the insulating body **22** is an organic insulating body, the organic insulating body is positioned on an inner side with respect to the outer surfaces **100** of the inorganic insulating body when viewed in the direction orthogonal to the bottom surface **100***b*. According to this, since the organic insulating body is provided, the organic insulating body easily imparts flowability, the organic insulating body easily fills a space between wirings adjacent to each other and enables insulating properties to be improved, in a case where the wirings (the bottom surface wirings **11***b* and the top surface wirings **11***t*) are covered with the organic insulating body. In addition, since the organic insulating body is not in contact with the outer surface of the inorganic insulating body, it is possible to decrease a load applied to the organic insulating body and reduce deformation and peeling of the organic insulating body when division into individual inductor components is performed.

(Coil **110**)

[0197] As shown in FIG. **7**, the bottom surface wiring **11***b* extends only in one direction. To be more specific, the bottom surface wirings **11***b* have a shape extending in the X direction. All the bottom surface wirings **11***b* are arranged parallel to each other in the Y direction. The top surface wirings **11***t* extend only in one direction. To be more specific, the top surface wirings **11***t* slightly tilt in the Y direction and extend in the X direction. All the top surface wirings **11***t* are arranged parallel to each other in the Y direction.

[0198] As shown in FIGS. **7** and **8**, the first penetration wirings **13** are disposed in the through-holes V of the element body **10** on the first end surface **100***e***1** side with respect to the axis AX, and the second penetration wirings **14** are disposed in the other through-holes V of the element body **10** on the second end surface **100***e***2** side with respect to the axis AX. Each of the first penetration wirings **13** and the second penetration wirings **14** extends in a direction orthogonal to the bottom surface **100***b* and the top surface **100***t*. The plurality of first penetration wirings **13** and the plurality of second penetration wirings **14** are all arranged parallel to each other in the Y direction.

[0199] The first penetration wiring **13** and the second penetration wiring **14** are not parallel to each other when viewed in the axis AX direction. To be more specific, the first penetration wirings **13** and the second penetration wirings **14** are inclined such that a space therebetween is widened toward the top surface wiring **11***t* side in the Z direction. Each of the first penetration wirings **13** and the second penetration wirings **14** has a shape expanding outward in the radial direction of the coil **110** toward the top surface wiring **11***t* in the Z direction. The coil **110** has a trapezoidal shape when viewed from the axis AX direction. According to the configuration described above, the first penetration wirings **13** and the second penetration wirings **14** can be linearly formed and shortened, and the DC resistance of the first penetration wirings **13** and the second penetration wirings **14** can be reduced.

[0200] FIG. **9** is a partially enlarged view of FIG. **8**. As shown in FIGS. **7**, **8**, and **9**, the first penetration wiring **13** has a first connection surface **13***y***1** connected to the bottom surface wiring **11***b* and a second connection surface **13***y***2** connected to the top surface wiring **11***t*. The first external electrode **121** is provided on the bottom surface **100***b* side, and the first external electrode **121** overlaps at least a part of the first connection surface **13***y***1** when viewed in the direction orthogonal to the bottom surface **100***b*. When viewed in the axis AX direction, an inclination angle α on the axis AX side formed by a straight line L**3** connecting a center of the first connection surface **13***y***1** and a center of the second connection surface **13***y***2** and a connection surface **11***t***2** of the top surface wiring **11***t* connected to the first penetration wiring **13** is 60° or larger and smaller than 90° (i.e., from is 60° to smaller than 90°).

[0201] According to the configuration described above, since the inclination angle α is smaller than 90°, it is possible to decrease an area of the bottom surface wiring **11***b* overlapping the first external electrode **121** when viewed in the direction orthogonal to the bottom surface **100***b*. Consequently, it is possible to decrease the parasitic capacitance between the first external electrode **121** and the bottom surface wirings **11***b* such that it is possible to increase the self-resonant frequency. In addition, since the inclination angle α is 60° or larger, it is possible to secure the inner diameter of the coil **110** such that it is possible to secure the Q value.

