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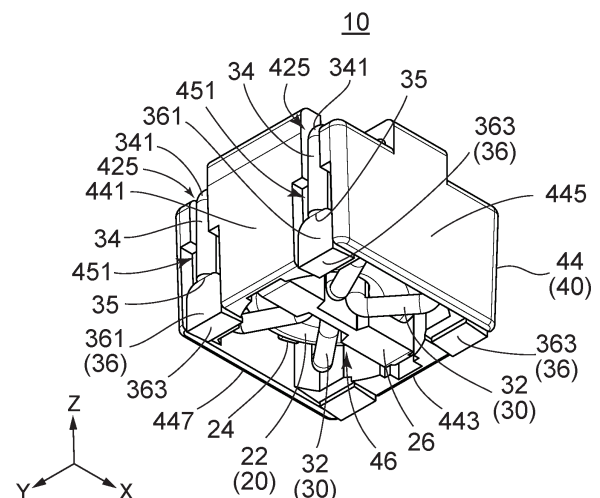
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(54) **CHOKE COIL**

(57) A choke coil 10 comprises a core, a coil member 30, and a case 40. The case 40 has a housing part 46 defined by an upper surface 42 and a lateral surface 44. The coil member 30 is constituted by a lead wire and has a coil main part 32, an extension part 34, and a terminal part 36. The coil main part 32 is wound around the core. The core and the coil main part 32 are housed in the housing part 46. The extension part 34 extends from the coil main part 32 and has a cross-sectional shape substantially the same as that of the coil main part 32. The extension part 34 has at least one bent portion 341 and is at least partially drawn out to the outside of the housing part 46. The terminal part 36 extends from the extension part 34 and has a thickness smaller than the size of the diameter of the extension part 34. The terminal part 36 has an L-shaped form. A boundary 35 between the terminal part 36 and the extension part 34 is located on the lateral surface of the case 40.



**FIG. 1**

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## Description

### Technical Field

**[0001]** This invention relates to a choke coil, in particular, to a surface-mount type choke coil.

### Background Art

**[0002]** Patent Document 1 discloses an example of a surface-mount type choke coil.

**[0003]** The choke coil of Patent Document has a closed magnetic path core, which consists of a board-shaped core and a concave-shaped core, and two coils wound concentrically. The coils are mounted on a central magnetic leg of the concave-shaped core and accommodated in the closed magnetic core. Lead end portions of the coils are formed in plate shapes by rolling. Each of ends of the lead end portions is formed with a claw portion. The lead end portions are drawn out to the outside of the closed magnetic core and arranged along leading grooves formed in external side surfaces of the concave-shaped core. The claw portions are received in hollow portions formed in an external undersurface of the concave-shaped core.

### Prior Art Documents

#### Patent Document(s)

**[0004]** Patent Document 1: JP2000-021655A

### Summary of Invention

#### Technical Problem

**[0005]** In the choke coil of Patent Document 1, the lead end portions (plate-like parts) extend from an inner part of the closed magnetic core. In other words, the closed magnetic core accommodates the lead end portions in part. Accordingly, the closed magnetic core has a size larger than that required to accommodate the coils.

**[0006]** It is an object of the present invention to provide a choke coil which can be further downsized.

#### Solution to Problem

**[0007]** One aspect of the present invention provides a choke coil, as a first choke coil, which comprises a core, a coil member and a case, wherein: the case has an upper surface and a lateral surface extending downward from the upper surface and also has a housing part defined by the upper surface and the lateral surface; the coil member is formed of a lead wire and has a coil main part, an extension part and a terminal part; the coil main part is wound onto the core; the core and the coil main part are accommodated in the housing part; the extension part extends from the coil main part and has a sectional shape

which is substantially same as that of the coil main part; the extension part has at least one bent portion and is drawn out to the outside of the housing part at least in part; the terminal part extends from the extension part and has a thickness size smaller than a diameter size of the extension part; the terminal part has an L-shape; and a boundary between the terminal part and the extension part is located on the lateral surface of the case.

### Advantageous Effects of Invention

**[0008]** In the choke coil according to the one aspect of the present invention, the coil member is formed of the lead wire and has the coil main part, the extension part and the terminal part. The coil main part is wound onto the core and accommodated with the core in the housing part of the case. The extension part extends from the coil main part and is drawn out to the outside of the housing part. The terminal part extends from the extension part. The boundary between the terminal part and the extension part is located on the lateral surface of the case. Since the terminal part is located outside the case, the choke coil according to the one aspect of the present invention can be downsized in comparison with a conventional choke coil in which a terminal part extends from the inside of a case to the outside of the case.

**[0009]** An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

### Brief Description of Drawings

#### **[0010]**

Fig. 1 is a bottom, perspective view showing a choke coil according to a first embodiment of the present invention.

Fig. 2 is a top, perspective view showing the choke coil of Fig. 1.

Fig. 3 is a bottom view showing the choke coil of Fig. 1.

Fig. 4 is a plan view showing the choke coil of Fig. 1. Fig. 5 is a bottom, perspective view showing a core case, which accommodates a core used for the choke coil of Fig. 1, and lead wires, which are wound onto the core case in part.

Fig. 6 is a bottom, perspective view showing an assembly in which the core case and the lead wires of Fig. 5 are combined with a case.

Fig. 7 is a plan view showing the assembly of Fig. 6. Fig. 8 is a top, perspective view showing the assembly of Fig. 6. The lead wires are bent to extend along upper grooves of the case.

Fig. 9 is a top, perspective view showing the assembly of Fig. 8. End portions of the lead wires are cut and pressed.

Fig. 10 is a top, perspective view showing a choke coil according to a second embodiment of the present invention.

Fig. 11 is a bottom, perspective view showing the choke coil of Fig. 9.

#### Description of Embodiments

**[0011]** While the invention may be realized in various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

#### [First Embodiment]

**[0012]** Referring to Figs. 1 to 4, a choke coil 10 according to a first embodiment of the present invention is provided with a core (not shown) accommodated in a core case 20, two coil members 30 and a case 40. In the present embodiment, the choke coil 10 is a common-mode choke coil. However, the present invention is not limited thereto. The choke coil of the present invention may be a normal-mode choke coil which is provided with one coil member 30.

**[0013]** Referring to Figs. 3 and 5, the core (not shown) accommodated in the core case 20 is made of ferromagnetic material and has a closed ring shape. In the present embodiment, the core is a toroidal core having a circular ring shape. However, the present invention is not limited thereto. The core may have a racetrack shape, an elliptic shape or an oval shape. Nevertheless, the toroidal core is preferable for obtaining intended magnetic characteristics. Moreover, in the case that the choke coil 10 is the normal-mode choke coil, the core may have a gap.

**[0014]** As shown in Figs. 3 and 5, the core case 20 is made of insulating resin and has a ring-shaped portion 22, protruding portions 24 and a frame portion 26. The ring-shaped portion 22 has a hollow shape and accommodates the core (not shown) therein. The protruding portions 24 protrude outward in diameter directions from the ring-shaped portion 22. The protruding portions 24 regulate movement of the coil members 30 wound onto the core case 20. The frame portion 26 surrounds the ring-shaped portion 22 so as to divide the ring-shaped portion 22 into two. As understood from Fig. 3, the frame portion 26 has an asymmetrical shape, and the case 40 has a cavity corresponding to the shape of the frame portion 26. Accordingly, the core case 20 can be inserted into the case 40 only when it has a suitable direction. In other words, the frame portion 26 serves as a guide when the core case 20 is accommodated in the case 40. As a result, lead wires 300 can be correctly, easily inserted into

apertures 421 (see Fig. 4). Thus, the frame portion 26 facilitates assembly of the choke coil 10 and prevents assembly errors. Moreover, the frame portion 26 of the core case 20 and the cavity of the case 40 regulate movement of the core case 20 relative to the case 40 after the core case 20 is accommodated in the case 40. Incidentally, in order to prevent the movement of the core case 20 relative to the case 40, the core case 20 may be fixed to the case 40 by the use of adhesive and etc.

