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(54) **COIL DEVICE**

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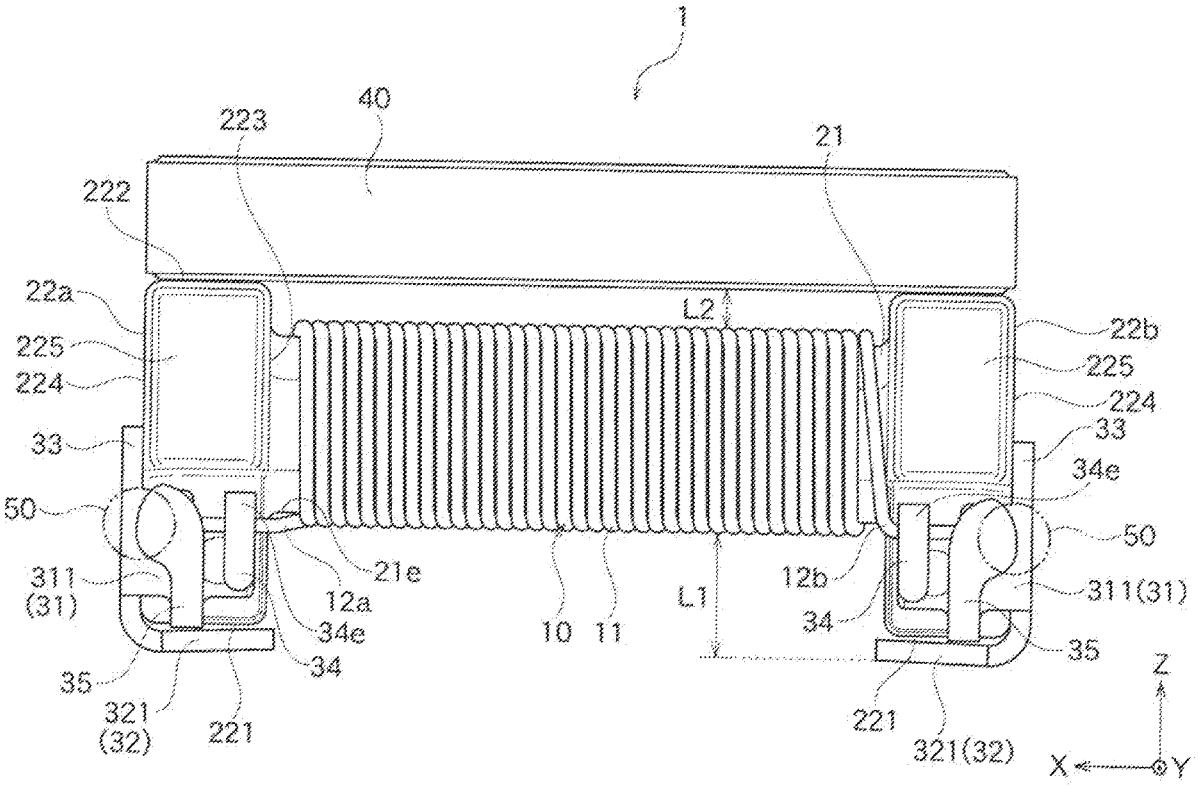
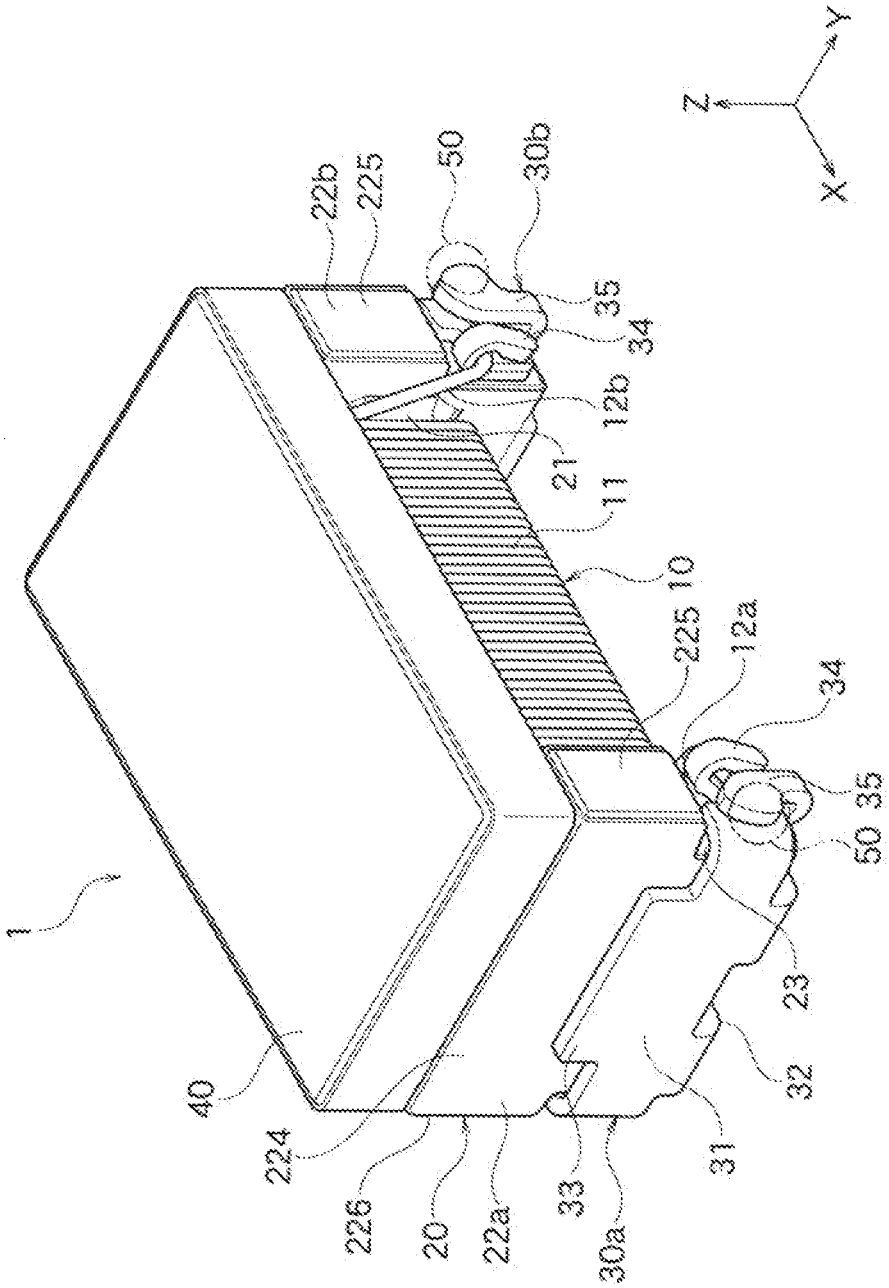
(57) **ABSTRACT**

A coil device includes a coil, a core, and a terminal fitting. The coil includes a winding portion and a lead portion led out from the winding portion. The core includes a winding core portion provided with the winding portion and a flange portion formed at an end in a first direction parallel to an axis of the winding core portion. The terminal fitting is provided with an engagement portion for engaging with the flange portion. The flange portion includes a first side surface located on one side in a second direction parallel to a mounting surface of the flange portion and a second side surface located on the other side in the second direction. The engagement portion is disposed from the first side surface to the second side surface and connected to the lead portion.

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Y
X
22b
225
50
30b
35
34
12b
21
11
10
225
12a
34
35
50
23
32
31
33
30a
22a
20
226
224
40
1

FIG. 1A

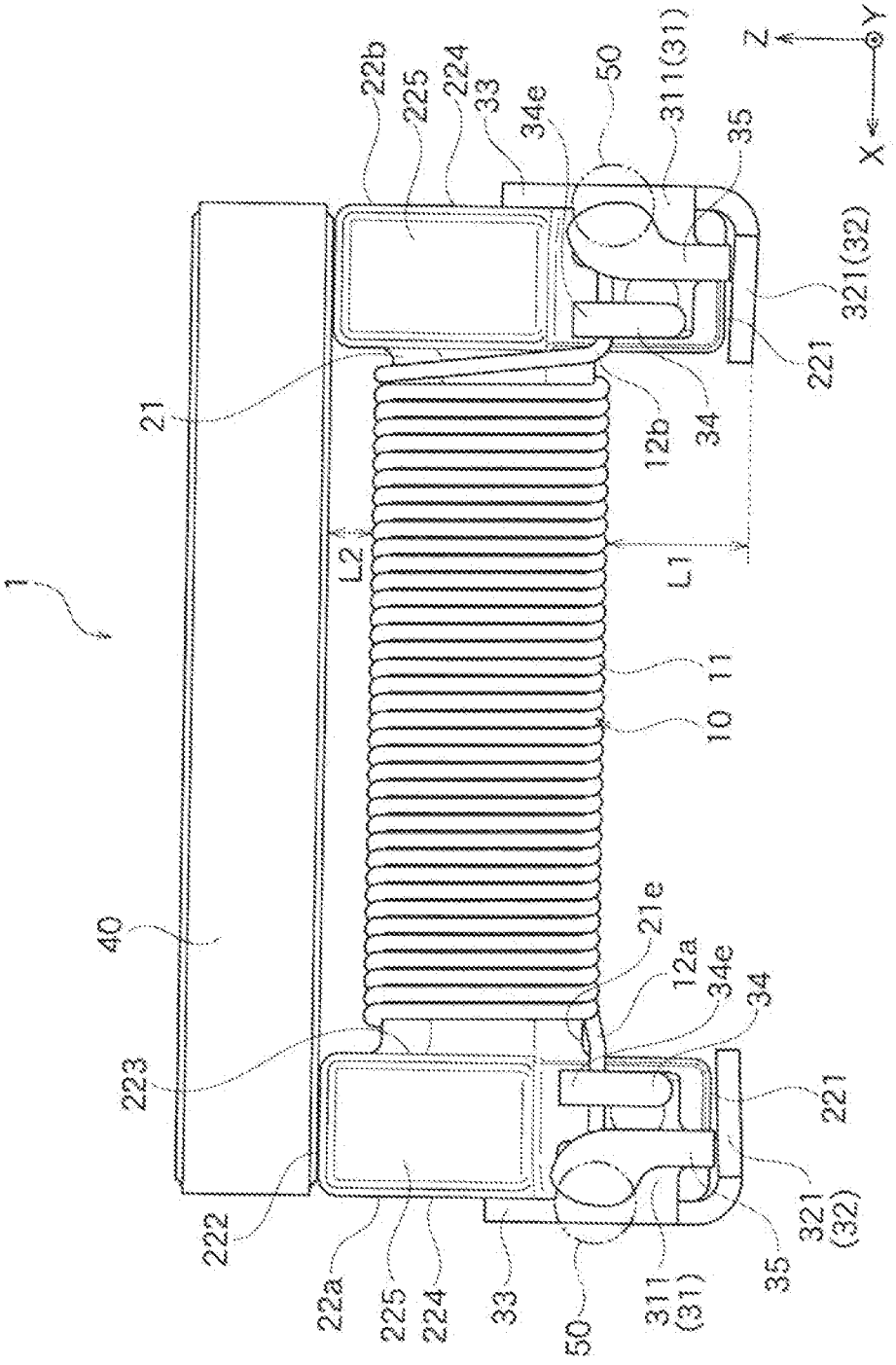

Z
Y
X
1
21
40
223
222
22a
225
224
33
34e
50
311(31)
35
321(32)
221
12b
34
L2
L1
10
11
21e
12a
22b