[0202] Similarly, the second penetration wiring **14** has a first connection surface **14**y**1** connected to the bottom surface wiring **11**b and a second connection surface **14**y**2** connected to the top surface wiring **11**t. The second external electrode **122** is provided on the bottom surface **100**b side, and the second external electrode **122** overlaps at least a part of the first connection surface **14**y**1** when viewed in the direction orthogonal to the bottom surface **100**b. In this case, when viewed in the axis AX direction, the inclination angle β on the axis AX side formed by a straight line L**4** connecting a center of the first connection surface **14**y**1** and a center of the second connection surface **14**y**2** and a connection surface **11**t**3** of the top surface wiring **11**t connected to the second penetration wiring **14** may be 60° or larger and smaller than 90° (i.e., from 60° to smaller than 90°).

[0203] According to the configuration described above, since the inclination angle β is smaller than 90°, it is possible to decrease an area of the bottom surface wiring **11**b overlapping the second external electrode **122** when viewed in the direction orthogonal to the bottom surface **100**b. Consequently, it is possible to decrease the parasitic capacitance between the second external electrode **122** and the bottom surface wirings **11**b such that it is possible to increase the self-resonant frequency. In addition, since the inclination angle β is 60° or larger, it is possible to secure the inner diameter of the coil **110** such that it is possible to secure the Q value.

[0204] Preferably, as shown in FIG. **7**, in the first penetration wiring **13**, a part of the first connection surface **13**y**1** and a part of the second connection surface **13**y**2** overlap each other when viewed in the direction orthogonal to the bottom surface **100**b. This allows the seed layer to be easily formed, in a case where the through-hole Vis formed in the element body **10**, the seed layer is provided on the inner surface of the through-hole V, and the first penetration wiring **13** is formed on the seed layer by electrolytic plating. Similarly, in the second penetration wiring **14**, a part of the first connection surface **14**y**1** and a part of the second connection surface **14**y**2** overlap each other when viewed in the direction orthogonal to the bottom surface **100**b.

[0205] Preferably, as shown in FIG. **7**, in the first penetration wiring **13**, a center of the first connection surface **13**y**1** is closer to the axis AX than a center of the second connection surface **13**y**2** is when viewed in the direction orthogonal to the bottom surface **100**b. This allows the first connection surface **13**y**1** to be disposed on an inner side of the coil **110** with respect to the second connection surface **13**y**2** when viewed in the direction orthogonal to the bottom surface **100**b. Consequently, it is possible to decrease the area of the bottom surface wiring **11**b overlapping the first external electrode **121** when viewed in the direction orthogonal to the bottom surface **100**b, and it is possible to decrease the parasitic capacitance between the first external electrode **121** and the bottom surface wiring **11**b such that it is possible to increase the self-resonant frequency. Similarly, in the second penetration wiring **14**, a center of the first connection surface **14**y**1** may be closer to the axis AX than a center of the second connection surface **14**y**2** may when viewed in the direction orthogonal to the bottom surface **100**b.

(Method for Manufacturing Inductor Component **1**F)

[0206] Next, a method for manufacturing the inductor component **1**F will be described with reference to FIGS. **10**A to **10**H. FIGS. **10**A to **10**H are views corresponding to a cross section taken along line VIII-VIII in FIG. **7**.

[0207] As shown in FIG. **10**A, copper foil **2001** is printed on a base substrate **2000**. A material of the base substrate **2000** is the same as that of the base substrate **1000** of the first embodiment.

[0208] As shown in FIG. **10**B, a glass substrate **2010** which becomes the element body **10** is provided on the base substrate **2000**. For example, the base substrate **2000** and the glass substrate **2010** are brought into close contact with each other using a jig such as a conductive tape, a pin, or a frame. The glass substrate **2010** has a first through-hole V**1** and a second through-hole V**2**. The first through-hole V**1** and the second through-hole V**2** are not parallel to each other. The glass substrate **2010** is, for example, a through glass via (TGV) substrate. The TGV substrate is a substrate in which a through-hole is formed in advance by a laser, photolithography, or the like. The glass substrate **2010** may be, for example, a through silicon via (TSV) substrate, or may be another substrate. In addition, Ti/Cu or other necessary conductive materials may be deposited on a surface of the glass substrate **2010** in advance as seeds by sputtering or the like.