**[0015]** As shown in Figs. 1 to 4, each of the coil members 30 has a coil main part 32, two extension parts 34 and two terminal parts 36. In each of the coil members 30, the coil main part 32 is situated at a middle portion of the coil member 30 (between the two extension parts 34) and wound onto the core (not shown) via the core case 20. The extension parts 34 extend from both ends of the coil main part 32, respectively. The terminal parts 36 extend from the extension parts 34, respectively. The terminal parts 36 are situated at both ends of the coil member 30. Unless otherwise noted, the description for one of the coil members 30 is applicable to the other of the coil members 30 in the following description. Moreover, unless otherwise noted, the description for one of the extension parts 34 is applicable to the remaining extension parts 34 and the description for one of the terminal parts 36 is applicable to the remaining terminal parts 36 in the following description.

**[0016]** As understood from Figs. 1 and 2, the case 40 is a single piece made of thermosetting resin. The case 40 has an upper surface 42 and a lateral surface 44. The lateral surface 44 extends downward from the upper surface 42. In the present embodiment, the lateral surface 44 is formed of four side surface portions 441, 443, 445 and 447. However, the present invention is not limited thereto. The lateral surface 44 may have another shape, such as a polygonal tube or a cylinder. In the present embodiment, an up-down direction is a Z-direction. A positive Z-direction is directed upward while a negative Z-direction is directed downward.

**[0017]** As understood from Figs. 1 and 3, the upper surface 42 and the lateral surface 44 define a housing part 46. In other words, the case 40 has the housing part 46 defined by the upper surface 42 and the lateral surface 44. In the present embodiment, the case 40 opens downward. In other words, the case 40 does not have an undersurface in the present embodiment. However, the present invention is not limited thereto. The case 40 may have an undersurface. Nevertheless, provided that insulation is secured between each of the coil parts 32 and a substrate (not shown) when the choke coil 10 is mounted on the substrate, it is preferable that the case 40 does not have the undersurface because it can reduce manufacturing costs and simplify the manufacturing process.

**[0018]** As shown in Figs. 1 and 3, the core case 20, which accommodates the core (not shown), and the coil main parts 32 are accommodated in the housing part 46 of the case 40. As shown in Figs. 1, 2 and 4, the extension

parts 34 are drawn out to the outside of the housing part 46 at least in part. Each of the extension parts 34 has at least one bent portion 341 and extends along the upper surface 42 and the lateral surface 44 of the case 40. In the present embodiment, each of the extension parts 34 has two or three bent portions 341. Each of the terminal parts 36 extends from the lateral surface 44 of the case 40 to a lower side of the case 40.

**[0019]** Referring to Figs. 4 and 7, the upper surface 42 of the case 40 is provided with at least two apertures 421. In the present embodiment, the upper surface 42 of the case 40 is provided with four apertures 421. The apertures 421 are divided into two groups. These groups of the apertures 421 correspond to the coil members 30, respectively. The apertures 421 of each of the groups correspond to the extension parts 34 of the coil member 30 corresponding thereto, respectively. The extension parts 34 of the coil members 30 are drawn out from the housing part 46 of the case 40 to the upper surface 42 of the case 40 through the apertures 421 corresponding thereto.

**[0020]** As shown in Figs. 4 and 7, the upper surface 42 of the case 40 is further formed with at least two upper grooves (groove portions) 423. In the present embodiment, the upper surface 42 of the case 40 is formed with four upper grooves 423. Moreover, in the present embodiment, the upper grooves 423 are grooves each of which does not have a bottom portion in part. The upper grooves 423 correspond to the apertures 421, respectively. The upper grooves 423 also correspond to the extension parts 34, respectively. Each of the upper grooves 423 extends from the aperture 421 corresponding thereto to the lateral surface 44 of the case 40 and has an end portion 425 at a position separate from the aperture 421. In the present embodiment, each of the extension parts 34 is received by the upper groove 423 corresponding thereto at least in part and extends along the upper groove 423.

**[0021]** As understood from Figs. 1, 2 and 3, the side surface portions 441, 443, 445 and 447 forming the lateral surface 44 face in directions different from one another. The side surface portions 441 and 443 face forward and rearward, respectively, in a front-rear direction perpendicular to the up-down direction. The side surface portions 445 and 447 face outward in a lateral direction perpendicular to both the up-down direction and the front-rear direction. In the present embodiment, the front-rear direction is an X-direction. A negative X-direction is directed forward while a positive X-direction is directed rearward. The lateral direction is a Y-direction.

**[0022]** As shown in Figs. 1 to 4 and 6, the lateral surface 44 of the case 40 is formed with side grooves 451 which are continuous with the upper grooves (the groove portions) 423, respectively. In the present embodiment, each of the side surface portions 441 and 443 is formed with two of the side grooves 451. The side grooves 451 extend from the end portions 425 of the upper grooves 423 to a lower end of the case 40. Each of the extension parts 34

of the coil members 30 is received, in part, by the side groove 451 corresponding thereto and extends along the side groove 451.

**[0023]** As shown in Fig. 1, each of the terminal parts 36 is bent to have an L-shape. In other words, the terminal part 36 has a first part 361, which extends from the extension part 34, and a second part 363, which extends from the first part 361. The first part 361 extends in the up-down direction and is received by the side groove 451. The second part 363 is located at a lower side of the case 40 and extends in the front-rear direction. Moreover, the second part 363 protrudes downward from the lower end of the case 40. Since the terminal parts 36 protrude downward from the lower end of the case 40, only the terminal parts 36 are brought into contact with the substrate (not shown) when the choke coil 10 is mounted on the substrate. At that time, the case 40, the core case 20 and the coil main parts 32 are not brought into contact with the substrate. In other words, the choke coil 10 is supported by only the terminal parts 36. In this manner, the choke coil 10 is supported by only the terminal parts 36 in the present embodiment. Nevertheless, reduction in mounting strength cannot be observed, and the terminal parts 36 can be securely connected to the substrate. However, the present invention is not limited thereto. The lower end of the case 40 may be brought into contact with the substrate. Nevertheless, the structure that only the terminal parts 36 are brought into contact with the substrate is preferable because isolation between the coil main parts 32 and the substrate can be ensured more certainly even if the case 40 does not have the under-surface.

**[0024]** As shown in Figs. 1 and 2, a boundary 35 between the extension part 34 and the terminal part 36 is located on the lateral surface 44 of the case 40 or in the side groove 451. In the vicinity of the boundary 35, the extension part 34 and the terminal part 36 extend along the same direction (the up-down direction). In other words, the coil member 30 is not bent at the boundary 35. Here, the extension part 34 and the terminal part 36 are different from each other in cross-sectional shape. If the coil member 30 is bent at the boundary 35 between different cross-sectional shapes, reduction in strength easily occurs at that part. In the present embodiment, the coil member 30 extends straight in the vicinity of the boundary 35, so that such strength reduction does not occur. Moreover, the whole of the terminal part 36 or the boundary 35 is located outside the case 40, so that downsizing can be realized in comparison with a conventional choke coil in which terminal parts extend from the inside of a case to the outside of the case.

**[0025]** As understood from Fig. 5, each of the coil members 30 is formed of the lead wire 300. In other words, the lead wires 300 are used in manufacture of the choke coil 10. In the present embodiment, each of the lead wires 300 is a single-piece member consisting of a conductor (not shown) of a single wire and an insulation coating (not shown) surrounding the conductor.

**[0026]** As shown in Fig. 5, a part of each of the lead wires 300 is wound onto the core case 20 at the time of manufacture. The part of the lead wire 300 which is wound onto the core case 20 becomes the coil main part 32. The extension parts 34 are parts extending from the coil main part 32. Each of the terminal parts 36 is formed by applying press working and bending to a part of each of the lead wires 300.

