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

(11) EP 2 804 256 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.11.2014 Bulletin 2014/47

(21) Application number: **14001751.8**

(22) Date of filing: **17.05.2014**

(51) Int Cl.:
H01Q 1/14 *(2006.01)* ***H01Q 1/32*** *(2006.01)*
H01Q 1/40 *(2006.01)* ***H01Q 1/08*** *(2006.01)*
H01Q 7/08 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **17.05.2013 JP 2013105068**

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(54) Antenna device and manufacturing method of antenna device

(57) There is provided an antenna device capable of securing waterproof property while suppressing changes of characteristics of the core, and a manufacturing method of an antenna device. An antenna device 10 has: a core body 20 having a core 21 formed of a magnetic material, a bobbin 30 having an insertion through hole 311 in which the core body 20 is inserted, a coil 40 disposed in the vicinity of the bobbin 30, and a case 50 which covers the coil 40 in the vicinity of the bobbin 30 in a state of sealing from an outside, has an insertion hole 511 allowing the core body 20 to be inserted therein in a state of communicating with the insertion through hole 311, and retains the core body 20 inside the insertion hole 511 after the core body 20 is inserted.

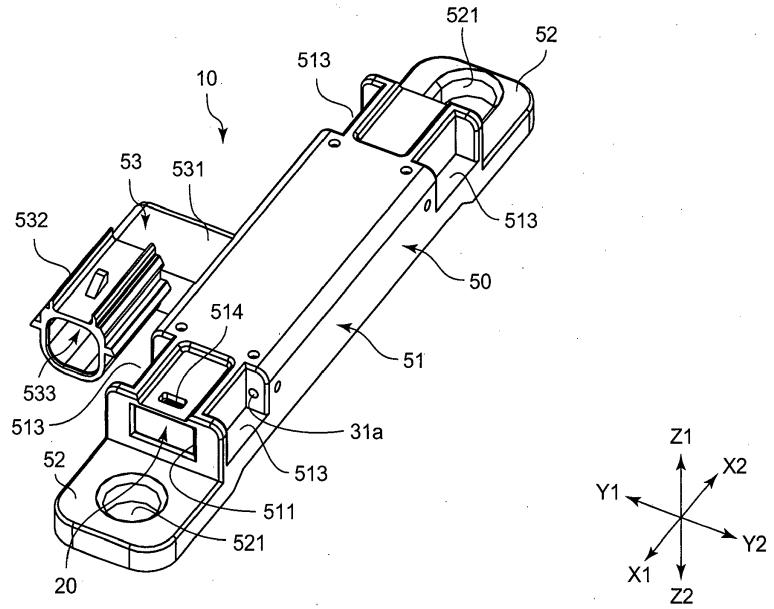

Fig.1

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Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to an antenna device and a manufacturing method of an antenna device.

2. DESCRIPTION OF THE RELATED ART

[0002] In recent years, vehicles have been increasing that have an antenna device mounted for receiving a signal for locking or unlocking a door. As such an antenna device, for example, there is one disclosed in Patent Document 1. In a structure disclosed in Patent Document 1, after a coil is formed on a core (magnetic body), a case is formed by molding so as to cover an outer peripheral side of a core.

[0003] [Patent Document 1] Japanese Patent Application Laid-open No. 2006-121278

SUMMARY OF THE INVENTION

[0004] Incidentally, in the structure disclosed in Patent Document 1, the case is formed by molding so as to cover the outer peripheral side of the core. Thus, reliability of waterproof property in the coil part is increased. However, there is a problem that characteristics of the core, such as inductance, are changed by pressure applied to the core during molding, contraction of the plastic case after molding, and the like. Further, there is another problem that the core cracks by large pressure applied to the core during molding.

[0005] The present invention is made in view of such problems, and it is an object thereof to provide an antenna device capable of securing waterproof property while suppressing changes of characteristics of the core, and a manufacturing method of an antenna device. Further, preferably, it is another object thereof to provide an antenna device capable of preventing cracking of the core, and a manufacturing method of an antenna device.

[0006] In order to solve the above problems, one aspect of an antenna device of the present invention has: a core body having a core formed of a magnetic material; a bobbin having an insertion through hole in which the core body is inserted; a coil disposed in a vicinity of the bobbin; and a case which covers the coil in the vicinity of the bobbin in a state of sealing from an outside, has an insertion hole allowing the core body to be inserted therein in a state of communicating with the insertion through hole, and retains the core body inside the insertion hole after the core body is inserted.

[0007] Further, in another aspect of the antenna device of the present invention, in addition to the above-described invention, preferably, the core body is provided to have a long shape, and at least one of one end side and another end side in a longitudinal direction of the core body is locked in a pressed state inside the insertion hole, and a portion between the one end side and the other end side in the longitudinal direction of the core body exists separately with a gap from an inside wall surface of the insertion hole.