[0209] As shown in FIG. **10**C, a first penetration conductor layer **2013** which becomes the first penetration wiring **13** is formed in the first through-hole V**1**. A second penetration conductor layer which becomes the second penetration wiring **14** is formed in the second through-hole V**2**. To be more specific, by supplying electric power from the copper foil **2001** on the base substrate **2000**, electrolytic plating is performed in the first through-hole V**1** to form the first penetration conductor layer **2013**, and electrolytic plating is performed in the second through-hole V**2** to form a second penetration conductor layer **2014**. Otherwise, a seed layer may be formed on the surface of the glass substrate **2010** or an inner surface of the through-hole V**1** or V**2** by sputtering or the like, and the penetration conductor layer may be formed by using a known method such as fill plating, conformal plating, or a printing filling method of a conductive paste. In a case where there is unnecessary plating growth on the surface of the glass substrate **2010**, an unnecessary part is removed by polishing, CMP, wet etching (etchback), or dry etching.

[0210] As shown in FIG. **10**D, the base substrate **2000** is peeled off from the glass substrate **2010**. In this case, the base substrate **2000** may be mechanically removed by grinding or the like, or may be chemically removed by etching or the like.

[0211] As shown in FIG. **10**E, a bottom surface conductor layer **2011**b which becomes the bottom surface wiring **11**b and a top surface conductor layer **2011**t which becomes the top surface wiring **11**t are formed on the glass substrate **2010**. To be more specific, a seed layer (not shown) is provided on the entire surface of the glass substrate **2010**, and patterned photoresist is formed on the seed layer. A copper layer is formed on the seed layer in an opening portion of the photoresist by electrolytic plating. The photoresist and the seed layer are removed by wet etching or dry etching. Consequently, the bottom surface conductor layer **2011**b and the top surface conductor layer **2011**t patterned in an arbitrary shape are formed. In this case, the bottom surface conductor layer **2011***b* and the top surface conductor layer **2011***t* may be formed one by one, or may be formed simultaneously.

[0212] As shown in FIG. **10**F, an insulating layer **2022** serving as the insulating body **22** is provided on a top surface and a bottom surface of the glass substrate **2010** to cover the conductor layer. In this case, the insulating layer **2022** on the bottom surface side and the insulating layer **2022** on the top surface side may be formed one by one, or may be formed simultaneously. Thereafter, a hole **2022***a* is formed in the bottom surface conductor layer **2011***b* of the insulating layer **2022** on the bottom surface side by photolithography or laser processing.

[0213] As shown in FIG. **10**G, a first external electrode conductor layer **2121** which becomes the first external electrode **121** is provided on the insulating layer **2022** on the bottom surface side. In this case, the first external electrode conductor layer **2121** is connected to the bottom surface conductor layer **2011***b*. To be more specific, a Pd catalyst (not shown) is provided on the insulating layer **2022** on the bottom surface side, and an Ni/Au plated layer is formed by electroless plating. Patterned photoresist is formed on the plating layer. A plating layer in an opening portion of the photoresist is removed by wet etching or dry etching. Consequently, the first external electrode conductor layer **2121** patterned in an arbitrary shape is formed. Alternatively, a seed layer (not shown) is provided on the insulating layer **2022** on the bottom surface side, and the patterned photoresist is formed on the seed layer. Next, the seed layer in the opening portion of the photoresist is removed by wet etching or dry etching. An Ni/Au plating layer may be formed on the remaining seed layer by electroless plating. Similarly, a second external electrode conductor layer **2122** which becomes the second external electrode **122** is provided on the insulating layer **2022** on the bottom surface side.

[0214] As shown in FIG. **10**H, division into individual components is performed along the cutting line C. Consequently, as shown in FIG. **8**, the inductor component **1**F is manufactured.