FIG. 1B

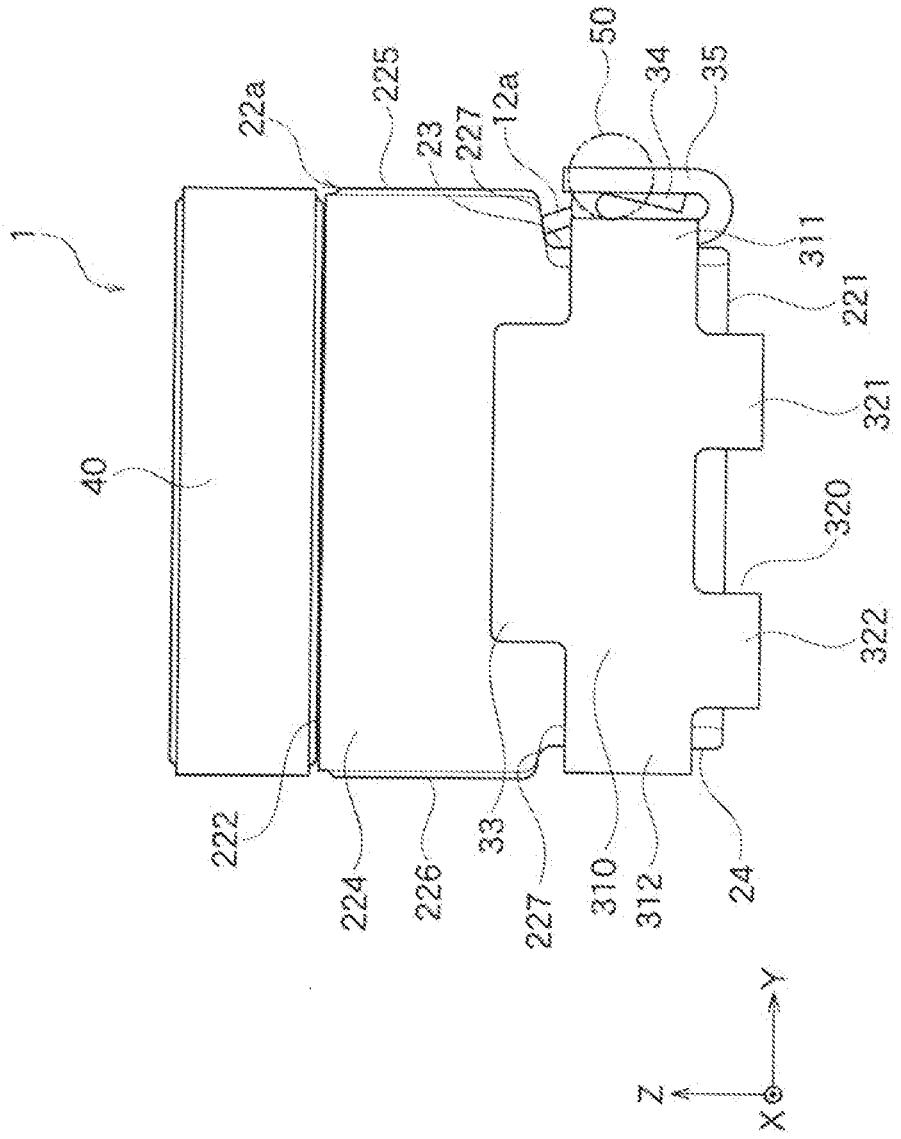

1
40
22a
225
23
227
12a
50
34
35
311
221
321
320
322
222
224
226
33
227
310
312
24
Y
Z
X

FIG. 1C

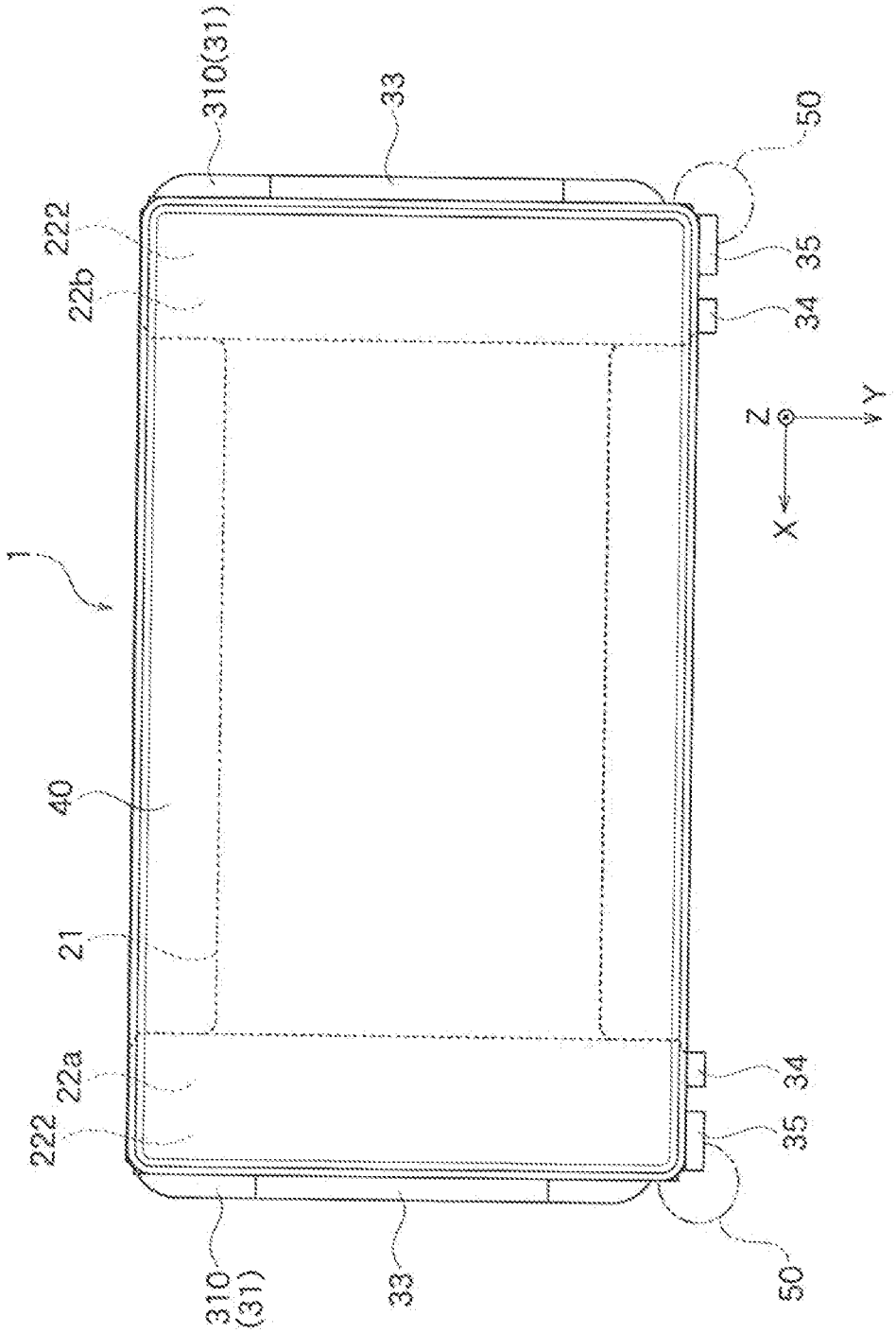


FIG. 1D

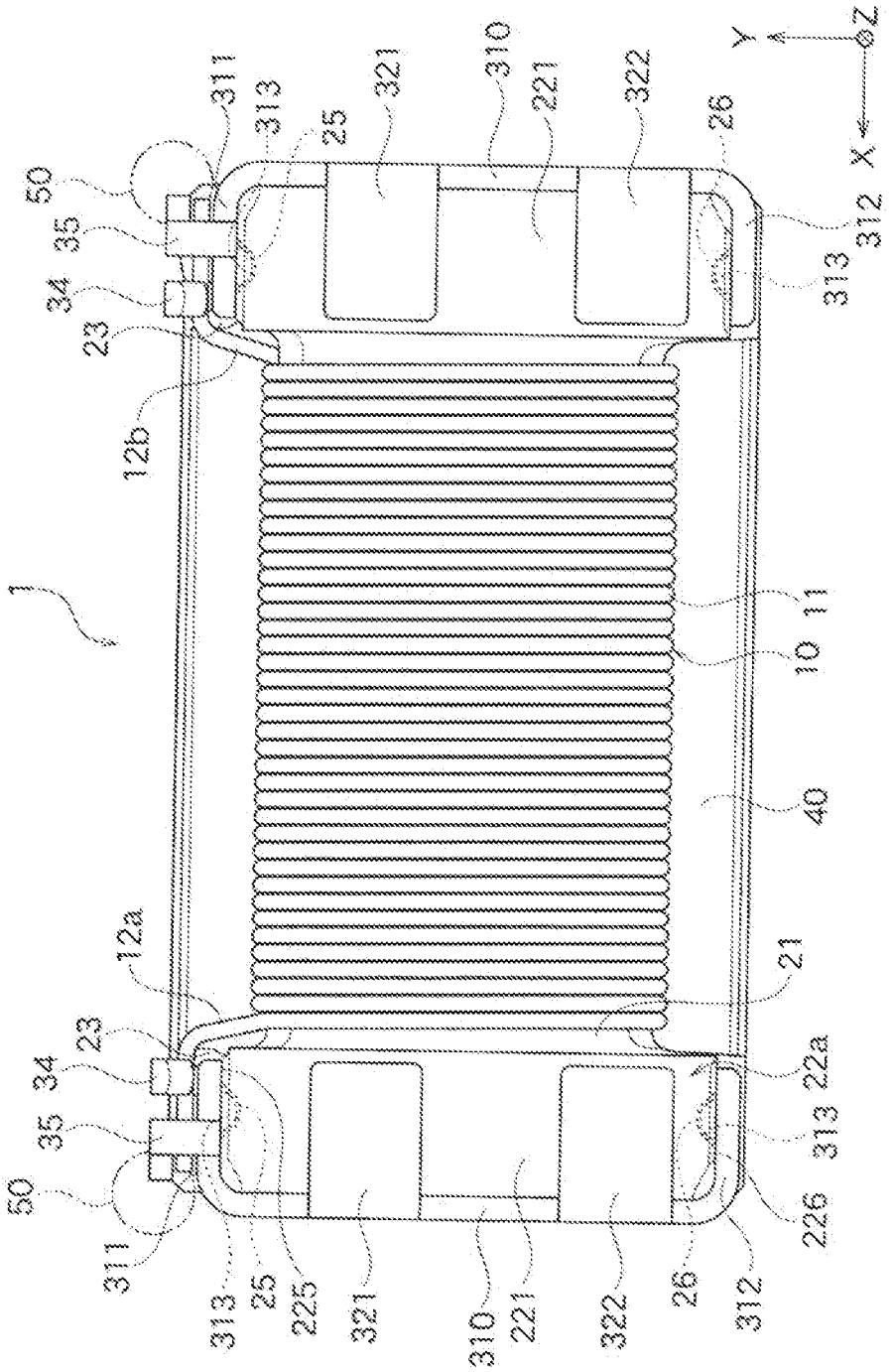

Y
Z
X
311
313
25
321
310
221
322
26
312
50
35
34
23
12b
1
11
10
40
21
12a
22a
225
226