[0008] Moreover, in another aspect of the antenna device of the present invention, in addition to the above-described invention, preferably, either one of the one end side and the other end side of the insertion hole is blocked, and locking projections supporting the core body in a tightly holding state are provided on a blocked deep side in the insertion hole.

[0009] Further, in another aspect of the antenna device of the present invention, in addition to the above-described invention, preferably, an outer peripheral side of the bobbin is provided with a circumferential projecting part projecting toward the case for sealing the coil from an outside, and at least a distal end side of the projecting part is integrated with an inner peripheral side of the case to form an integrated part.

[0010] Moreover, in another aspect of the antenna device of the present invention, in addition to the above-described invention, preferably, the core body is provided with a cap attached to the core, and a pulling-out restriction part which restricts the core body from being pulled out of the insertion hole is provided between the case and the cap.

[0011] Further, one aspect of a manufacturing method of an antenna device of the present invention has: a coil forming step of forming a coil by winding a conducting wire around a bobbin having an insertion through hole for inserting the core body having a core formed of a magnetic material; a setting step of setting the bobbin to a predetermined position inside a mold after the coil forming step; a case forming step of pouring a molten resin into the mold to form a case covering a vicinity of the bobbin in a state that the coil is sealed from an outside; and a core body attaching step of inserting the core body in an insertion hole communicating with the insertion through hole in the case formed in the case forming step, to thereby retain the core body in the insertion hole.

[0012] According to the present invention, it becomes possible to secure waterproof property while suppressing changes of characteristics of the core. Further, it becomes also possible to prevent cracking of a core.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a perspective view illustrating an overall structure of an antenna device according to one embodiment of the present invention;

Fig. 2 is a side cross-sectional view illustrating the structure of the antenna device of Fig. 1;

Fig. 3 is a perspective view illustrating a structure of a core body of Fig. 1;

Fig. 4 is a partial side cross-sectional view illustrating

a structure in the vicinity where a cap is attached to the core body of Fig. 1;

Fig. 5 is a perspective view illustrating a structure of a bobbin of Fig. 1; and

Fig. 6 is a front cross-sectional view of an area where locking projections exist in the antenna device of Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Hereinafter, an antenna device 10 according to one embodiment of the present invention will be described with reference to the drawings.

[0015] Note that in the following description, the side where a flange part 52 is located is a lower side (Z2 side), and the opposite side thereof is an upper side (Z1 side). Further, the side where an opening of an insertion hole 511 exists is one end side (X1 side), and the opposite side thereof where the opening of the insertion hole 511 does not exist is another end side (X2 side). Further, in Fig. 1, a direction orthogonal to the X direction and the Z direction is a Y direction, and the left side is a Y1 side and the opposite right side is a Y2 side.

[0016] Fig. 1 is a perspective view illustrating an overall structure of the antenna device 10. Fig. 2 is a side cross-sectional view illustrating the structure of the antenna device 10. As illustrated in Fig. 1 and Fig. 2, the antenna device 10 has, as main components, a core body 20, a bobbin 30, a coil 40, and a case 50.

[0017] Fig. 3 is a perspective view illustrating a structure of the core body 20. Fig. 4 is a partial side cross-sectional view illustrating a structure in the vicinity where a cap 22 is attached to the core body 20. The core body 20 includes a core 21 and a cap 22. The core 21 is formed of a magnetic material and is provided in a long shape in an X direction. Further, the core 21 has a rectangular cross section when seen from the front. Note that the core 21 is constituted of a magnetic material, and as the magnetic material it is possible to use, for example, one of various types of magnetic materials such as ferrite, such as nickel-based ferrite or manganese-based ferrite, permalloy, and sendust, and mixtures of various types of magnetic materials.

[0018] The cap 22 is attached so as to cover an outer peripheral side of the one end side (X1 side) of the core 21 and an end face of the one end side (X1 side). This cap 22 is formed of a resin as a material. The cap 22 has a block part 221 and a cylindrical part 222. The block part 221 is a block-shaped part located on the X1 side from the end face of the one end side (X1 side) of the core 21. From this block part 221, the cylindrical part 222 is provided to be directed toward the other end side (X2 side) of the core 21. The cylindrical part 222 is provided in a cylindrical shape so as to cover the outer peripheral surface of the core 21.

[0019] Note that as illustrated in Fig. 2, the cap 22 barely enters an insertion through hole 311 of the bobbin 30 and is located outside the bobbin 30, but enters the insertion hole 511 of a case 50, which will be described later.