**[0027]** As understood from Fig. 5, there is no clear boundary between the coil main part 32 and the part which becomes each of the extension parts 34. Accordingly, each of the extension parts 34 has a cross-sectional shape substantially the same as that of the coil main part 32. Here, that the extension parts 34 and the coil main part 32 have substantially the same cross-sectional shapes means that their cross-sectional shapes are the same as each other except for a part deformed by the bending. Incidentally, in the present embodiment, the cross-sectional shape is a round shape.

**[0028]** As understood from Figs. 6 and 7, at the time of manufacture of the choke coil 10, the core case 20 onto which the lead wires 300 are wound is inserted into the housing part 46 from beneath the case 40. Accordingly, the core case 20 accommodating the core (not shown) and the coil main parts 32 are accommodated in the housing part 46. At that time, each of end portions of the lead wires 300 is drawn out to the outside of the case 40 through the aperture 421 corresponding thereto.

**[0029]** Here, a diameter of the conductor of the lead wire 300 used for the coil member 30 may be decided depending on application of the choke coil 10. In the present embodiment, the diameter of the conductor is more than or equal to 0.8 mm to meet a predetermined current which is a relatively large current. Moreover, in the present embodiment, the diameter of the conductor is less than or equal to 1.8 mm in consideration of easiness of processing.

**[0030]** Moreover, an internal diameter of the aperture 421 of the case 40 is slightly larger than an external diameter of the coil member 30. It is preferable that the internal diameter of the aperture 421 is smaller. This is to suppress reduction in strength of the case 40 and to suppress heat from entering the case 40 during a reflow process to mount the choke coil 10 on the substrate (not shown).

**[0031]** As shown in Fig. 8, each of the lead wires 300 is bent to extend along the upper grooves (the groove portions) 423 corresponding thereto and received by the upper grooves 423 in part. After that, each of the end portions of the lead wire 300 is cut to have an appropriate length. On a surface of the end portion of the lead wire 300 after cutting, solder is formed as necessary. By forming the solder, the insulation coating on a part of the lead wire 300 which becomes the terminal part 36 (see Fig. 9) is removed. In the case that the solder is not formed, it is necessary to remove the insulation coating on the part of the lead wire 300 which becomes the terminal part 36.

**[0032]** As shown in Fig. 9, the end portions of the lead wires 300 (see Fig. 8) are pressed, so that plate-shaped portions 38 which become the terminal parts 36 are formed. At that time, the boundaries 35 are formed between the extension parts 34 and the terminal parts 36 of the coil members 30. Since the press working is applied to limited ranges of the lead wires 300 or to only the parts which become the terminal parts 36, a small-sized press machine can be used. Moreover, the end portions of the lead wires 300 can be pressed simultaneously.

**[0033]** As understood from Figs. 9, 1 and 2, after that, the plate-shaped portions 38 are bent to become the terminal parts 36. Thus, the terminal parts 36 are formed by the bending after the conductors of the lead wires 300 (see Fig. 8) are pressed. In other words, each of the terminal parts 36 is not a discrete part which is connected to the lead wire 300 by welding etc. In the present embodiment, each of the terminal parts 36 is covered with solder at least in part. Incidentally, formation of the solder may be performed after formation of the terminal parts 36. However, if the formation of the solder is performed after the press working is performed, it is easy to cause problems, such as unevenness of the solder. Accordingly, it is preferable that the formation of the solder is performed before the press working.

**[0034]** As understood from Fig. 9, a thickness size of the plate-shaped portion 38 which becomes the terminal part 36 is smaller than a diameter size of the extension part 34. In detail, the thickness size of the plate-shaped portion 38 is more than or equal to one quarter of the diameter size of the extension part 34 and less than or equal to three quarters of the diameter size of the extension part 34. The thickness size of the plate-shaped portion 38 may be more than or equal to 0.2 mm and less than or equal to 0.6 mm, for example. This is because it is easy to cause crack in the solder during the bending if the thickness size of the plate-shaped portion 38 is too small. Moreover, this is because the bending is difficult if the thickness size of the plate-shaped portion 38 is too large. Incidentally, in the present embodiment, a thickness size of the terminal part 36 is equal to the thickness size of the plate-shaped portion 38. In other words, in the present embodiment, the thickness size of the terminal part 36 is more than or equal to one quarter of the diameter size of the extension part 34 and less than or equal to three quarters of the diameter size of the extension part 34. Moreover, in the present embodiment, the thickness size of the terminal part 36 may be more than or equal to 0.2 mm or less than or equal to 0.6 mm.

**[0035]** As understood from Figs. 9 and 2, each of the extension parts 34 is further bent to extend along the side groove 451 corresponding thereto. Thus, the first part 361 of the terminal part 36 is received by the side groove 451. As a result, a distance between the two terminal parts 36 of each of the coil members 30 is determined. The distance between the terminal parts 36 depends on a size of the case 40, so that there is little variation between products. Thus, according to the present invention, in

each of the coil members 30, the distance (pitch) between the terminal parts 36 can be accurately determined by the simple process of bending of the extension parts 34.

**[0036]** As understood from Fig. 7, a distance D1 between the end portions 425 of the two upper grooves 423 extending from the two apertures 421 of each of the groups is longer than a distance D2 between the apertures 421 of each of the groups. The side grooves 451 extend along the up-down direction, so that a distance between the side grooves 451 in the front-rear direction depends on the distance D1 between the end portions 425 of the upper grooves 423. As a result, as understood from Figs. 3 and 4, a distance between the terminal parts 36 of each of the coil members 30 in the front-rear direction depends on the distance D1 between the end portions 425 of the upper grooves 423, and it is longer than the distance D2 between the apertures 421. Thus, according to the present embodiment, the distance between the terminal parts 36 can be longer than the distance between positions (the apertures 421) where the extension parts 34 are drawn out to the outside of the case 40. This is advantageous in securing insulation between pads which are connected to the terminal parts 36 when the choke coil 10 is mounted on the substrate. Moreover, since the distance between the terminal parts 36 depends on the distance D1 between the end portions 425, it is hard to cause variation. Accordingly, this structure is advantageous in downsizing the choke coil 10.

**[0037]** As understood from Fig. 2, in the present embodiment, the extension part 34 is routed from the upper surface 42 of the case 40 to the lateral surface 44 of the case 40. In other words, in the present embodiment, the coil members 30 are arranged so that parts of the coil members 30 which are exposed outside the case 40 are longer. As a result, heat generated on the coil members 30 is efficiently discharged outside the case 40. Accordingly, the structure of the choke coil 10 of the present embodiment excels at heat radiation efficiency and is suitable for application for large current.

[Second Embodiment]

**[0038]** Referring to Figs. 10 and 11, a choke coil 10A according to a second embodiment of the present invention is different from the choke coil 10 according to the first embodiment in that it has a case 40A in place of the case 40.

**[0039]** As understood from Figs. 10 and 11, the case 40A has a body 400 and a top cover 410. The body 400 has an undersurface 402 and a lateral surface 404 extending upward from the undersurface 402. The body 400 opens upward and has an upper opening (not shown). The top cover 410 is combined with the body 400 and closes the upper opening of the body 400. The top cover 410 and the lateral surface 404 of the body 400 define a housing part (not shown) which accommodates a core case (not shown), which accommodates a core (not shown), and coil main parts (not shown) of coil

members 30.

**[0040]** As shown in Figs. 10 and 11, in the present embodiment, each of extension parts 34 of the coil members 30 is drawn out from the case 40 at upper end of the lateral surface 404 of the case 40 and extends downward. Thus, in the present invention, the extension parts 34 may be drawn out from the lateral surface 404 of the case 40A to the outside of the case 40A and extend along the lateral surface 404 of the case 40A. Nevertheless, when the coil members 30 are drawn out from the upper surface 42 of the case 40 as in the case of the choke coil 10 according to the first embodiment, the parts exposed outside the case 40 are longer and excel in heat radiation.