FIG. 1E

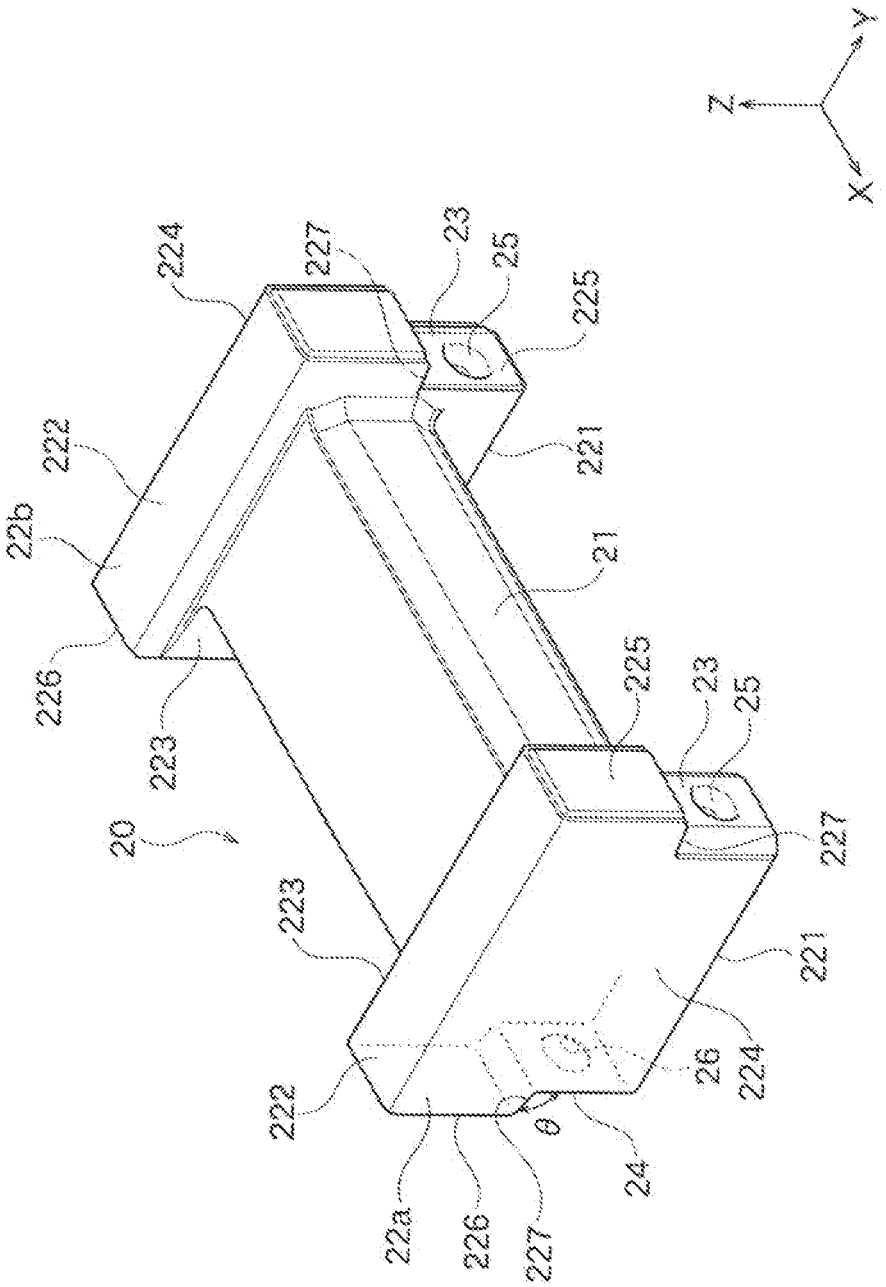
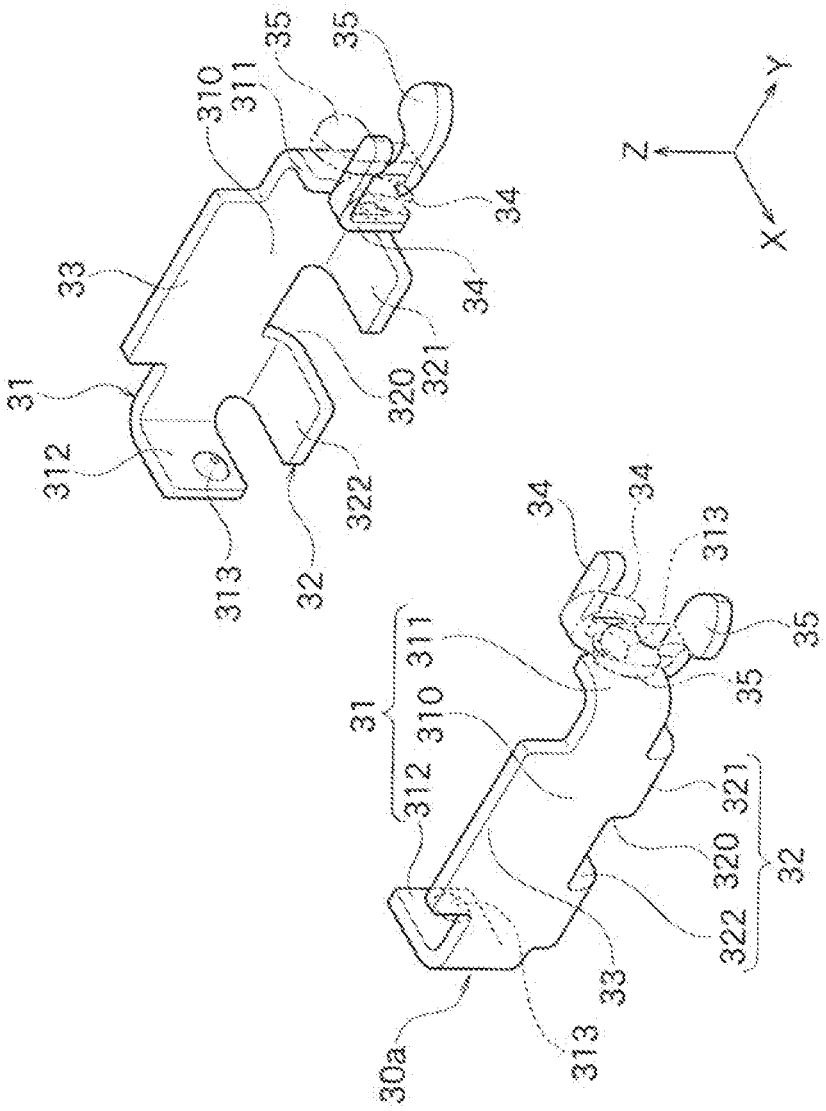

Y
Z
X
224
227
23
25
225
222
221
22b
21
226
223
20
225
23
25
227
223
221
222
26
224
θ
24
22a
226
227

FIG. 2


35
35
310
311
34
33
34
31
321
320
312
322
313
32
Z
Y
X
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34
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35
310
35
312
321
320
32
322
33
30a
313

FIG. 3A

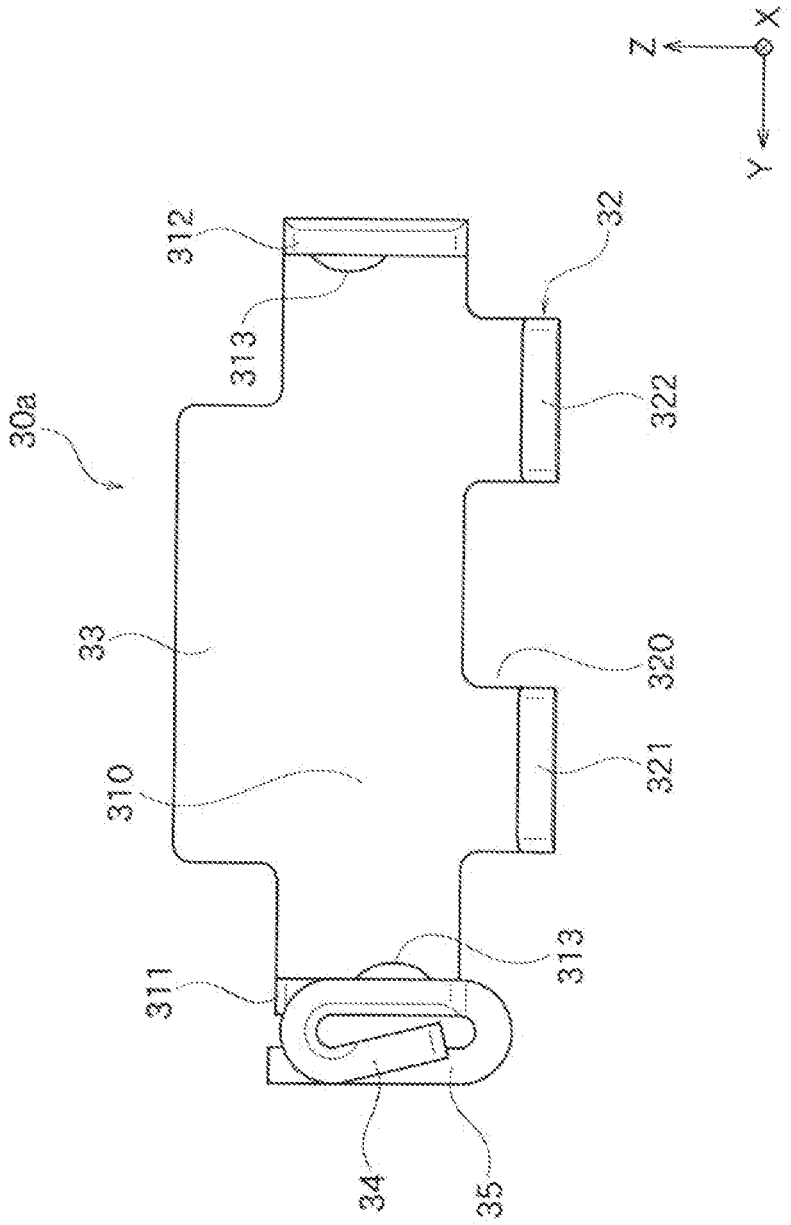

FIG. 3B

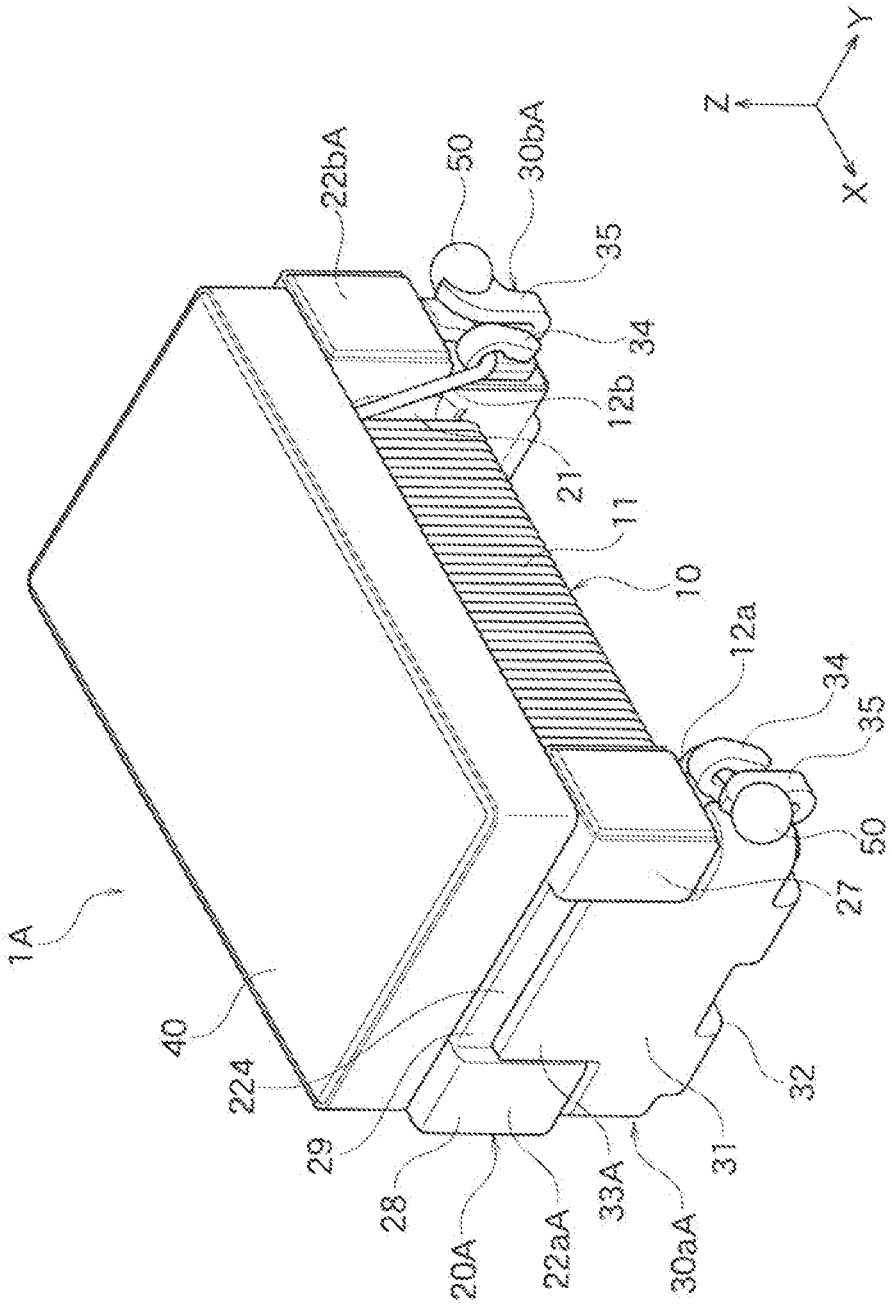
Y
Z
X
22bA
50
30bA
35
34
12b
21
11
10
12a
34
35
50
27
1A
40
224
29
28
20A
22aA
33A
30aA
31
32

FIG. 4

COIL DEVICE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a coil device including a terminal fitting.