2. MODIFICATION EXAMPLES

First Modification Example

[0215] FIG. **11**A is a view showing a first modification example of the inductor component, and the view corresponds to a part of a cross section taken along line VIII-VIII in FIG. **7**. As shown in FIG. **11**A, in an inductor component **1**G of the first modification example, a cross-sectional area of each of both end portions **13***e* of the first penetration wiring **13** in the extending direction thereof is larger than a cross-sectional area of a central portion **13***m* of the first penetration wiring **13** in the extending direction. The cross-sectional area of the first penetration wiring **13** is an area of a cross section of the first penetration wiring **13** in the direction orthogonal to the bottom surface **100***b*. On a cross section of the first penetration wiring **13** in the extending direction, a width of the first penetration wiring **13** in the direction orthogonal to the bottom surface **100***b* is continuously increased from the central portion **13***m* toward both the end portions **13***e*.

[0216] This enables the cross-sectional area of the end portion **13***e* of the first penetration wiring **13** to be increased, so that the connectivity between the first penetration wiring **13** and at least one of the bottom surface wiring **11***b* and the top surface wiring **11***t* can be improved. In addition, when the through-hole V is formed as a hole portion in the element body **10**, the through-hole V is filled with a conductive material by fill plating or the like, and the first penetration wiring **13** is formed in the through-hole V, it is easy to fill the through-hole V on an opening side with the conductive material. Since the cross-sectional area of the end portion **13***e* of the first penetration wiring **13** is large, and the cross-sectional area of the central portion **13***m* of the first penetration wiring **13** is small, the first penetration wiring **13** is easily formed.

[0217] Note that the cross-sectional area of one end portion **13***e* of the first penetration wiring **13** may be larger than the cross-sectional area of the central portion **13***m* of the first penetration wiring **13**. Similarly, the cross-sectional area of at least one end portion of the second penetration wiring **14** may be larger than the cross-sectional area of the central portion **13***m* of the first penetration wiring **13**.

Second Modification Example

[0218] FIG. **11**B is a view showing a second modification example of the inductor component, and the view corresponds to a part of the cross section taken along line VIII-VIII in FIG. **7**. As shown in FIG. **11**B, in an inductor component **1**H of the second modification example, the first penetration wiring **13** includes a conductive layer **13***s* positioned on an outer circumferential side thereof when viewed from an extending direction of the first penetration wiring **13**, and a non-conductive layer **13***u* positioned inside the conductive layer **13***s*. This prevents the Q value from being reduced by providing the conductive layer **13***s* on the outer circumferential side since a current mainly flows in a surface of the first penetration wiring **13** due to a skin effect in the case of use in a high frequency band. In addition, by providing the non-conductive layer **13***u* inside, stress can be alleviated, and manufacturing costs can be reduced by using no conductor.

[0219] An example of a method of forming the conductive layer **13***s* and the non-conductive layer **13***u* will be described. A seed layer is provided on the inner surface of the through-hole V of the element body **10** by sputtering or electroless plating. A plating layer is formed on the seed layer by electrolytic plating. In this manner, for example, a plurality of conductive layers **13***s* of Ti/Cu/electrolytic Cu, Pd/electroless Cu/electrolytic Cu, or the like can be formed on the first penetration wiring **13** on the outer circumferential side thereof. Thereafter, the inside of the conductive layer **13***s* is sealed with a resin by printing, hot pressing, or the like to form the non-conductive layer **13***u* made of a resin. In this manner, stress can be alleviated by the non-conductive layer **13***u* inside the first penetration wiring **13** while a current flows in the surface (the conductive layer **13***s*) of the first penetration wiring **13**.

[0220] Similarly, the second penetration wiring **14** may include a conductive layer positioned on an outer circumferential side thereof when viewed from an extending direction of the second penetration wiring **14**, and a non-conductive layer positioned inside the conductive layer. Note that a cross-sectional area of each of both end portions of the first penetration wiring **13** in the extending direction is larger than a cross-sectional area of a central portion of the first penetration wiring **13** in the extending direction, but the cross-sectional area of each of both the end portions of the first penetration wiring **13** in the extending direction may be the same as the cross-sectional area of the central portion of the first penetration wiring **13** in the extending direction.