**[0041]** As shown in Figs. 10 and 11, in the present embodiment as well, the boundaries 35 between the extension parts 34 and the terminal parts 36 are located on the lateral surface 404 of the case 40A. Moreover, in the vicinity of each of the boundaries 35, the extension part 34 and the terminal part 36 extend along the same direction. In other words, at the boundary 35 between a flattened part of a lead wire and an unflattened part of the lead wire, the lead wire is not bent. Accordingly, at each of the boundaries 35 of the coil members 30, predetermined strength is maintained. Moreover, the whole of the terminal part 36 or the boundary 35 is located outside the case 40A, so that downsizing can be performed in comparison with a conventional choke coil in which terminal parts extend from the inside of a case to the outside of the case.

**[0042]** Although the specific explanation about the present invention is made above with reference to concrete embodiments, the present invention is not limited thereto but susceptible of various modifications and alternative forms without departing from the spirit of the invention.

**[0043]** For example, although the coil members 30 (the lead wires 300) are wound onto the core case 20 accommodating the core (not shown) in the aforementioned embodiments, the coil members 30 (the lead wires 300) may be wound onto a core (coated core) of which surface is coated with insulation coating.

**[0044]** Moreover, although the case 40 is made of the thermosetting resin in the aforementioned embodiments, the case 40 may be made of another insulator, such as ceramic.

**[0045]** This application is based on a Japanese Patent Application of JP2023-171545 filed with the Japanese Patent Office on October 2, 2023, the contents of which are incorporated herein in their entirety by reference.

**[0046]** While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

## Reference Signs List

**[0047]**

|                    |                               |
|--------------------|-------------------------------|
| 10                 | choke coil                    |
| 20                 | core case                     |
| 22                 | ring-shaped portion           |
| 24                 | protruding portion            |
| 26                 | frame portion                 |
| 30                 | coil member                   |
| 300                | lead wire                     |
| 32                 | coil main part                |
| 34                 | extension part                |
| 341                | bent portion                  |
| 35                 | boundary                      |
| 36                 | terminal part                 |
| 361                | first part                    |
| 363                | second part                   |
| 38                 | plate-shaped portion          |
| 40, 40A            | case                          |
| 400                | body                          |
| 402                | undersurface                  |
| 404                | lateral surface               |
| 410                | top cover                     |
| 42                 | upper surface                 |
| 421                | aperture                      |
| 423                | upper groove (groove portion) |
| 425                | end portion                   |
| 44                 | lateral surface               |
| 441, 443, 445, 447 | side surface portion          |
| 451                | side groove                   |
| 46                 | housing part                  |

**Claims**

1. A choke coil comprises a core, a coil member and a case, wherein:

the case has an upper surface and a lateral surface extending downward from the upper surface and also has a housing part defined by the upper surface and the lateral surface; the coil member is formed of a lead wire and has a coil main part, an extension part and a terminal part; the coil main part is wound onto the core; the core and the coil main part are accommodated in the housing part; the extension part extends from the coil main part and has a sectional shape which is substantially same as that of the coil main part; the extension part has at least one bent portion and is drawn out outside the housing part at least in part; the terminal part extends from the extension part and has a thickness size smaller than a diameter size of the extension part; the terminal part has an L-shape; and

a boundary between the terminal part and the extension part is located on the lateral surface of the case.

- 5 2. The choke coil as recited in claim 1, wherein the core has a closed ring shape.
3. The choke coil as recited in claim 1 or 2, wherein:
- 10 the terminal part is covered with solder at least in part; and the thickness size of the terminal part is larger than or equal to one quarter of the diameter size of the extension part and smaller than or equal to three quarters of the diameter size of the extension part.
- 15 4. The choke coil as recited in claim 3, wherein the thickness size of the terminal part is more than or equal to 0.2 mm and smaller than or equal to 0.6 mm.
- 20 5. The choke coil as recited in any one of claims 1 to 4, wherein:
- 25 the upper surface of the case is formed with at least two apertures; and the extension part is drawn out onto the upper surface of the case through one of the apertures.
- 30 6. The choke coil as recited in claim 5, wherein:
- the upper surface of the case is further formed with at least two groove portions which are continuous with the apertures, respectively; each of the groove portions has an end portion which is placed away from the apertures; and a distance between the end portions is longer than a distance between the apertures.
- 35 7. The choke coil as recited in any one of claims 1 to 6, wherein:
- the case comprises a single piece; and the terminal part protrudes downward from a lower end of the case.
- 40 45

**Amended claims under Art. 19.1 PCT**

- 50 1. [Amended]. A choke coil comprises a core, a coil member and a case, wherein:
- 55 the case has an upper surface and a lateral surface extending downward from the upper surface and also has a housing part defined by the upper surface and the lateral surface; the coil member is formed of a lead wire and has a coil main part, an extension part and a terminal part;

the coil main part is wound onto the core;  
 the core and the coil main part are accommodated in the housing part;  
 the extension part extends from the coil main part;  
 the extension part has at least one bent portion and is drawn out outside the housing part at least in part; and  
 the terminal part extends from the extension part and has a thickness size smaller than a diameter size of the extension part.

is substantially same as that of the coil main part; the terminal part has an L-shape; and a boundary between the terminal part and the extension part is located on the lateral surface of the case.

2. The choke coil as recited in claim 1, wherein the core has a closed ring shape.

3. The choke coil as recited in claim 1 or 2, wherein:

the terminal part is covered with solder at least in part; and  
 the thickness size of the terminal part is larger than or equal to one quarter of the diameter size of the extension part and smaller than or equal to three quarters of the diameter size of the extension part.

4. The choke coil as recited in claim 3, wherein the thickness size of the terminal part is more than or equal to 0.2 mm and smaller than or equal to 0.6 mm.

5. The choke coil as recited in any one of claims 1 to 4, wherein:

the upper surface of the case is formed with at least two apertures; and  
 the extension part is drawn out onto the upper surface of the case through one of the apertures.

6. The choke coil as recited in claim 5, wherein:

the upper surface of the case is further formed with at least two groove portions which are continuous with the apertures, respectively; each of the groove portions has an end portion which is placed away from the apertures; and a distance between the end portions is longer than a distance between the apertures.

7. The choke coil as recited in any one of claims 1 to 6, wherein:

the case comprises a single piece; and  
 the terminal part protrudes downward from a lower end of the case.