[0002] As shown in Patent Document 1, a coil device in which a terminal fitting is provided on a flange portion of a core is conventionally known. In this coil device, the terminal fitting includes an engagement portion for engaging with the flange portion. The engagement portion includes a mounting portion disposed on a lower surface (mounting surface) of the flange portion, a wire connection portion disposed on an upper surface (surface opposite to the mounting surface) of the flange portion, and a main body portion disposed on an outer end surface of the flange portion. The mounting portion is connected to a land pattern of a substrate, the wire connection portion is connected to a lead portion of a coil, and the main body portion is disposed perpendicularly to the substrate.

[0003] In the coil device of Patent Document 1, the fixing strength between the terminal fitting and the flange portion can be increased by engaging the engagement portion with the flange portion. Also, since the lead portion of the coil can be connected to the engagement portion, there is no need to provide the terminal fitting with a wire connection portion separately from the engagement portion, and the terminal fitting and further the coil device can be downsized.

[0004] By the way, in the coil device of Patent Document 1, when the terminal fitting is attached to the flange portion, the engagement portion may rotate (pivot) around the axis of the main body portion and be fixed to the flange portion in a direction different from a desired direction. In this case, when the coil device is mounted on the substrate, it may be difficult to dispose the mounting portion at a desired position on the land pattern of the substrate.

[0005] Patent Document 1: JP2005056934 (A)

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention has been achieved under such circumstances. It is an object of the invention to provide a coil device having a small size and a high attachment stability of a terminal fitting to a flange portion.

[0007] To achieve the above object, a coil device according to the present invention comprises:

[0008] a coil including:

[0009] a winding portion; and

[0010] a lead portion led out from the winding portion;

[0011] a core including:

[0012] a winding core portion provided with the winding portion; and

[0013] a flange portion formed at an end in a first direction parallel to an axis of the winding core portion; and

[0014] a terminal fitting provided with an engagement portion for engaging with the flange portion,

[0015] wherein

[0016] the flange portion includes:

[0017] a first side surface located on one side in a second direction parallel to a mounting surface of the flange portion; and

[0018] a second side surface located on the other side in the second direction, and

[0019] the engagement portion is disposed from the first side surface to the second side surface and connected to the lead portion.

[0020] In the coil device according to the present invention, the engagement portion is disposed from the first side surface to the second side surface of the flange portion.

[0021] Thus, a portion of the engagement portion disposed on the first side surface and a portion of the engagement portion disposed on the second side surface function as stoppers (rotation stoppers), and the engagement portion is less likely to rotate (pivot) within a plane parallel to the mounting surface. Thus, when the terminal fitting is attached to the flange portion, the engagement portion can be fixed to the flange portion in a desired direction, and it is possible to enhance the attachment stability of the terminal fitting to the flange portion. Also, since the lead portion is connected to the engagement portion, there is no need to provide the terminal fitting with a wire connection portion separately from the engagement portion, and the terminal fitting and further the coil device can be downsized.

[0022] The engagement portion may include a first side portion opposing to the first side surface, and the lead portion may be connected to an outer surface of the first side portion facing outward in the second direction. In this case, the lead portion can be led out over a short distance. Thus, the length of the lead portion can be reduced, and the DC resistance and the stray capacitance of the lead portion can be reduced. Moreover, the disconnection of the lead portion can be prevented.

[0023] The engagement portion may include a first side portion opposing to the first side surface, the first side surface may be provided with a first notch portion, and the first side portion may be disposed in the first notch portion. In this case, the first side portion is less likely to be exposed more outward than one end of the flange portion in the second direction. Thus, the size of the coil device in the second direction can be reduced, and the coil device can be downsized.

[0024] The engagement portion may include a second side portion opposing to the second side surface, the second side surface may be provided with a second notch portion, and the second side portion may be disposed in the second notch portion. In this case, the second side portion is less likely to be exposed more outward than the other end of the flange portion in the second direction. Thus, the size of the coil device in the second direction can be reduced, and the coil device can be further downsized.

[0025] The first notch portion may be located on one side of the first side surface, which is a side close to the mounting surface, and the second notch portion may be located on one side of the second side surface, which is a side close to the mounting surface. In this case, the main portions of the terminal fitting, such as the first side portion disposed in the first notch portion and the second side portion disposed in the second notch portion, can be arranged closer to the mounting surface, and the terminal fitting can be downsized.

[0026] A depth of the first notch portion from the first side surface along the second direction may be larger than a depth of the second notch portion from the second side surface along the second direction. For example, when the lead portion is connected to the first side portion, with the above-mentioned configuration, the first side portion and the lead portion connected thereto are less likely to be exposed more outward than one end of the flange portion in the

second direction. Thus, the size of the coil device in the second direction can be reduced, and the coil device can be downsized.

[0027] The engagement portion may be engaged with the flange portion at a position closer to the mounting surface than to a mounting opposite surface opposite to the mounting surface of the flange portion. In this case, the main portions of the terminal fitting, such as the engagement portion, can be arranged closer to the mounting surface, and the terminal fitting can be downsized.

[0028] The lead portion may be connected to an outer surface of the first side portion facing outward in the second direction by a conductive connection portion, and at least a part of the conductive connection portion may be disposed in the first notch portion. In this case, the conductive connection portion is less likely to be exposed more outward than one end of the flange portion in the second direction. Thus, the size of the coil device in the second direction can be reduced, and the coil device can be further downsized. Note that, the whole of the conductive connection portion may be disposed in the first notch portion. In this case, it is possible to prevent dimensional variations of the coil device in the second direction due to variations in the shape of the conductive connection portion.

[0029] At least a part of the conductive connection portion may be hidden by the flange portion when the flange is viewed from the opposite side to the mounting surface along a third direction perpendicular to the mounting surface. In this case, at least a part of the conductive connection portion can be prevented from being exposed more outward than an outer edge of the flange portion. Thus, the size of the coil device can be reduced, and the coil device can be downsized.

[0030] The engagement portion may include a first side portion opposing to the first side surface, and a protrusion protruding toward the first side surface may be formed on an inner surface of the first side surface facing inward in the second direction. In this case, the protrusion functions as a stopper (rotation stopper), and the engagement portion is thus less likely to rotate (pivot) within a plane parallel to the mounting surface.

[0031] The first side surface may be provided with a concave portion for engaging with the protrusion. When the protrusion is engaged with the concave portion, the engagement portion is further less likely to rotate (pivot) within a plane parallel to the mounting surface.

[0032] The terminal fitting may include a mounting portion for being disposed on the mounting surface, the mounting portion may include a first section and a second section, and the first section and the second section may be separated with a gap in the second direction. In this case, the area of the mounting portion can be reduced depending on the size of the gap. This makes it possible to reduce the area of a land pattern of a substrate connected to the mounting portion and to reduce the stray capacitance of the land pattern.

[0033] The terminal fitting may include a mounting portion for being disposed on the mounting surface, and the mounting portion may be offset from a center of the mounting surface in the second direction to the other side in the second direction. For example, when the lead portion is connected to one side (the above-mentioned first side portion) of the engagement portion in the second direction, with the above-mentioned configuration, solder or the like connecting the mounting portion and the substrate is less likely to attach to the lead portion, and the disconnection of the lead portion can be prevented.

[0034] The engagement portion may include: a first side portion opposing to the first side surface; and a caulking piece for caulking the lead portion led to the first side portion, an end of the caulking piece may be connected to the first side portion, and a position of the end of the caulking piece may be equal to a position of the end of the winding core portion located closer to the mounting surface of the flange portion with respect to a third direction perpendicular to the mounting surface. In this case, for example the lead portion can be led out straight from the end of the winding core portion toward the end of the caulking piece. Also, the lead portion can be caulked with the end of the caulking piece (the root of the caulking piece), and it is possible to prevent positional displacement of the lead portion.

[0035] The engagement portion may include a main body portion and an extended portion arranged on an outer end surface of the flange portion, the main body portion may be located between the first side portion and the second side portion, and the extended portion may extend from the main body portion toward the opposite side to the mounting surface along a third direction perpendicular to the mounting surface. In this case, the contact area between the outer end surface of the flange portion and the engagement portion can be increased by the extended portion, and it is thus possible to increase the fixing strength between the terminal fitting and the flange portion.

[0036] The flange portion may include a first convex portion and a second convex portion protruding outward in the first direction from the outer end surface of the flange portion, the first convex portion may be disposed on one side of the flange portion in the second direction, the second convex portion may be disposed on the other side of the flange portion in the second direction, and the extended portion may be disposed between the first convex portion and the second convex portion. In this case, the position of the extended portion is limited to between the first convex portion and the second convex portion in the second direction. Thus, it is possible to prevent positional displacement of the engagement portion to one side or the other side in the second direction.

[0037] The coil device according to the present invention may further comprise a plate core for being attached to a mounting opposite surface opposite to the mounting surface of the flange portion. The inductance characteristics of the coil device can be improved by attaching the plate core to the flange portion. Also, in the present embodiment, the engagement portion is not engaged with the mounting surface or the mounting opposite surface, but is engaged with the first side surface and the second side surface. Thus, unlike Patent Document 1, it is not necessary to cut the mounting opposite surface or the plate core for the purpose of preventing interference between the engagement portion (or the lead portion, etc. connected to the engagement portion) and the plate core. Thus, it is possible to secure the area of the bonding surface between the mounting opposite surface and the plate core, and in this respect as well, the inductance characteristics of the coil device can be improved. Moreover, it is possible to secure the bonding strength between the mounting opposite surface and the plate core.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0038] FIG. **1**A is a perspective view of a coil device according to First Embodiment;

[0039] FIG. **1**B is a side view of the coil device shown in FIG. **1**A viewed from the Y-axis direction;

[0040] FIG. **1**C is a side view of the coil device shown in FIG. **1**A viewed from the X-axis direction;

[0041] FIG. **1**D is a plane view of the coil device shown in FIG. **1**A;

[0042] FIG. **1**E is a bottom view of the coil device shown in FIG. **1**A;

[0043] FIG. **2** is a perspective view of a core shown in FIG. **1**A;

[0044] FIG. **3**A is a perspective view of a terminal shown in FIG. **1**A;

[0045] FIG. **3**B is a side view of a modified example of the terminal shown in FIG. **3**A viewed from the X-axis direction; and

[0046] FIG. **4** is a perspective view of a coil device according to Second Embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0047] Hereinafter, embodiments of the present invention are described with reference to the figures. Note that, the illustrated contents are merely schematically and exemplarily illustrated for understanding the present invention, and the appearance, dimensional ratio, etc. may be different from the actual one. Moreover, the present invention is not limited to the following embodiments.