[0221] Note that the present disclosure is not limited to the embodiments described above, and can be modified in design without departing from the gist of the present disclosure. For example, the individual characteristic points of the first and second embodiments may be variously combined.

[0222] The present disclosure includes the following aspects.

[0223] <1> An inductor component comprising an element body having a first principal surface and a second principal surface opposite to each other; a coil that is provided in the element body and is wound in a spiral shape along an axis; and a first external electrode and a second external electrode that are provided on the element body and are electrically connected to the coil. The axis of the coil is disposed parallel to the first principal surface. The coil includes a plurality of first coil wirings which are provided on the first principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the first principal surface, a plurality of second coil wirings which are provided on the second principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the second principal surface, a plurality of first penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings and are arranged along the axis, and a plurality of second penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings, are provided on a side opposite to the respective first penetration wirings with respect to the axis, and are arranged along the axis. Each of the first coil wirings, each of the first penetration wirings, each of the second coil wirings, and each of the second penetration wirings form at least a part of the spiral shape by being connected in this order, and the first penetration wirings and the second penetration wirings are not parallel to each other when viewed in the axial direction.

[0224] <2 The inductor component according to <1>, in which the first penetration wirings and the second penetration wirings are linearly symmetric with respect to the axis when viewed in a direction orthogonal to the first principal surface.

[0225] <3> The inductor component according to <1> or <2>, in which the first penetration wirings and the second penetration wirings are linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

[0226] <4> The inductor component according to any one of <1> to <3>, in which a line edge roughness of the first penetration wirings is higher than a line edge roughness of the first coil wirings.

[0227] <5> The inductor component according to any one of <1> to <3>, in which a line edge roughness of the first penetration wirings is equal to or lower than a line edge roughness of the first coil wirings.

[0228] <6> The inductor component according to <1>, in which a width of each of the first penetration wirings is different from a width of each of the second penetration wirings.

[0229] <7> The inductor component according to any one of <1> to <6>, in which the first penetration wirings have respective outer circumferential parts positioned on an outer side with respect to the first coil wirings and the second coil wirings in a radial direction of the coil when viewed in the axial direction, and the outer circumferential parts are disposed between 0.3 or more and 0.7 (i.e., from 0.3 to 0.7) or less of a height of the element body with the first principal surface as a reference in the direction orthogonal to the first principal surface.

[0230] <8> The inductor component according to any one of <1> to <7>, further comprising a second coil that is provided in the element body and is wound in a spiral shape along a second axis parallel to the axis; and a third external electrode and a fourth external electrode that are provided on the element body and are electrically connected to the second coil. The second coil includes a plurality of third coil wirings which are provided on the first principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the first principal surface, a plurality of fourth coil wirings which are provided on the second principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the second principal surface, a plurality of third penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings and are arranged along the second axis, and a plurality of fourth penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings, are provided on a side opposite to the respective third penetration wirings with respect to the second axis, and are arranged along the second axis. Each of the third coil wirings, each of the third penetration wirings, each of the fourth coil wirings, and each of the fourth penetration wirings form at least a part of a spiral shape of the second coil by being connected in this order, and the second penetration wirings and the third penetration wirings are adjacent to each other.

[0231] <9> The inductor component according to <8>, in which the first penetration wirings and the second penetration wirings, and the third penetration wirings and the fourth penetration wirings are linearly symmetric with respect to a center line between the coil and the second coil when viewed in the axial direction of the coil.

[0232] <10> The inductor component according to <8> or <9>, in which the second penetration wirings and the third penetration wirings are arranged parallel to each other, when viewed in the axial direction of the coil.

[0233] <11> The inductor component according to <9>, in which the first penetration wirings and the second penetration wirings are not linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

[0234] <12> The inductor component according to <8>, in which the third penetration wirings and the fourth penetration wirings are not parallel to each other when viewed in the second axial direction.