8. The choke coil as recited in any one of claims 1 to 7, wherein:

the extension part has a sectional shape which



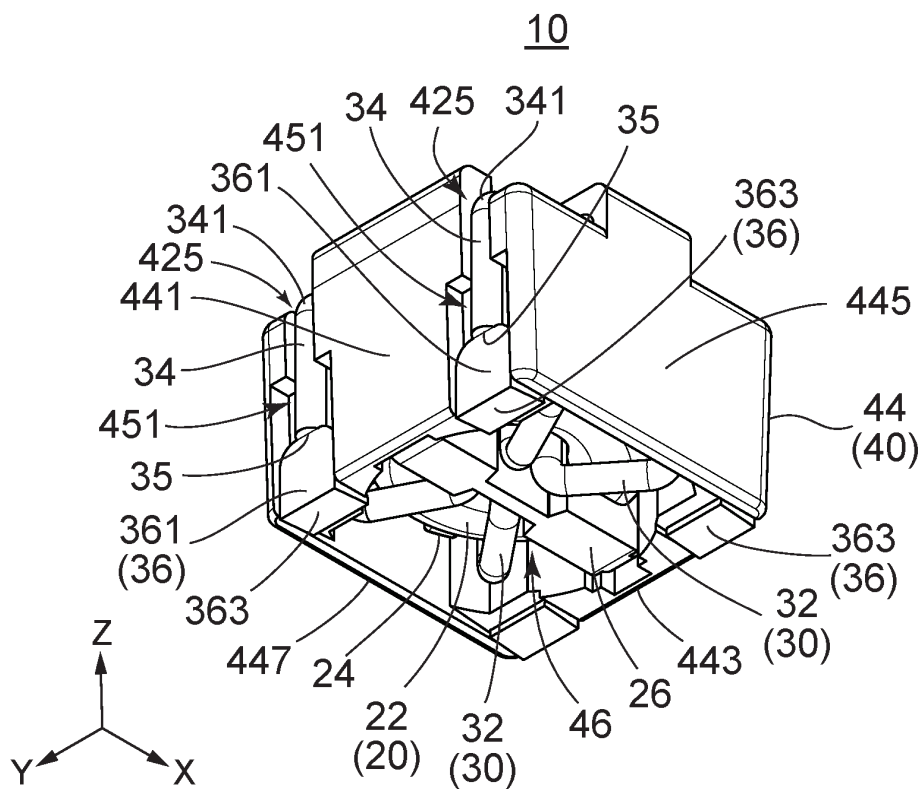


FIG. 1

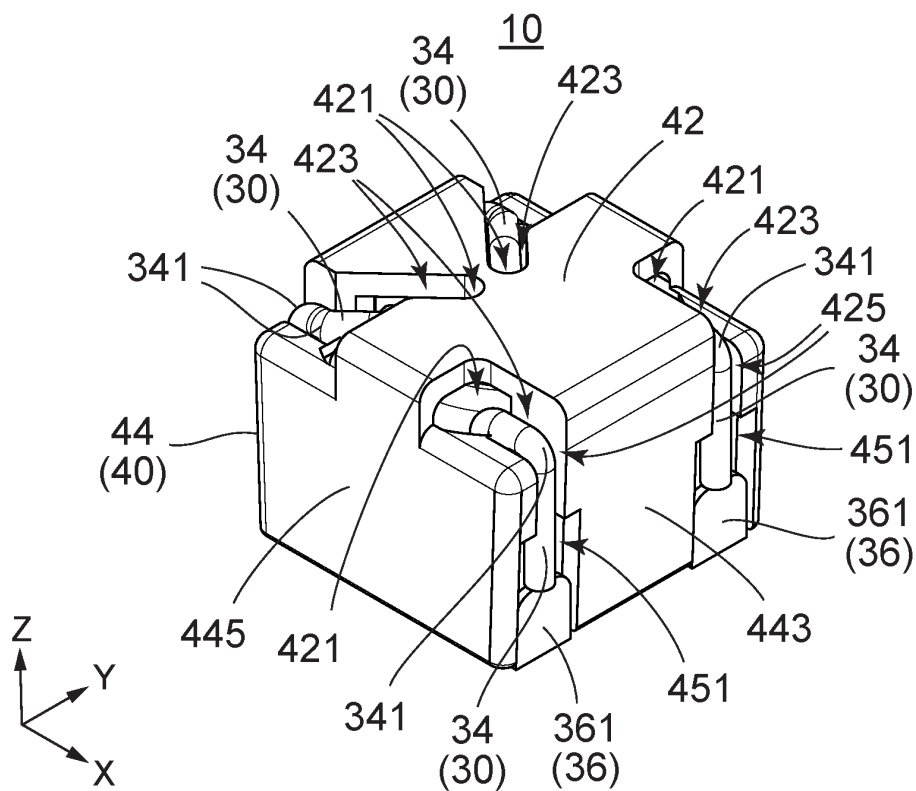