First Embodiment

[0048] A coil device **1** shown in FIG. **1**A functions, for example, as an inductor and is installed in electric sources, etc. of various electrical devices. The coil device **1** includes a coil **10**, a core **20**, and terminal fittings **30***a* and **30***b*. In addition to these members, the coil device **1** may include a plate core **40**.

[0049] The coil **10** includes a winding portion **11** formed by a wire wound in a coil shape and lead portions **12***a* and **12***b* led out from the winding portion **11**. The wire may be an insulated wire, such as a copper wire coated with an insulating film. The diameter of the wire is not limited and is, for example, 10 to 300 μm. The coating may be removed from the ends of the lead portions **12***a* and **12***b*.

[0050] As shown in FIG. **2**, the core **20** is a drum core and includes a winding core portion **21** and flange portions **22***a* and **22***b*. The material of the core **20** is a magnetic material such as metal and ferrite, but is not limited. In FIG. **2**, etc., the X-axis is an axis parallel to the axis of the winding core portion **21**. The Y-axis is an axis perpendicular to the axis of the winding core portion **21** when the core **20** is viewed in plan. The Z-axis is an axis perpendicular to the X-axis and the Y-axis. Hereinafter, regarding each of the X-axis, Y-axis, and Z-axis, the side toward the center of the core **20** is referred to as the "inner side", and the side away from the center of the core **20** is referred to as the "outer side". The size of the core **20** is not limited. For example, the length of the core **20** in the X-axis direction is 1 to 6 mm, the length of the core **20** in the Y-axis direction is 0.5 to 4 mm, and the length of the core **20** in the Z-axis direction is 0.5 to 3 mm.

[0051] Note that, in the present embodiment, the wording of "parallel" is not limited to cases where multiple objects are strictly parallel and also includes cases where multiple objects are substantially parallel (e.g., cases where there are errors within **±5** degrees between the multiple objects). Also, the wording of "perpendicular" or "orthogonal" is not limited to cases where multiple objects are strictly perpendicular and also includes cases where multiple objects are substantially perpendicular (e.g., cases where there are errors within ±5 degrees between the multiple objects).

[0052] As shown in FIG. **1**B, the winding core portion **21** may be offset from the center of the inner end surface of the flange portion **22***a* (or the flange portion **22***b*) in the Z-axis direction to the positive side in the Z-axis (the side where the plate core **40** is located). Here, L**2**<L**1** is satisfied, where L**1** is a distance between the winding core portion **21** (or the winding portion **11** wound around the winding core portion **21**) and the bottom surface of the mounting portion **32** of the terminal fitting **30***b*, and L**2** is a distance between the winding core portion **21** (or the winding portion **11** wound around the winding core portion **21**) and the bottom surface of the plate core **40**. Note that, the winding core portion **21** may be connected to the center of the inner end surface of the flange portion **22***a* (or the flange portion **22***b*) in the Z-axis direction.

[0053] The winding portion **11** is provided around the winding core portion **21**. The cross-sectional shape of the winding core portion **21** perpendicular to its axial direction is octagonal, but may be another polygonal shape (e.g., quadrangular or hexagonal), circular, or elliptical. The flange portion **22***a* is formed at one end of the winding core portion **21** in its axial direction, and the flange portion **22***b* is formed at the other end of the winding core portion **21** in its axial direction. The flange portion **22***a* and the flange portion **22***b* have a symmetrical shape (same shape). Hereinafter, for the purpose of preventing duplicate description, common matters between the flange portions **22***a* and **22***b* may be described only for the flange portion **22***a*.

[0054] As shown in FIG. **2**, the flange portion **22***a* includes a mounting surface **221**, a mounting opposite surface **222**, an inner end surface **223**, an outer end surface **224**, a first side surface **225**, and a second side surface **226**. Likewise, the flange portion **22***b* includes a mounting surface **221**, a mounting opposite surface **222**, an inner end surface **223**, an outer end surface **224**, a first side surface **225**, and a second side surface **226**.

[0055] The mounting surface **221** is located on one side of the flange portion **22***a* in the Z-axis direction, and the mounting opposite surface **222** is located on the other side of the flange portion **22***a* in the Z-axis direction. The mounting surface **221** and the mounting opposite surface **222** oppose to each other in the Z-axis direction. The mounting surface **221** is a surface opposing to a substrate (not shown) on which the coil device **1** is mounted. The mounting surface **221** and the mounting opposite surface **222** are, for example, flat surfaces parallel to the XY plane.

[0056] The inner end surface **223** is located on one side of the flange portion **22***a* in the X-axis direction, and the outer end surface **224** is located on the other side of the flange portion **22***a* in the X-axis direction. The inner end surface **223** and the outer end surface **224** oppose to each other in the X-axis direction. The inner end surface **223** is a surface for connecting to the tube portion **21**. The first side surface **225** is located on one side of the flange portion **22***a* in the Y-axis direction, and the second side surface **226** is located on the other side of the flange portion **22***a* in the Y-axis direction.

The first side surface **225** and the second side surface **226** oppose to each other in the Y-axis direction.

[0057] A first notch portion **23** may be formed on the first side surface **225**, and a second notch portion **24** may be formed on the second side surface **226**. The first notch portion **23** is a notch recessed inward in the Y-axis direction from the first side surface **225**. The second notch portion **24** is a notch recessed inward in the Y-axis direction from the second side surface **226**. The first notch portion **23** and the second notch portion **24** oppose to each other in the Y-axis direction.

[0058] In the present embodiment, the first notch portion **23** is located on one side of the first side surface **225** in the Z-axis direction, which is a side close to the mounting surface **221** (the negative side of the first side surface **225** in the Z-axis direction). More specifically, the first notch portion **23** is formed as a whole closer to the mounting surface **221** than the center of the first side surface **225** in the Z-axis direction.

[0059] However, the shape of the first notch portion **23** is not limited to the shape shown in FIG. **2**. For example, a part of the first notch portion **23** may be located closer to the mounting opposite surface **222** than the center of the first side surface **225** in the Z-axis direction. The length of the first notch portion **23** in the Z-axis direction is not limited and is ½ or less of the length of the flange portion **22***a* in the Z-axis direction.

[0060] The second notch portion **24** is located on one side of the second side surface **226** in the Z-axis direction, which is a side close to the mounting surface **221** (on the negative side of the second side surface **226** in the Z-axis direction). More specifically, the second notch portion **24** is formed as a whole closer to the mounting surface **221** than the center of the second side surface **226** in the Z-axis direction. However, the shape of the second notch portion **24** is not limited to the shape shown in FIG. **2**. For example, a part of the second notch portion **24** may be located closer to the mounting opposite surface **222** than the center of the second side surface **226** in the Z-axis direction. The length of the second notch portion **24** in the Z-axis direction is not limited and is ½ or less of the length of the flange portion **22***a* in the Z-axis direction.

[0061] The depth of the first notch portion **23** from the first side surface **225** in the Y-axis direction is larger than the depth of the second notch portion **24** from the second side surface **226** in the Y-axis direction. The depth of the first notch portion **23** from the first side surface **225** in the Y-axis direction is, for example, larger than one time the depth of the second notch portion **24** from the second side surface **226** in the Y-axis direction and may be 1.5 times or more or 2 times or more the depth of the second notch portion **24** from the second side surface **226** in the Y-axis direction. However, these depths may be equal to each other. Alternatively, the latter depth may be larger than the former depth.

[0062] The first side surface **225** may be provided with a step forming surface **227**, and the first side surface **225** may be formed in a step shape. A part of the terminal fitting **30***a* is disposed closer to the mounting surface **221** than the step forming surface **227** on the first side surface **225** (see FIG. **1**A). The second side surface **226** may be provided with a step forming surface **227**, and the second side surface **226** may be formed in a step shape. A part of the terminal fitting **30***a* is disposed closer to the mounting surface **221** than the step forming surface **227** on the second side surface **226** (see FIG. **1**A). The angle θ formed by the step forming surface **227** and the second side surface **226** (the same applies to the first side surface **225**) is not limited, but is $90° \leq \theta \leq 120°$.

[0063] The first side surface **225** may be provided with a first concave portion **25**. The first concave portion **25** is formed at the position of the first notch portion **23** on the first side surface **225** and is located closer to the mounting surface **221** than the step forming surface **227**. The second side surface **226** may be provided with a second concave portion **26**. The second concave portion **26** is formed at the position of the second notch portion **24** on the second side surface **226** and is located closer to the mounting surface **221** than the step forming surface **227**. Although details are described below, protrusions formed on the terminal fitting **30***a* engage with the first concave portion **25** and the second concave portion **26**.

[0064] As shown in FIG. **3**A, each of the terminal fittings **30***a* and **30***b* includes an engagement portion **31**. In addition to the engagement portion **31**, each of the terminal fittings **30***a* and **30***b* may include a mounting portion **32**, an extended portion **33**, a first caulking portion (first caulking piece) **34**, and a second caulking portion (second caulking piece) **35**. As shown in FIG. **1**A, the terminal fitting **30***a* is attached to the flange portion **22***a*, and the terminal fitting **30***b* is attached to the flange portion **22***b*. The terminal fitting **30***a* and the terminal fitting **30***b* are arranged opposite to each other along the X-axis. As shown in FIG. **3**A, the terminal fitting **30***a* and the terminal fitting **30***b* have mirror-symmetrical shapes with respect to the YZ plane, for example, when they are arranged opposite to each other along the X-axis. However, the terminal fitting **30***a* and the terminal fitting **30***b* may have the same shape. Note that, in the present embodiment, the wording of "same" or "equal" is not limited to cases where multiple objects are strictly the same and also includes cases where multiple objects are substantially the same (e.g., cases where there are errors within ±5% or ±10% between physical quantities of the multiple objects).

[0065] The terminal fittings **30***a* and **30***b* may be made of a conductor such as metal. A plating film of Sn, Ni, etc. may be formed on the surfaces of the terminal fittings **30***a* and **30***b*. The thickness of each of the terminal fittings **30***a* and **30***b* is not limited, but is 50 to 300 μm.

[0066] Each constituent of the engagement portion **31**, the mounting portion **32**, the extended portion **33**, the first caulking portion **34**, and the second caulking portion **35** of the terminal fitting **30***a* is the same as each constituent of the engagement portion **31**, the mounting portion **32**, the extended portion **33**, the first caulking portion **34**, and the second caulking portion **35** of the terminal fitting **30***b*, but may be different from each constituent of the engagement portion **31**, the mounting portion **32**, the extended portion **33**, the first caulking portion **34**, and the second caulking portion **35** of the terminal fitting **30***b*. Hereinafter, each constituent mentioned above is described for the terminal fitting **30***a*. If necessary, however, each constituent mentioned above is also described for the terminal fitting **30***b*.

[0067] The engagement portion **31** is a portion for engaging with the flange portion **22***a* and has a C shape. As shown in FIG. **1**C, the engagement portion **31** is disposed from the first side surface **225** to the second side surface **226**. For more detail, the engagement portion **31** is disposed so as to cross over the outer end surface **224**, the first side surface

225, and the second side surface 226. The engagement portion 31 engages with the flange portion 22*a* so as to sandwich the first side surface 225 and the second side surface 226. That is, the engagement portion 31 is a so-called horizontal engagement type engagement portion and is different from a so-called vertical engagement type engagement portion (see Patent Document 1). The engagement portion 31 may be joined to the outer end surface 224 with, for example, an adhesive. As shown in FIG. 1A, the engagement portion 31 of the terminal fitting 30*a* is connected to the lead portion 12*a* of the coil 10, and the engagement portion 31 of the terminal fitting 30*b* is connected to the lead portion 12*b* of the coil 10.