[0235] <13> The inductor component according to any one of <1> to <12>, in which the first penetration wirings have respective first connection surfaces connected to the respective first coil wirings and respective second connection surfaces connected to the respective second coil wirings, and the first external electrode is provided on the first principal surface side, and overlaps at least a part of each of the first connection surfaces when viewed in the direction orthogonal to the first principal surface. Also, when viewed in the axial direction, an inclination angle on the axial side formed by a straight line connecting a center of each of the first connection surfaces and a center of each of the second connection surfaces and a connection surface of each of the second coil wirings connected to each of the first penetration wirings is 60° or larger and smaller than 90° (i.e., from 60° to smaller than) 90°.

[0236] <14> The inductor component according to <13>, in which a part of each of the first connection surfaces and a part of each of the second connection surfaces overlap each other when viewed in the direction orthogonal to the first principal surface.

[0237] <15> The inductor component according to <13> or <14>, in which the center of each of the first connection surfaces is closer to the axis than the center of each of the second connection surfaces is when viewed in the direction orthogonal to the first principal surface.

[0238] <16> The inductor component according to any one of <1> to <15>, in which each of the first penetration wirings includes a conductive layer positioned on an outer circumferential side when viewed in an extending direction of the first penetration wirings, and a non-conductive layer positioned inside the conductive layer.

[0239] <17> The inductor component according to any one of <1> to <16>, in which a cross-sectional area of at least one of both end portions of each of the first penetration wirings in the extending direction is larger than a cross-sectional area of a central portion of each of the first penetration wirings in the extending direction.

[0240] <18> The inductor component according to any one of <1> to <17>, in which the inductor component has a thickness of 200 μm or smaller.

[0241] <19> The inductor component according to any one of <1> to <18>, in which, when viewed in the direction orthogonal to the first principal surface, the first external electrode and the second external electrode are positioned on an inner side with respect to an outer circumferential surface of the element body.

[0242] <20> The inductor component according to any one of <1> to <19>, further including an organic insulating body provided on the first principal surface, in which the element body is an inorganic insulating body, and the organic insulating body is positioned on an inner side with respect to an outer surface of the inorganic insulating body when viewed in the direction orthogonal to the first principal surface.

What is claimed is:

1. An inductor component comprising:

an element body having a first principal surface and a second principal surface opposite to each other;

a coil that is in the element body and is wound in a spiral shape along an axis; and

a first external electrode and a second external electrode that are on the element body and are electrically connected to the coil, wherein

the axis of the coil is parallel to the first principal surface,

the coil includes

a plurality of first coil wirings which are on the first principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the first principal surface,

a plurality of second coil wirings which are on the second principal surface side with respect to the axis and are arranged along the axis on a plane parallel to the second principal surface,

a plurality of first penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings and are arranged along the axis, and

a plurality of second penetration wirings which extend from the respective first coil wirings toward the respective second coil wirings, are on a side opposite to the respective first penetration wirings with respect to the axis, and are arranged along the axis,

each of the first coil wirings, each of the first penetration wirings, each of the second coil wirings, and each of the second penetration wirings configure at least a part of the spiral shape by being connected in this order, and

the first penetration wirings and the second penetration wirings are not parallel to each other when viewed in the axial direction.

2. The inductor component according to claim **1**, wherein

the first penetration wirings and the second penetration wirings are linearly symmetric with respect to the axis when viewed in a direction orthogonal to the first principal surface.

3. The inductor component according to claim **1**, wherein

the first penetration wirings and the second penetration wirings are linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

4. The inductor component according to claim **1**, wherein

a line edge roughness of the first penetration wirings is higher than a line edge roughness of the first coil wirings.

5. The inductor component according to claim **1**, wherein

a line edge roughness of the first penetration wirings is equal to or lower than a line edge roughness of the first coil wirings.

6. The inductor component according to claim **1**, wherein

a width of each of the first penetration wirings is different from a width of each of the second penetration wirings.