FIG. 2

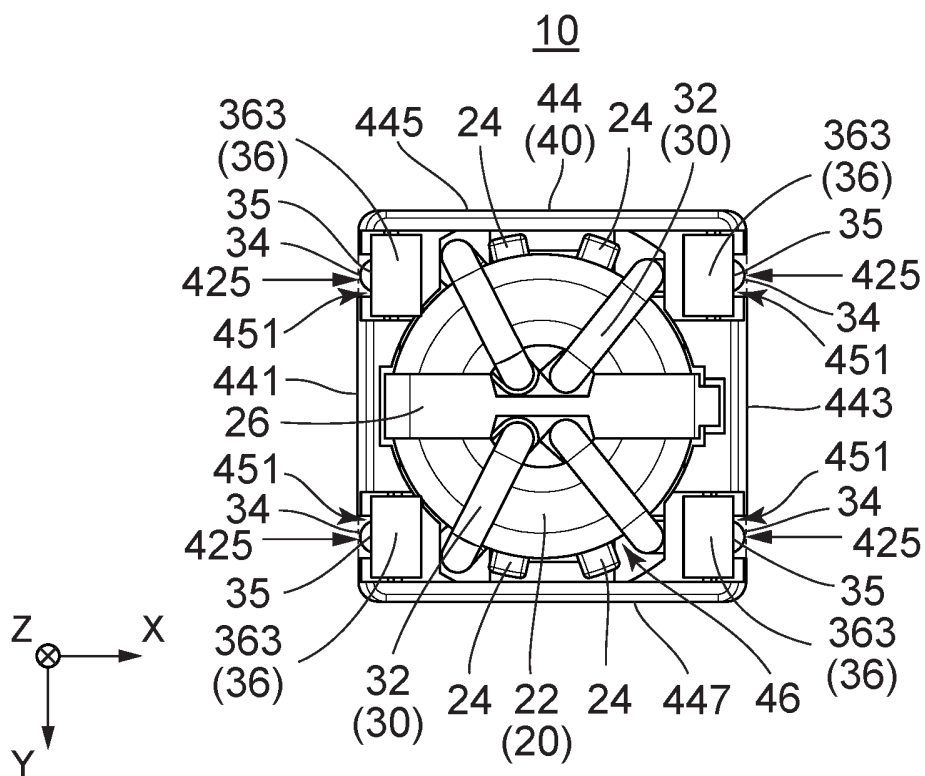


FIG. 3

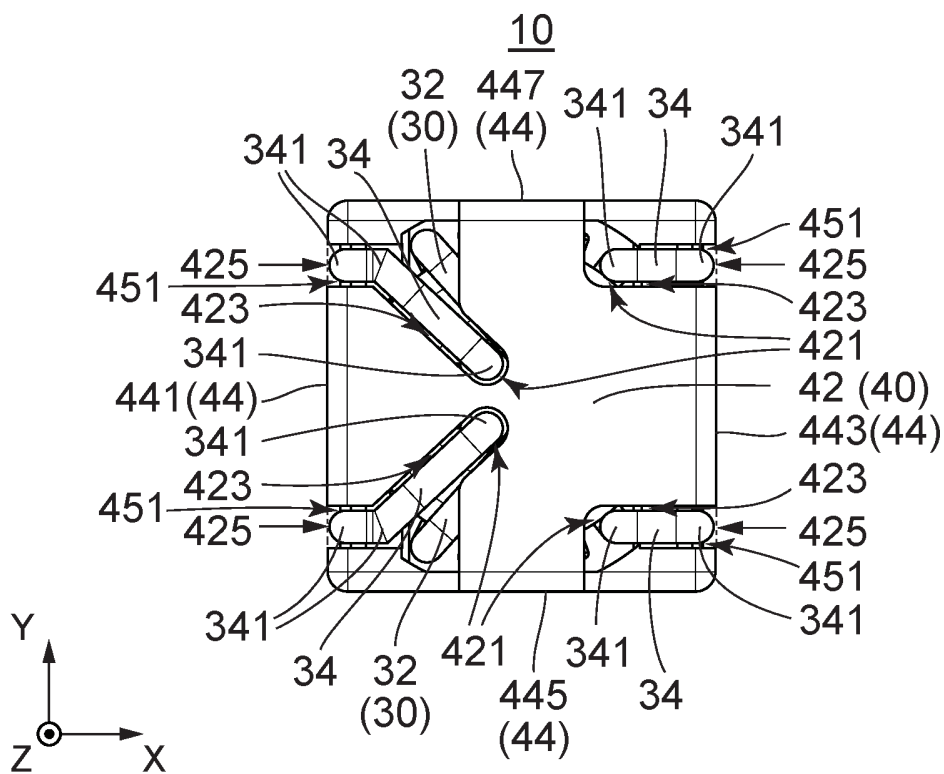


FIG. 4

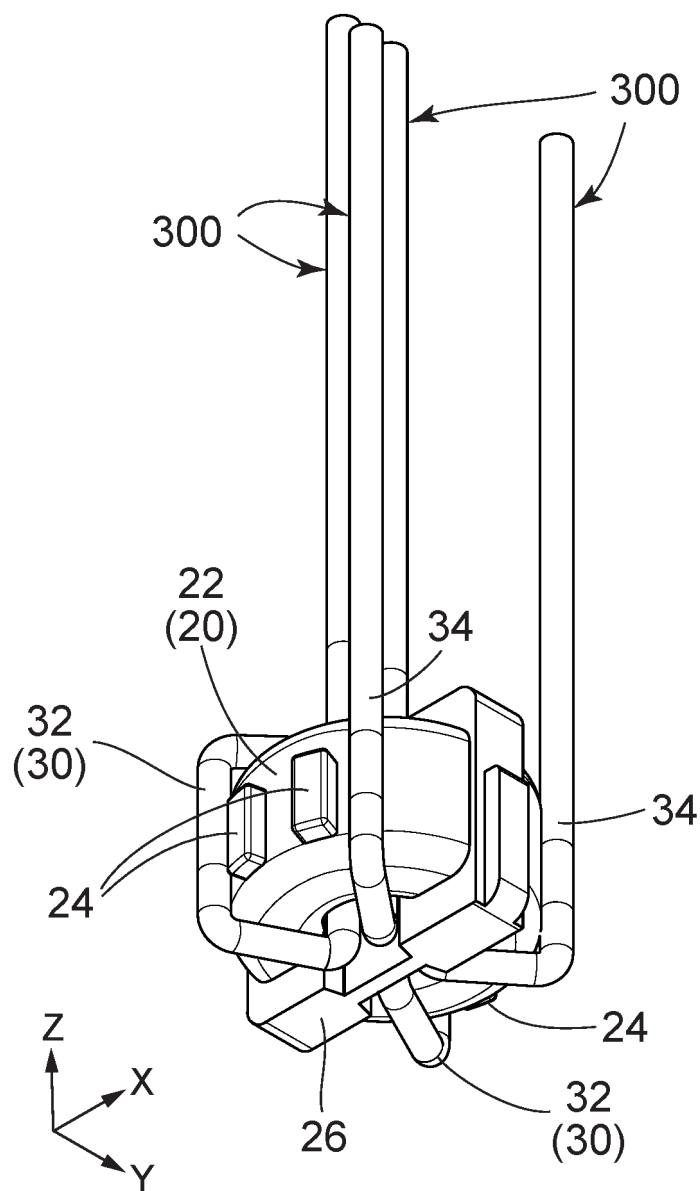


FIG. 5

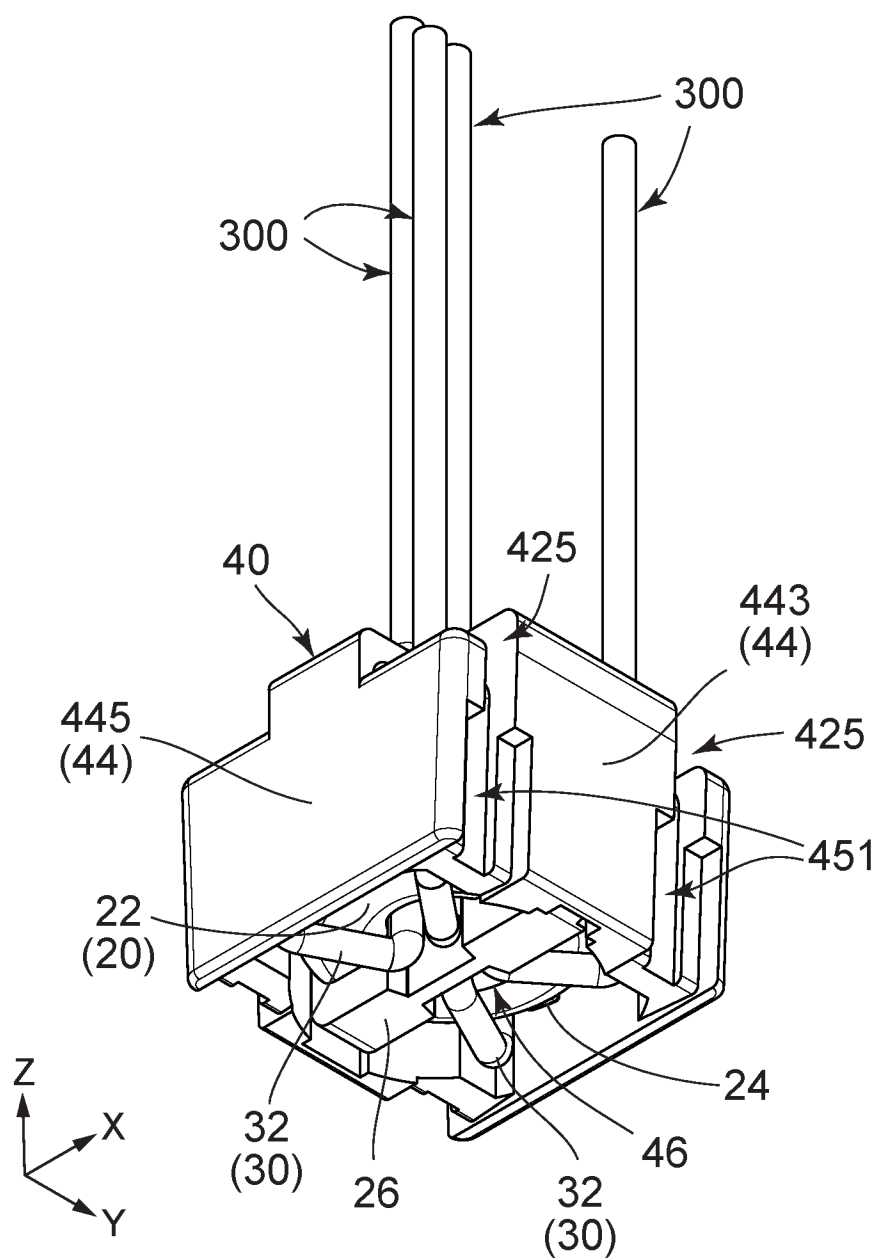