[0068] As shown in FIG. 1B, the engagement portion 31 is engaged with the flange portion 22*a* on the side closer to the mounting surface 221 than the mounting opposite surface 222. Thus, the main portions of the terminal fitting 30*a*, such as the engagement portion 31 and the mounting portion 32, can be arranged on the mounting surface 221 side, and the terminal fitting 30*a* can be downsized. In the present embodiment, the engagement portion 31 is disposed closer to the mounting surface 221 than the center of the flange portion 22*a* in the Z-axis direction and is not disposed closer to the mounting opposite surface 222 than the center of the flange portion 22*a* in the Z-axis direction.

[0069] As shown in FIG. 3A, the engagement portion 31 includes a main body portion 310, a first side portion 311, and a second side portion 312. As shown in FIG. 1C, the main body portion 310 is a portion disposed opposite to the outer end surface 224 of the flange portion 22*a*. The main body portion 310 is located between the first side portion 311 and the second side portion 312. The main body portion 310 extends along the Y-axis and connects the first side portion 311 and the second side portion 312 along the Y-axis. The axis of the main body portion 310 (the axis connecting the first side portion 311 and the second side portion 312) is disposed in parallel to the mounting surface 221 or a mounting substrate (not shown). The main body portion 310 is disposed closer to the mounting surface 221 than to the mounting opposite surface 222. More specifically, the main body portion 310 is disposed as a whole closer to the mounting surface 221 than the center of the outer end surface 224 in the Z-axis direction.

[0070] As shown in FIG. 1B and FIG. 1E, the first side portion 311 is a portion disposed opposite to the first side surface 225 of the flange portion 22*a*. The first side portion 311 may be in contact with the first side surface 225, or a gap may be formed between the first side portion 311 and the first side surface 225. The first side portion 311 is formed at one end of the main body portion 310 in the Y-axis direction. The first side portion 311 extends (bends) in a direction perpendicular to the main body portion 310. The length of the first side portion 311 in the X-axis direction may be equal to the length of the first side surface 225 in the X-axis direction.

[0071] As shown in FIG. 1C, the first side portion 311 is disposed in the first notch portion 23. Thus, the first side portion 311 is not exposed more outward (the positive side in the Y-axis direction) than the one end of the flange portion 22*a* in the Y-axis direction, but is disposed more inward than the first side surface 225 in the Y-axis direction (however, a portion of the first side surface 225 located closer to the mounting opposite surface 222 than the step forming surface 227). Thus, in the present embodiment, the size of the coil device 1 in the Y-axis direction can be reduced, and the coil device 1 can be downsized.

[0072] The first side portion 311 is disposed closer to the mounting surface 221 than the mounting opposite surface 222. More specifically, the first side portion 311 is disposed as a whole closer to the mounting surface 221 than the center of the first side surface 225 in the Z-axis direction.

[0073] As shown in FIG. 3A, the first side portion 311 is provided with the first caulking portion 34 and the second caulking portion 35. As shown in FIG. 1B, the first portion 34 and the second caulking portion 35 of the terminal fitting 30*a* caulk the lead portion 12*a* led out to the first side portion 311 of the flange portion 22*a*. The first caulking portion 34 and the second caulking portion 35 of the terminal fitting 30*b* caulk the lead portion 12*b* led out to the first side portion 311 of the flange portion 22*b*. The end of the first caulking portion 34 is connected to the end of the first side portion 311 on the positive side in the Z-axis direction, and the end of the second caulking portion 35 is connected to the end of the first side portion 311 on the negative side in the Z-axis direction. That is, each end of the first caulking portion 34 and the second caulking portion 35 is located on the opposite side of the first side portion 311 in the Z-axis direction.

[0074] The first caulking portion 34 and the second caulking portion 35 are arranged so as to be positionally displaced in the X-axis direction. The first caulking portion 34 is disposed closer to the inner end surface 223 than the outer end surface 224. Meanwhile, the second caulking portion 35 is disposed closer to the outer end surface 224 than the inner end surface 223. Thus, different positions of the lead portion 12*a* can be caulked with the first caulking portion 34 and the second caulking portion 35.

[0075] As shown in FIG. 3A, the first caulking portion 34 is formed bendably and can bend from the state shown by the solid line (the state where the lead portion 12*a* is not caulked) to the state shown by the two-dot chain line (the state where the lead portion 12*a* is caulked). Likewise, the second caulking portion 35 is formed bendably and can bend from the state shown by the solid line (the state where the lead portion 12*a* is not caulked) to the state shown by the two-dot chain line (the state where the lead portion 12*a* is caulked).

[0076] As shown in FIG. 1B, the first caulking portion 34 is provided on the first side portion 311 so as to temporarily fix the lead portion 12*a*. The second caulking portion 35 is provided on the first side portion 311 so as to permanently fix the lead portion 12*a*.

[0077] The lead portion 12*a* is disposed on the outer surface of the first side portion 311 facing outward in the Y-axis direction and is caulked with the first caulking portion 34 and the second caulking portion 35. In this state, the lead portion 12*a* is integrated with the second caulking portion 35 by laser welding.

[0078] The connection portion between the lead portion 12*a* and the second caulking portion 35 may be provided with a welded portion (welded ball) 50. The lead portion 12*a* is connected to the outer surface of the first side portion 311 by the welded portion 50. The welded portion 50 is a conductive connection portion having conductivity and connecting the lead portion 12*a* and the second caulking portion 35. The lead portion 12*a* may be connected to the second caulking portion 35 using other conductive connection portions, such as solder and conductive adhesive. The welded

portion **50** is formed so as to cover a part of the second caulking portion **35** (particularly, the tip of the second caulking portion **35**), but may be formed so as to cover the whole of the second caulking portion **35**. Note that, the welded portion **50** is not formed at the connection portion between the lead portion **12***a* and the first caulking portion **34**.

[0079] As in the present embodiment, when the lead portion **12***a* is connected to the outer surface of the first side portion **311**, the lead portion **12***a* can be led out from the winding core portion **21** over a short distance, compared to when the lead portion **12***a* is connected to a portion other than the first side portion **311** (e.g., the mounting portion **32**). Thus, the length of the lead portion **12***a* can be reduced, and the DC resistance and the stray capacitance of the lead portion **12***a* can be reduced. Moreover, solder or the like attached to the mounting portion **32** is less likely to be in contact with the lead portion **12***a,* and the disconnection of the lead portion **12***a* can be prevented.

[0080] Mainly from the viewpoint of having a space for forming the welded portion **50**, the second caulking portion **35** may be formed wider in the X-axis direction than the first caulking portion **34**, particularly at the tip. Moreover, the second caulking portion **35** may be formed longer than the first caulking portion **34** in the Z-axis direction. Note that, at least one of the first caulking portion **34** and the second caulking portion **35** is not essential and may be omitted. In this case, the lead portion **12***a* may be connected to the outer surface of the first side portion **311** by, for example, laser welding, solder, conductive adhesive, thermocompression bonding, ultrasonic bonding, resistance brazing, or ultraviolet curing resin bonding.

[0081] As shown in FIG. **1**E, the lead portion **12***a* disposed on the outer surface of the first side portion **311** of the flange portion **22***a* is disposed in the first notch portion **23** of the flange portion **22***a*. Also, the lead portion **12***b* disposed on the outer surface of the first side portion **311** of the flange portion **22***b* is disposed in the first notch portion **23** of the flange portion **22***b*. In this case, the lead portions **12***a* and **12***b* are less likely to be exposed more outward (the positive side in the Y-axis direction) than one ends of the flange portions **22***a* and **22***b* in the Y-axis direction. Thus, the size of the coil device **1** in the Y-axis direction can be reduced, and the coil device **1** can be downsized. However, at least a part of the lead portion **12***a* may protrude outward in the Y-axis direction (the positive side in the Y-axis direction) from the first notch portion **23**. Likewise, at least a part of the lead portion **12***b* may protrude outward in the Y-axis direction (the positive side in the Y-axis direction) from the first notch portion **23**.

[0082] As shown in FIG. **1**C and FIG. **1**E, at least a part of the welded portion **50** may be disposed in the first notch portion **23** of the flange portion **22***a*. Also, at least a part of the welded portion **50** may be disposed in the first notch portion **23** of the flange portion **22***b*. In this case, the welded portion **50** is less likely to be exposed more outward (the positive side in the Y-axis direction) than one end of the flange portion **22***a* or **22***b* in the Y-axis direction. Thus, the size of the coil device **1** in the Y-axis direction can be reduced, and the coil device **1** can be downsized.

[0083] Note that, the whole of the welded portion **50** may be disposed in the first notch portion **23** of the flange portion **22***a*. Also, the whole of the welded portion **50** may be disposed in the first notch portion **23** of the flange portion **22***b*. In this case, it is possible to prevent dimensional variations of the coil device **1** in the Y-axis direction due to variations in the shape of the welded portion **50**.

[0084] A part of the welded portion **50** protrudes more outward in the X-axis direction than the outer end surface **224** of the flange portion **22***a,* but the welded portion **50** may be located more inward in the X-axis direction than the outer end surface **224**. Also, a part of the welded portion **50** protrudes more outward in the X-axis direction than the outer end surface **224** of the flange portion **22***b,* but the welded portion **50** may be located more inward in the X-axis direction than the outer end surface **224**. In this case, the size of the coil device **1** in the X-axis direction can be reduced, and the coil device **1** can be downsized.

[0085] As shown in FIG. **1**D, when the flange portion **22***a* is viewed from the opposite side to the mounting surface **221** (i.e., the mounting opposite surface **222** side) along the Z-axis direction (the direction perpendicular to the mounting surface **221** in FIG. **2**), at least a part of the welded portion **50** may be hidden by the flange portion **22***a*. Also, when the flange portion **22***a* is viewed from the opposite side to the mounting surface **221** along the Z-axis direction, at least a part of the welded portion **50** may be hidden by the plate core **40**.

[0086] Likewise, when the flange portion **22***b* is viewed from the opposite side to the mounting surface **221** (i.e., the mounting opposite surface **222** side) along the Z-axis direction (the direction perpendicular to the mounting surface **221** in FIG. **2**), at least a part of the welded portion **50** may be hidden by the flange portion **22***b*. Also, when the flange portion **22***b* is viewed from the opposite side to the mounting surface **221** along the Z-axis direction, at least a part of the welded portion **50** may be hidden by the plate core **40**.

[0087] In this case, at least a part of the welded portion **50** can be prevented from being exposed more outward than the outer edge of the flange portion **22***a* or **22***b*. Thus, the size of the coil device **1** can be reduced, and the coil device **1** can be downsized.

[0088] As shown in FIG. **1**D and FIG. **1**E, the first caulking portion **34** and the second caulking portion **35** are exposed outward (the positive side in the Y-axis direction) from one end of the flange portion **22***a* in the Y-axis direction. However, at least a part of the first caulking portion **34** may be disposed in the first notch portion **23** so as not to be exposed more outward than one end of the flange portion **22***a* in the Y-axis direction (the positive side in the Y-axis direction). Also, at least a part of the second caulking portion **35** may be disposed in the first notch portion **23** so as not to be exposed more outward than one end of the flange portion **22***a* in the Y-axis direction (the positive side in the Y-axis direction).

[0089] As shown in FIG. **1**B, with respect to the Z-axis direction, the position of an end (root) **34***e* of the first caulking portion **34** is completely or substantially equal to the position of an end **21***e* of the winding core portion **21** located on the mounting surface **221** side. The position of the end (root) **34***e* of the first caulking portion **34** may be positionally displaced by a predetermined distance L from the position of the end **21***e* of the winding core portion **21** toward the positive side in the Z-axis direction or the negative side in the Z-axis direction. For example, $0<L\leq D$ or $0<L\leq 2D$ is satisfied, where D is a diameter of the wire.