[0020] Further, the cap 22 is provided with plural (four in Fig. 3 and Fig. 4) fins 223. The fins 223 are projecting parts preventing the core body 20 from being pulled out of the insertion hole 511 when the core body 20 is inserted in the insertion hole 511 of the case 50, which will be described later. Note that on the X1 side of the fin 223, a face orthogonal to a longitudinal direction (X direction) of the core body 20 exists, and on the X2 side of this orthogonal face, a slope gradually declining toward the core 21 exists.

[0021] Further, the cap 22 is provided with a fitting projection 224. Similarly to the fins 223, the fitting projection 224 also is a part to be a pulling-out preventer preventing the core body 20 from being pulled out of the insertion hole 511. However, the fitting projection 224 enters a fitting hole 514 of the case 50, which will be described later. By this, the fitting projection 224 functions as a pulling-out preventer of the core body 20. Here, on the fitting projection 224, a face 224a orthogonal to the longitudinal direction (X direction) of the core body 20 exists, but on the X2 side of this orthogonal face 224a, a slope 224b gradually declining toward the core 21 exists. The slope 224b is a part to function as a guide for fitting the fitting projection 224 into the fitting hole 514, and the orthogonal face 224a is a part to function as a pulling-out preventer of the core body 20 by abutting on an inside wall of the fitting hole 514.

[0022] Note that the fitting projection 224 and the fitting hole 514 function as a pulling-out restriction part.

[0023] Next, the bobbin 30 will be described. The bobbin 30 is formed of, for example, a thermoplastic resin such as PBT (polybutylene terephthalate) resin as a material. Fig. 5 is a perspective view illustrating a structure of the bobbin 30. As illustrated in Fig. 5, the bobbin 30 has a cylindrical body part 31 and a terminal attachment part 32. The cylindrical body part 31 is a part having a cylindrical shape covering the core 21, is formed to be shorter than the length of the core 21, and is provided so that the one end side and the other end side of the core 21 project from the cylindrical body part 31.

[0024] The cylindrical body part 31 is provided with the insertion through hole 311. The insertion through hole 311 is a hole penetrating through the cylindrical body part 31, and the core 21 is inserted in this insertion through hole 311. Thus, the insertion through hole 311 is provided to have a rectangular shape corresponding to the rectangular shape which is the cross-sectional shape of the core 21, and the insertion through hole 311 is formed larger than the cross-sectional shape of the core 21 to an extent that allows easily inserting the core 21. However, it may be structured to restrict, by the cap 22 reaching the insertion through hole 311, the core 21 from pushed into the insertion through hole 311.

[0025] Further, the cylindrical body part 31 is provided with a winding frame part 312 and sealing parts 313. The

winding frame part 312 is a part on which the coil 40 is disposed, and is formed to recess from the sealing parts 313. Thus, the coil 40 disposed on the winding frame part 312 does not project more than the sealing parts 313, and is in a state that it is also possible to perform positioning of the coil 40.

[0026] Further, the sealing parts 313 are provided on both end sides sandwiching the winding frame part 312 in the structure illustrated in Fig. 5. The sealing parts 313 are formed to project outward from the winding frame part 312 (toward the side departing from a center line of the insertion through hole 311). In the following description, when it is necessary to distinguish the pair of sealing parts 313, the sealing part 313 on one end side (X1 side) is referred to as a sealing part 313a, and the sealing part 313 on the other end side is referred to as a sealing part 313b.

[0027] Each sealing part 313 is provided with fins 314 corresponding to a projecting part. Plural (four each in Fig. 5) fins 314 are provided, which project in an annular form so as to extend across an outer periphery of the sealing part 313. These fins 314 are parts which abut on inside walls 511 a of an insertion hole 511 of the case 50, which will be described later. Thus, the fins 314 seal the insertion hole 511 from the outside. Here, as will be described later, the case 50 is formed by injection molding after the bobbin 30 in a state that the coil 40 is formed thereon is placed in a mold. Then, due to the temperature and so on during the injection molding, tip sides of the fins 314 melt to form an integrated part M integrated with the case 50 (inside walls 511 a of the case 50 in particular). By formation of such an integrated part M, sealing property of the insertion hole from the outside improves, and thus waterproof property can be improved.

[0028] Further, the bobbin 30 is provided with a guide trench 315. The guide trench 315 is a trench part for guiding a conducting wire to be bound to a connection terminal 60 (60a), which will be described later. A portion of this guide trench 315 is formed in the terminal attachment part 32, but a main portion of the guide trench 315 is formed in the cylindrical body part 31 and is formed in particular across the entire X direction of the winding frame part 312. The guide trench 315 is provided to recess from the winding frame part 312, and is formed such that the depth of the recess is to an extent of allowing sufficient insertion of the lead wire.