FIG. 6

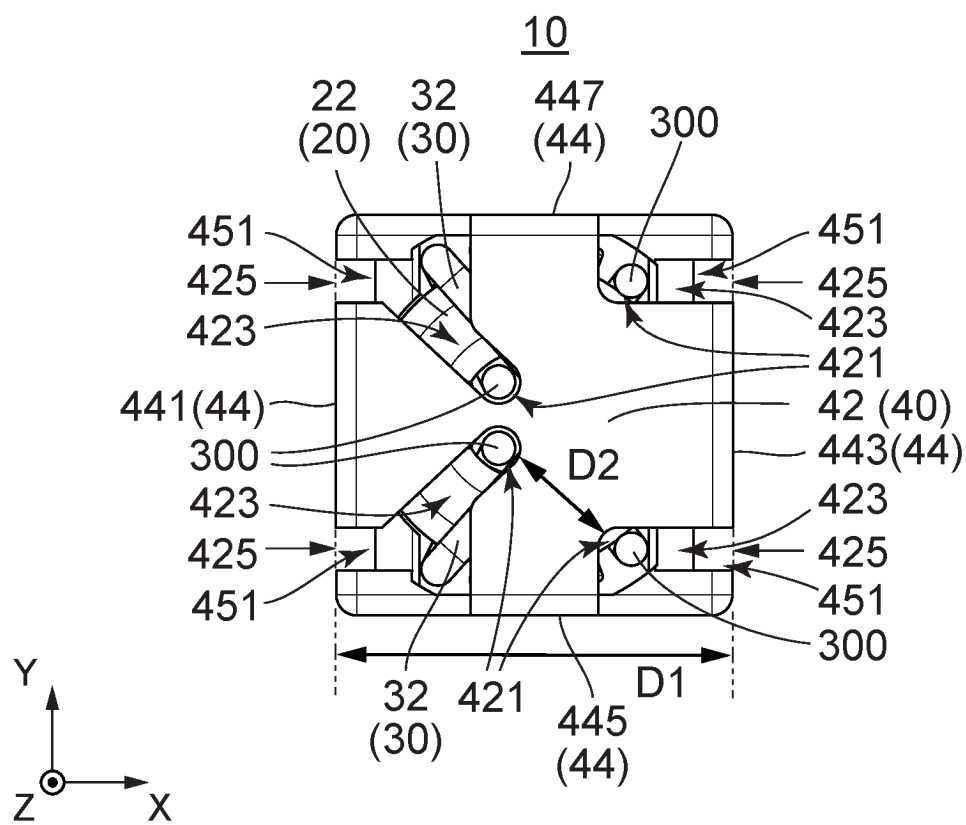
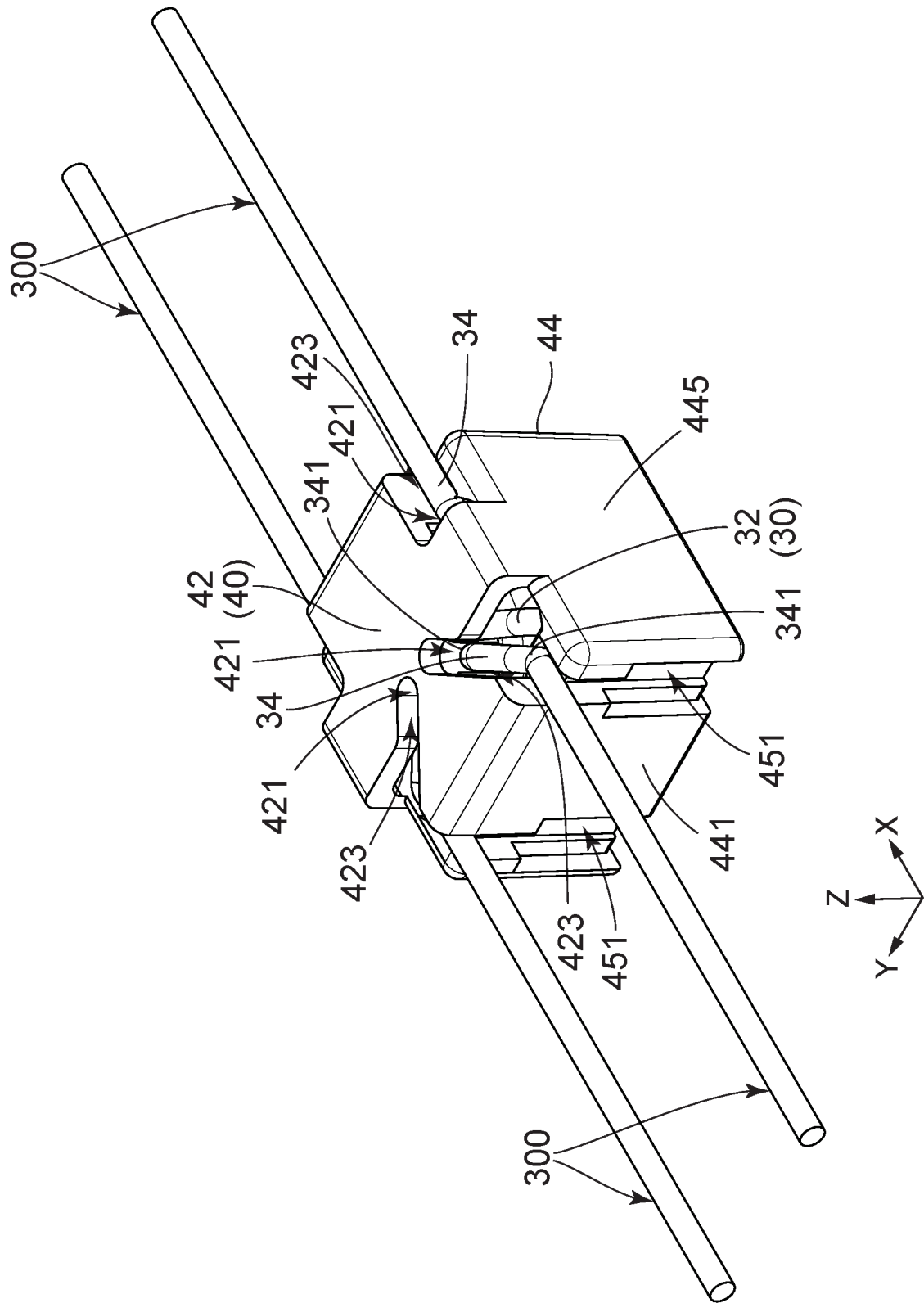


FIG. 7



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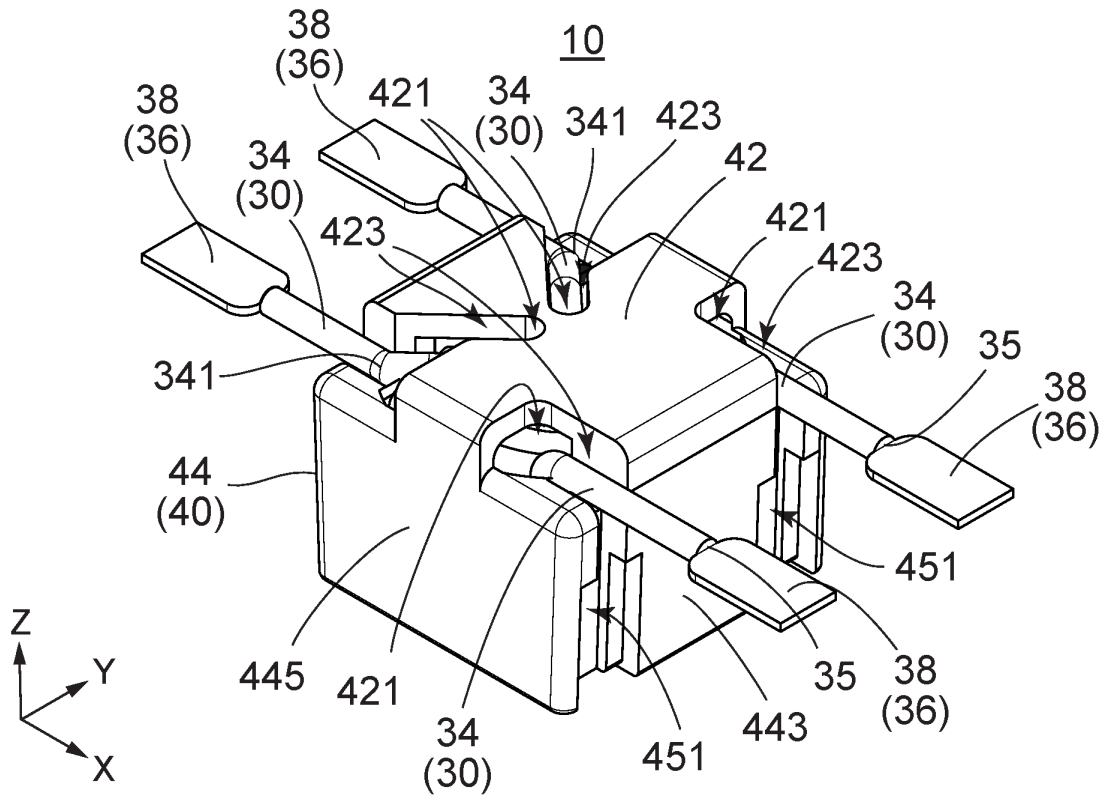