7. The inductor component according to claim **1**, wherein

the first penetration wirings have respective outer circumferential parts positioned on an outer side with respect to the first coil wirings and the second coil wirings in a radial direction of the coil when viewed in the axial direction, and

the outer circumferential parts are disposed between from 0.3 to 0.7 of a height of the element body with the first principal surface as a reference in the direction orthogonal to the first principal surface.

8. The inductor component according to claim **1**, further comprising:

a second coil that is in the element body and is wound in a spiral shape along a second axis parallel to the axis; and

a third external electrode and a fourth external electrode that are on the element body and are electrically connected to the second coil, wherein

the second coil includes

a plurality of third coil wirings which are on the first principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the first principal surface,

a plurality of fourth coil wirings which are on the second principal surface side with respect to the second axis and are arranged along the second axis on a plane parallel to the second principal surface, a plurality of third penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings and are arranged along the second axis, and

a plurality of fourth penetration wirings which extend from the respective third coil wirings toward the respective fourth coil wirings, are on a side opposite to the respective third penetration wirings with respect to the second axis, and are arranged along the second axis,

each of the third coil wirings, each of the third penetration wirings, each of the fourth coil wirings, and each of the fourth penetration wirings configure at least a part of a spiral shape of the second coil by being connected in this order, and

the second penetration wirings and the third penetration wirings are adjacent to each other.

9. The inductor component according to claim **8**, wherein

the first penetration wirings and the second penetration wirings, and the third penetration wirings and the fourth penetration wirings are linearly symmetric with respect to a center line between the coil and the second coil when viewed in the axial direction of the coil.

10. The inductor component according to claim **8**, wherein

the second penetration wirings and the third penetration wirings are parallel to each other, when viewed in the axial direction of the coil.

11. The inductor component according to claim **9**, wherein

the first penetration wirings and the second penetration wirings are not linearly symmetric with respect to a straight line orthogonal to the first principal surface and including the axis when viewed in the axial direction.

12. The inductor component according to claim **8**, wherein

the third penetration wirings and the fourth penetration wirings are not parallel to each other when viewed in the second axial direction.

13. The inductor component according to claim **1**, wherein

the first penetration wirings have respective first connection surfaces connected to the respective first coil wirings and respective second connection surfaces connected to the respective second coil wirings,

the first external electrode is on the first principal surface side, and overlaps at least a part of each of the first connection surfaces when viewed in the direction orthogonal to the first principal surface, and

when viewed in the axial direction, an inclination angle on the axial side defined by a straight line connecting a center of each of the first connection surfaces and a center of each of the second connection surfaces and a connection surface of each of the second coil wirings connected to each of the first penetration wirings is from 60° to smaller than 90°.

14. The inductor component according to claim **13**, wherein

a part of each of the first connection surfaces and a part of each of the second connection surfaces overlap each other when viewed in the direction orthogonal to the first principal surface.

15. The inductor component according to claim **13**, wherein

the center of each of the first connection surfaces is closer to the axis than the center of each of the second connection surfaces is when viewed in the direction orthogonal to the first principal surface.

16. The inductor component according to claim **1**, wherein

each of the first penetration wirings includes a conductive layer positioned on an outer circumferential side when viewed in an extending direction of the first penetration wirings, and a non-conductive layer positioned inside the conductive layer.

17. The inductor component according to claim **1**, wherein

a cross-sectional area of at least one of both end portions of each of the first penetration wirings in the extending direction is larger than a cross-sectional area of a central portion of each of the first penetration wirings in the extending direction.

18. The inductor component according to claim **1**, wherein

the inductor component has a thickness of 200 μm or smaller.

19. The inductor component according to claim **1** wherein

when viewed in the direction orthogonal to the first principal surface, the first external electrode and the second external electrode are positioned on an inner side with respect to an outer circumferential surface of the element body.

20. The inductor component according to claim **1**, further comprising:

an organic insulating body on the first principal surface, wherein

the element body is an inorganic insulating body, and the organic insulating body is positioned on an inner side with respect to an outer surface of the inorganic insulating body when viewed in the direction orthogonal to the first principal surface.

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