[0090] In this case, the lead portion **12***a* can be led out straight from the end **21***e* of the winding core portion **21**

toward the end **34***e* of the first caulking portion **34**, for example, along the X-axis. Also, the lead portion **12***a* can be caulked with the end **34***e* of the first caulking portion **34** (the root of the first caulking portion **34**), and it is possible to prevent positional displacement of the lead portion **12***a*. In the present embodiment, both of the lead portions **12***a* and **12***b* are led out from the end **21***e* of the winding core portion **21** toward the end **34***e* of the first caulking portion **34** along the X-axis without excessively bending.

[0091] As shown in FIG. **1**E and FIG. **3**, the second side portion **312** is a portion disposed so as to oppose to the second side surface **226** of the flange portion **22***a*. The second side portion **312** may be in contact with the second side surface **226**, or a gap may be formed between the second side portion **312** and the second side surface **226**. The second side portion **312** is formed at the other end of the main body portion **310** in the Y-axis direction (the end on the negative side in the Y-axis direction). The second side portion **312** extends in a direction perpendicular to the main body portion **310**. The length of the second side portion **312** in the X-axis direction may be equal to the length of the second side surface **226** in the X-axis direction.

[0092] As shown in FIG. **1**C, the second side portion **312** is disposed in the second notch portion **24**. Thus, the second side portion **312** is not exposed more outward (the negative side in the Y-axis direction) than the other end of the flange portion **22***a* in the Y-axis direction, but is disposed more inward than the second side surface **226** in the Y-axis direction (however, a portion of the second side surfaces **226** located closer to the mounting opposite surface **222** than the step forming surface **227**). Thus, in the present embodiment, the size of the coil device **1** in the Y-axis direction can be reduced, and the coil device **1** can be downsized.

[0093] The second side portion **312** is disposed closer to the mounting surface **221** than the mounting opposite surface **222**. More specifically, the second side portion **312** is disposed as a whole closer to the mounting surface **221** than the center of the second side surface **226** in the Z-axis direction.

[0094] As described above, the depth of the first notch portion **23** from the first side surface **225** in the Y-axis direction is larger than the depth of the second notch portion **24** from the second side surface **226** in the Y-axis direction. Thus, the first side portion **311** disposed in the first notch portion **23** is closer to the center of the flange portion **22***a* in the Y-axis direction than the second side portion **312** disposed in the second notch portion **24**. In the present embodiment, since the depth of the first notch portion **23** from the first side surface **225** in the Y-axis direction is relatively large, the first side portion **311** and the lead portion **12***a* connected thereto are less likely to be exposed more outward (the positive side in the Y-axis direction) than one end of the flange portion **22***a* in the Y-axis direction. Thus, the size of the coil device **1** in the Y-axis direction can be reduced, and the coil device **1** can be downsized.

[0095] As shown in FIG. **3**A, a protrusion **313** is formed on the inner surface of the first side portion **311** facing inward in the Y-axis direction. Likewise, a protrusion **313** is formed on the inner surface of the second side portion **312** facing inward in the Y-axis direction. The shape of the protrusion **313** is not limited, but is a tapered shape that tapers toward the tip. The shape of the protrusion **313** viewed from the Y-axis direction may be circular, oval, or polygonal. As shown in FIG. **1**E, the protrusions **313** formed on the first side portions **311** protrude toward the first side surfaces **225** and are engaged with the first concave portions **25** formed on the first side surfaces **225**. The protrusions **313** formed on the second side portions **312** protrude toward the second side surfaces **226** and are engaged with the second concave portions **26** formed on the second side surfaces **226**.

[0096] The protrusions **313** function as stoppers (rotation stoppers). Thus, when the protrusions **313** are engaged with the first concave portions **25** or the second concave portions **26**, the engagement portions **31** are less likely to rotate (pivot) within a plane parallel to the mounting surface **221** (within a plane parallel to the XY plane). Note that, the protrusions **313** are not essential, and the protrusion **313** formed on at least one of the first side portion **311** and the second side portion **312** may be omitted.

[0097] In the example shown in FIG. **3**A, the protrusion **313** formed on the first side portion **311** and the protrusion **313** formed on the second side portion **312** are located at the same height from the bottom of the main body portion **310** along the Z-axis. As shown in FIG. **3**B, however, the protrusion **313** formed on the first side portion **311** and the protrusion **313** formed on the second side portion **312** may be positionally displaced along the Z-axis. In the example shown in FIG. **3**B, the former protrusion **313** is located closer to the mounting surface **221** (FIG. **2**) than the latter protrusion **313**, but may be located closer to the mounting opposite surface **222** (FIG. **2**). In this case, the engagement portion **31** is further less likely to rotate (pivot) within a plane parallel to the mounting surface **221** (FIG. **2**) (within a plane parallel to the XY plane).

[0098] As shown in FIG. **3**A, the extended portion **33** is formed at the end of the main body portion **310** in the Z-axis direction and is located on the opposite side of the mounting portion **32** in the Z-axis direction. The extended portion **33** extends in a direction parallel to the main body portion **310**. The extended portion **33** has a rectangular shape when viewed from the X-axis direction, but may have a square or another polygonal shape.

[0099] As shown in FIG. **1**C, the extended portion **33** is disposed on the outer end surface **224** of the flange portion **22***a*. The extended portion **33** extends from the main body portion **310** toward the opposite side of the mounting surface **221** along the Z-axis. The length of the extended portion **33** in the Z-axis direction is not limited, but is ¼ times or more and ⅗ times or less the length of the main body portion **310** in the Z-axis direction. The extended portion **33** may extend to the end of the outer end surface **224** in the Z-axis direction (the intersection between the outer end surface **224** and the mounting opposite surface **222**). In the present embodiment, the contact area between the outer end surface **224** and the engagement portion **31** can be increased by the extended portion **33**, and it is thus possible to increase the fixing strength between the terminal fitting **30***a* and the flange portion **22***a*. Also, the fixing strength between the terminal fitting **30***a* and the flange portion **22***a* can be further increased by, for example, bonding the extended portion **33** to the outer end surface **224** with an adhesive or the like. Note that, the extended portion **33** is not essential and may be omitted from the terminal fitting **30***a* or **30***b*.

[0100] As shown in FIG. **3**A, the mounting portion **32** is formed at the end of the main body portion **310** in the Z-axis direction and is located on the opposite side to the extended portion **33** in the Z-axis direction. The mounting portion **32** includes a first section **321** and a second section **322**. The

shape of the first section **321** and the shape of the second section **322** are the same, but may be different from each other. The first section **321** and the second section **322** protrude inward in the X-axis direction and extend (bend) in a direction perpendicular to the main body portion **310**. The first section **321** and the second section **322** are separated from each other with a gap **320** in the Y-axis direction. The length of the gap **320** in the Y-axis direction may be equal to or larger than the length of the first section **321** or the second section **322** in the X-axis direction.

[0101] In the present embodiment, the area of the mounting portion **32** can be reduced depending on the size of the gap **320**. This makes it possible to reduce the area of a land pattern of a substrate (not shown) connected to the mounting portion **32** and to reduce the stray capacitance of the land pattern. Note that, the mounting portion **32** is connected to the substrate with a connecting material, such as solder and conductive adhesive. The main body portion **310** may be formed with fillets of the connecting material.

[0102] As shown in FIG. **1**E, the first section **321** and the second section **322** are arranged on the mounting surface **221**. The length of each of the first section **321** and the second section **322** in the X-axis direction may be equal to the length of the mounting surface **221** in the X-axis direction. The mounting portion **32** is offset as a whole from the center of the mounting surface **221** (or the axis of the winding core portion **21**) in the Y-axis direction to the negative side in the Y-axis direction. Thus, the distance between the first section **321** and the first side portion **311** is larger than the distance between the second section **322** and the second side portion **312**. As in the present embodiment, when the lead portion **12***a* is connected to the first side portion **311**, by offsetting the mounting portion **32** to the second side portion **312**, the solder etc. attached to the first section **321** is less likely to be in contact with the lead portion **12***a*, and the disconnection of the lead portion **12***a* can be prevented. Also, the coil device **1** can be balanced on one side and the other side in the Y-axis direction, and the mounting stability of the coil device **1** can be enhanced.

[0103] As shown in FIG. **1**C, the first section **321** and the second section **322** are arranged between the first side portion **311** and the second side portion **312** in the Y-axis direction. Since the first section **321** is located on the inner side of the first side portion **311** in the Y-axis direction, the intersection between the mounting surface **221** and the first side surface **225** of the flange portion **22***a* is exposed from the terminal fitting **30***a*. Also, since the second portion **322** is located on the inner side of the second side portion **312** in the Y-axis direction, the intersection between the mounting surface **221** and the second side surface **226** of the flange portion **22***a* is exposed from the terminal fitting **30***a*. Also, the mounting surface **221** is exposed from the terminal fitting **30***a* at the position of the gap **320**. In such a manner, in the present embodiment, the mounting surface **221** is exposed from the terminal fitting **30***a* at a plurality of locations on the mounting surface **221**. Thus, the solder etc. attached to the mounting portion **32** (particularly, the first section **321**) is less likely to be in contact with the lead portion **12***a*, and the disconnection, etc. of the lead portion **12***a* can be prevented.

[0104] As shown in FIG. **1**A, the plate core **40** has a rectangular parallelepiped shape (plate shape). The plate core **40** may be made of a material similar to that of the core **20** or may be made of a material different from that of the core **20**. The plate core **40** is attached to the core **20** using, for example, an adhesive. For more detail, the plate core **40** is fixed to the mounting opposite surfaces **222** (FIG. **2**) of the flange portions **22***a* and **22***b*.

[0105] As shown in FIG. **1**A and FIG. **2**, the inductance characteristics of the coil device **1** can be improved by attaching the plate core **40** to the flange portions **22***a* and **22***b*. Also, in the present embodiment, the engagement portion **31** is not engaged with the mounting surface **221** or the mounting opposite surface **222**, but is engaged with the first side surface **225** and the second side surface **226**. Thus, for example, unlike Patent Document 1, it is not necessary to cut the mounting opposite surface **222** or the plate core **40** for the purpose of preventing interference between the engagement portion **31** (or the lead portion **12***a*, etc. connected to the engagement portion **31**) and the plate core **40**. Thus, it is possible to secure the area of the bonding surface between the mounting opposite surface **222** and the plate core **40**, and in this respect as well, the inductance characteristics of the coil device **1** can be improved. Moreover, it is possible to secure the bonding strength between the mounting opposite surface **222** and the plate core **40**.

[0106] Next, a method of manufacturing the coil device **1** is explained. First, a wire and a plate core **40** shown in FIG. **1**A, a core **20** shown in FIG. **2**, and terminal fittings **30***a* and **30***b* shown in FIG. **3**A are prepared. Next, as shown in FIG. **1**A and FIG. **2**, an engagement portion **31** of the terminal fitting **30***a* is disposed on an outer end surface **224**, a first side surface **225**, and a second side surface **226** of a flange portion **22***a*.

[0107] Then, the engagement portion **31** is engaged with the flange portion **22***a* so that the first side surface **225** and the second side surface **226** are sandwiched by the engagement portion **31**. Likewise, the engagement portion **31** of the terminal fitting **30***b* is disposed on an outer end surface **224**, a first side surface **225**, and a second side surface **226** of a flange portion **22***b*. Then, the engagement portion **31** is engaged with the flange portion **22***b* so that the first side surface **225** and the second side surface **226** are sandwiched by the engagement portion **31**. If necessary, the main body portion **310** (and further an extended portion **33**) may be bonded to the outer end surface **224** with an adhesive or the like.