FIG. 9

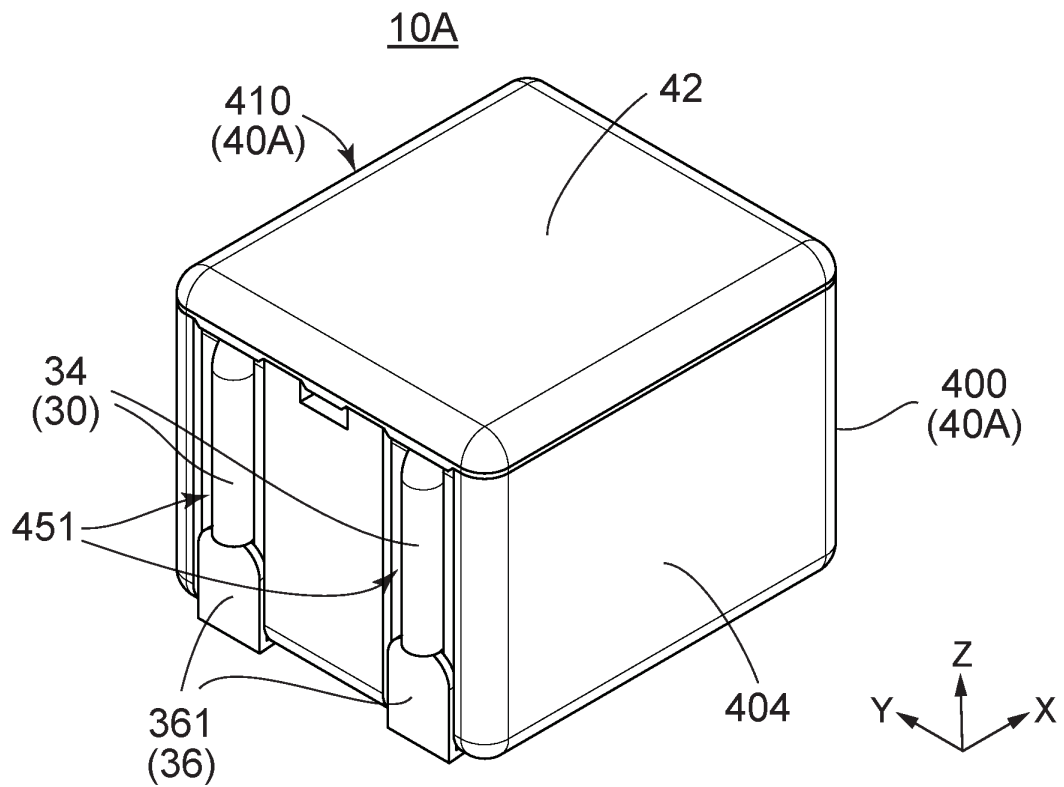


FIG. 10

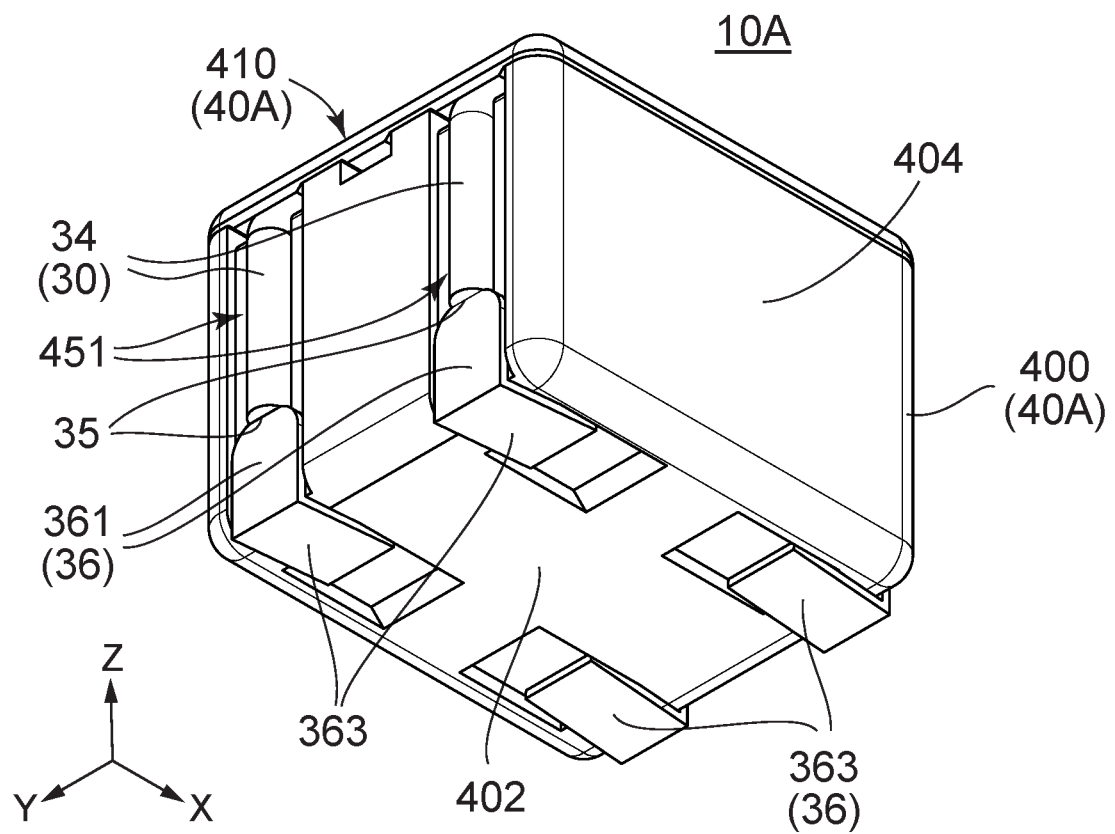


FIG. 11



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/034810

## A. CLASSIFICATION OF SUBJECT MATTER

**H01F 27/29**(2006.01)i; **H01F 17/06**(2006.01)i; **H01F 37/00**(2006.01)i  
 FI: H01F27/29 H; H01F37/00 N; H01F37/00 G; H01F17/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F17/00-27/00; H01F37/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996  
 Published unexamined utility model applications of Japan 1971-2024  
 Registered utility model specifications of Japan 1996-2024  
 Published registered utility model applications of Japan 1994-2024

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                      | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | WO 2017/169737 A1 (MURATA MANUFACTURING CO., LTD.) 05 October 2017 (2017-10-05)<br>entire text, all drawings                                                                                                            | 1-7                   |
| A         | JP 2007-227661 A (TDK CORPORATION) 06 September 2007 (2007-09-06)<br>entire text, all drawings                                                                                                                          | 1-7                   |
| A         | JP 11-16747 A (TOKIN CORP.) 22 January 1999 (1999-01-22)<br>entire text, all drawings                                                                                                                                   | 1-7                   |
| A         | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 134943/1988 (Laid-open No. 56415/1990) (TOKIN CORP.) 24 April 1990 (1990-04-24), entire text, all drawings | 1-7                   |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&amp;” document member of the same patent family

Date of the actual completion of the international search

06 November 2024

Date of mailing of the international search report

19 November 2024

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)  
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915  
 Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT  
Information on patent family members

International application No.  
**PCT/JP2024/034810**

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| Patent document<br>cited in search report | Publication date<br>(day/month/year) | Patent family member(s)                                           | Publication date<br>(day/month/year) |
|-------------------------------------------|--------------------------------------|-------------------------------------------------------------------|--------------------------------------|
| WO 2017/169737 A1                         | 05 October 2017                      | US 2018/0025831 A1<br>entire text, all drawings<br>CN 107533898 A |                                      |
| JP 2007-227661 A                          | 06 September 2007                    | (Family: none)                                                    |                                      |
| JP 11-16747 A                             | 22 January 1999                      | (Family: none)                                                    |                                      |
| JP 2-56415 U1                             | 24 April 1990                        | (Family: none)                                                    |                                      |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2000021655 A [0004]
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