[0108] Next, the wire is wound around a winding core portion **21** to form a coil **10** including the winding portion **11** around the winding core portion **21**. A lead portion **12***a* is led out from an end **21***e* (FIG. **1**B) of the winding core portion **21** toward the first side surface **225** of the flange portion **22***a* at the same height as the end **21***e*. A lead portion **12***b* is led out from an end **21***e* (FIG. **1**B) of the winding core portion **21** toward the first side surface **225** of the flange portion **22***b* at the same height as the end **21***e*. Note that, after forming the coil **10** around the winding core portion **21**, the terminal fitting **30***a* may be disposed in the flange portion **22***a*, and the terminal fitting **30***b* may be disposed in the flange portion **22***b*.

[0109] Next, as shown in FIG. **1**B, the lead portion **12***a* is caulked with a first caulking portion **34** of the terminal fitting **30***a* and is fixed (temporarily fixed) to the outer surface of the first side portion **311**. Also, the lead portion **12***a* is caulked with a second caulking portion **35** of the terminal fitting **30***a* and is fixed to the outer surface of the first side portion **311**. Likewise, the lead portion **12***b* is caulked with the first caulking portion **34** of the terminal fitting **30***b* and

is fixed (temporarily fixed) to the outer surface of the first side portion **311**. Also, the lead portion **12***b* is caulked with the second caulking portion **35** of the terminal fitting **30***b* and is fixed to the outer surface of the first side portion **311**.

[0110] Next, for example, by laser welding, the lead portion **12***a* is connected to the second caulking portion **35** of the terminal fitting **30***a,* and the lead portion **12***b* is connected to the second caulking portion **35** of the terminal fitting **30***b.* Thus, by a welded portion **50**, the laser portion **12***a* is connected to the second caulking portion **35** of the terminal fitting **30***a,* and the lead portion **12***b* is connected to the second caulking portion **35** of the terminal fitting **30***b.*

[0111] Next, the plate core **40** is attached to a mounting opposite surface **222** of each of the flange portions **22***a* and **22***b* using a connecting material, such as an adhesive. Accordingly, the coil device **1** shown in FIG. **1**A can be manufactured.

[0112] In the coil device **1** of the present embodiment, as shown in FIG. **1**A and **1**C, the engagement portion **31** is disposed from the first side surface **225** to the second side surface **226** of the flange portion **22***a.* Thus, the first side portion **311** disposed on the first side surface **225** and the second side portion **312** disposed on the second side surface **226** function as stoppers (rotation stoppers), and the engagement portion **31** is less likely to rotate (pivot) within a plane parallel to the mounting surface **221** (within a plane parallel to the XY plane). Thus, when the terminal fitting **30***a* is attached to the flange portion **22***a,* the engagement portion **31** can be fixed to the flange portion **22***a* in a desired direction, and it is possible to enhance the attachment stability of the terminal fitting **30***a* to the flange portion **22***a.* Also, since the lead portion **12***a* is connected to the engagement portion **31** (the outer surface of the first side portion **311**), there is no need to provide the terminal fitting **30***a* with a wire connection portion separately from the engagement portion **31**, and the terminal fitting **30***a* and further the coil device **1** can be smaller and lower in height.

[0113] The first notch portion **23** is located on the mounting surface **221** side of the first side surface **225**, and the second notch portion **24** is located on the mounting surface **221** side of the second side surface **226**. Thus, the main portions of the terminal fitting **30***a,* such as the first side portion **311** disposed in the first notch portion **23**, the second side portion **312** disposed in the second notch portion **24**, and the mounting portion **32**, can be arranged on the mounting surface **221** side, and the terminal fitting **30***a* can be downsized. Moreover, as a result of downsizing of the terminal fitting **30***a*, the coil device **1** can be further smaller and lower in height.

Second Embodiment

[0114] Except for the following matters, a coil device **1**A according to Second Embodiment shown in FIG. **4** has configurations similar to those of the coil device **1** according to First Embodiment. Overlapping portions with the coil device **1** according to First Embodiment are provided with the same references and are not described in detail.

[0115] The coil device **1**A includes a core **20**A and terminal fittings **30***a*A and **30***b*A. The core **20**A includes flange portions **22***a*A and **22***b*A. The flange portion **22***a*A includes a first convex portion **27** and a second convex portion **28** protruding outward in the X-axis direction from an outer end surface **224**. The first convex portion **27** is disposed on one side of the flange portion **22***a*A in the Y-axis direction, and the second convex portion **28** is disposed on the other side of the flange portion **22***a*A in the Y-axis direction. The protrusion length of the first convex portion **27** and the second convex portion **28** from the outer end surface **224** is not limited, but is ⅓ times or more and 2 times or less the plate thickness of the terminal fitting **30***a*A. The shape of each of the first convex portion **27** and the second convex portion **28** viewed from the X-axis direction is quadrangular, but may be another polygonal shape.

[0116] An end surface concave portion **29** is formed between the first convex portion **27** and the second convex portion **28** in the Y-axis direction. The length of the end surface concave portion **29** in the Y-axis direction is equal to or larger than the length of an extended portion **33**A in the Y-axis direction. The extended portion **33**A is accommodated into the end surface concave portion **29** and is disposed between the first convex portion **27** and the second convex portion **28**. Thus, the position of the extended portion **33**A is limited to between the first convex portion **27** and the second convex portion **28** in the Y-axis direction. Accordingly, the first convex portion **27** and the second convex portion **28** function as stoppers and can prevent positional displacement of the engagement portion **31** to one side or the other side in the Y-axis direction.

[0117] Note that, the present invention is not limited to the above-described embodiments and can be variously modified within the scope of the present invention. For example, as shown in FIG. **1**A, in each of the above-described embodiments, a single coil **10** is provided in the winding core portion **21**, but a plurality of coils **10** may be provided in the winding core portion **21**. In this case, depending on the number of coils **10**, a plurality of terminal fittings may be installed on the flange portion **22***a,* or a plurality of terminal fittings may be installed on the flange portion **22***b.*

[0118] In each of the above-described embodiments, an application example of the coil device **1** or **1**A to an inductor is described, but the coil device **1** or **1**A may be applied to other electronic components (e.g., transformer).

[0119] In each of the above-described embodiments, the plate core **40** may be omitted from the coil device **1** or **1**A.

DESCRIPTION OF THE REFERENCE NUMERICAL

[0120] **1**, **1**A . . . coil device
[0121] **10** . . . coil
[0122] **11** . . . winding portion
[0123] **12***a,* **12***b* . . . lead portion
[0124] **20**, **20**A... core
[0125] **21** . . . winding core portion
[0126] **22***a,* **22***b,* **22***a*A, **22***b*A . . . flange portion
[0127] **221** . . . mounting surface
[0128] **222** . . . mounting opposite surface
[0129] **223** . . . inner end surface
[0130] **224** . . . outer end surface
[0131] **225** . . . first side surface
[0132] **226** . . . second side surface
[0133] **227** . . . step forming surface
[0134] **23** . . . first notch portion
[0135] **24** . . . second notch portion
[0136] **25** . . . first concave portion
[0137] **26** . . . second concave portion
[0138] **27** . . . first convex portion
[0139] **28** . . . second convex portion
[0140] **29** . . . end surface concave portion

[0141] **30***a*, **30***b*, **30***a*A, **30***b*A . . . terminal fitting
[0142] **31** . . . engagement portion
[0143] **310** . . . main body portion
[0144] **311** . . . first side portion
[0145] **312** . . . second side portion
[0146] **313** . . . protrusion
[0147] **32** . . . mounting portion
[0148] **320** . . . gap
[0149] **321** . . . first section
[0150] **322** . . . second section
[0151] **33**, **33**A . . . extended portion
[0152] **34** . . . first caulking portion
[0153] **35** . . . second caulking portion
[0154] **40** . . . plate core
[0155] **50** . . . welded ball

What is claimed is:

1. A coil device comprising:
a coil including:
a winding portion; and
a lead portion led out from the winding portion;
a core including:
a winding core portion provided with the winding portion; and
a flange portion formed at an end in a first direction parallel to an axis of the winding core portion; and
a terminal fitting provided with an engagement portion for engaging with the flange portion,
wherein
the flange portion includes:
a first side surface located on one side in a second direction parallel to a mounting surface of the flange portion; and
a second side surface located on the other side in the second direction, and
the engagement portion is disposed from the first side surface to the second side surface and connected to the lead portion.

2. The coil device according to claim **1**, wherein
the engagement portion includes a first side portion opposing to the first side surface, and
the lead portion is connected to an outer surface of the first side portion facing outward in the second direction.

3. The coil device according to claim **1**, wherein
the engagement portion includes a first side portion opposing to the first side surface,
the first side surface is provided with a first notch portion, and
the first side portion is disposed in the first notch portion.

4. The coil device according to claim **3**, wherein
the engagement portion includes a second side portion opposing to the second side surface,
the second side surface is provided with a second notch portion, and
the second side portion is disposed in the second notch portion.

5. The coil device according to claim **4**, wherein
the first notch portion is located on one side of the first side surface, which is a side close to the mounting surface, and
the second notch portion is located on one side of the second side surface, which is a side close to the mounting surface.

6. The coil device according to claim **4**, wherein a depth of the first notch portion from the first side surface along the second direction is larger than a depth of the second notch portion from the second side surface along the second direction.

7. The coil device according to claim **1**, wherein the engagement portion is engaged with the flange portion at a position closer to the mounting surface than to a mounting opposite surface opposite to the mounting surface of the flange portion.

8. The coil device according to claim **3**, wherein
the lead portion is connected to an outer surface of the first side portion facing outward in the second direction by a conductive connection portion, and
at least a part of the conductive connection portion is disposed in the first notch portion.

9. The coil device according to claim **8**, wherein at least a part of the conductive connection portion is hidden by the flange portion when the flange portion is viewed from the opposite side to the mounting surface along a third direction perpendicular to the mounting surface.

10. The coil device according to claim **1**, wherein
the engagement portion includes a first side portion opposing to the first side surface, and
a protrusion protruding toward the first side surface is formed on an inner surface of the first side surface facing inward in the second direction.

11. The coil device according to claim **10**, wherein the first side surface is provided with a concave portion for engaging with the protrusion.

12. The coil device according to claim **1**, wherein
the terminal fitting includes a mounting portion for being disposed on the mounting surface,
the mounting portion includes a first section and a second section, and
the first section and the second section are separated with a gap in the second direction.

13. The coil device according to claim **1**, wherein
the terminal fitting includes a mounting portion for being disposed on the mounting surface, and
the mounting portion is offset from a center of the mounting surface in the second direction to the other side in the second direction.

14. The coil device according to claim **1**, wherein
the engagement portion includes:
a first side portion opposing to the first side surface; and
a caulking piece for caulking the lead portion led to the first side portion,
an end of the caulking piece is connected to the first side portion, and
a position of the end of the caulking piece is equal to a position of the end of the winding core portion located closer to the mounting surface of the flange portion with respect to a third direction perpendicular to the mounting surface.

15. The coil device according to claim **1**, wherein
the engagement portion includes a main body portion and an extended portion arranged on an outer end surface of the flange portion,
the main body portion is located between the first side portion and the second side portion, and
the extended portion extends from the main body portion toward the opposite side to the mounting surface along a third direction perpendicular to the mounting surface.

16. The coil device according to claim **15**, wherein

the flange portion includes a first convex portion and a second convex portion protruding outward in the first direction from the outer end surface of the flange portion,

the first convex portion is disposed on one side of the flange portion in the second direction,

the second convex portion is disposed on the other side of the flange portion in the second direction, and

the extended portion is disposed between the first convex portion and the second convex portion.

17. The coil device according to claim **1**, further comprising a plate core for being attached to a mounting opposite surface opposite to the mounting surface of the flange portion.

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