[0029] Further, the guide trench 315 is provided to continue to a vertical trench 316. The vertical trench 316 is formed by recessing an outer peripheral surface along the vertical direction (Z direction) of the sealing part 313b toward the Y2 side. The vertical trench 316 is provided to recess toward the Y2 side from the outer peripheral surface along the vertical direction (Z direction) of the winding frame part 312.

[0030] Further, between the vertical trench 316 and the winding frame part 312, a flange part 317 partitioning them is provided. The flange part 317 is provided to project toward the Y1 side from the winding frame part 312. In addition, the flange part 317 is provided to project also toward a lower side (Z2 side) and an upper side (Z1 side). In particular, by the flange part 317 provided to project toward the lower side (Z2 side), the conducting wire passed through the vertical trench 316 is routed around the lower side of this flange part 317 and is guided to the winding frame part 312. Thus, it is possible to route the conducting wire in a position recessed from the winding frame part 312 and the sealing part 313b, and it is possible to prevent breakage of the conducting wire when large pressure is applied during injection molding of the case 50.

[0031] Note that as illustrated in Fig. 5, the conducting wire passed through the vertical trench 316 and wound on the winding frame part 312 to form the coil 40 is routed around an end portion of a flange part 319 and then introduced into a wiring trench 318. The function of the wiring trench 318 is similar to the above-described guide trench 315 and vertical trench 316. However, there is a difference such that the guide trench 315 and the vertical trench 316 are parts the conducting wire enters before forming the coil 40, whereas the wiring trench 318 is a part the conducting wire enters after forming the coil 40. The wiring trench 318 is provided from a portion adjacent to the sealing part 313a to a portion where a connection terminal 60 (60b) of the terminal attachment part 32 exists in the cylindrical body part 31.

[0032] Further, the terminal attachment part 32 is provided to project toward the Y1 side from a portion adjacent to the sealing part 313a in a side face of the cylindrical body part 31. This terminal attachment part 32 is a part to which the connection terminals 60 are attached. In this embodiment, the terminal attachment part 32 is provided with holes (not illustrated) for inserting the connection terminals 60, and the connection terminals 60 are attached by inserting the connection terminals 60 in the holes. However, they may be formed by inserting the connection terminals 60 when the case 50 is formed by injection molding.

[0033] Note that in this embodiment, a capacitor 61 is attached to the terminal attachment part 32. Then, one side of the capacitor 61 is attached to the connection terminal 60a, and the other side of the capacitor 61 is connected to the connection terminal 60c. However, a structure omitting the capacitor 61 may be employed, and in this case, the connection terminal 60a has the same structure as the connection terminal 60b.

[0034] Further, the coil 40 is a part formed by winding the conducting wire. In this embodiment, the coil 40 is of single layer winding (wound by only one layer), but the coil 40 may also be of multilayer winding.

[0035] Next, the case 50 will be described. The case 50 covers a part excluding the insertion through hole 311 of the bobbin 30 to which the coil 40 is attached. As illustrated in Fig. 1, the case 50 has a case main body 51, flange parts 52, and a side projecting part 53. The case main body 51 is a part provided to be cylindrical in the case 50, and has the insertion hole 511 extending along

a longitudinal direction (X direction). However, the case main body 51 is provided to be cylindrical with a bottom in which opening on the other end side of the insertion hole 511 is blocked, which is different from the cylindrical body part 31 of the bobbin 30.

[0036] Note that the case 50 is formed of, for example, a thermoplastic resin such as PBT (polybutylene terephthalate) resin as a material. Here, when the bobbin 30 and the case 50 are of the same material, the integrated part M can be formed easily by that the fins 314 are integrated with the inside walls 511a of the case 50. However, the bobbin 30 and the case 50 may be of different materials. Further, it is preferred that the fins 314 form the integrated part M with the inside walls 511a of the case 50, but the fins 314 need not form the integrated part M.

[0037] The bobbin 30 on which the coil 40 is formed is located in the insertion hole 511. In addition, in the insertion hole 511, the core body 20 is located in a state of being inserted in the insertion through hole 311 of the bobbin 30, but the one end side and the other end side of the core body 20 project from the insertion through hole 311 and directly located in the insertion hole 511.

[0038] Here, as illustrated in Fig. 2, on a deep side (X2 side) of the insertion hole 511, locking projections 512 are provided to project from the inside walls 511a. The locking projections 512 are projections for locking the core 21 located on the deep side (X2 side) to suppress a backlash of the core body 20, and to prevent the core body 20 from being pulled out of the insertion hole 511. Fig. 6 is a front cross-sectional view of an area where the locking projections 512 exist in the antenna device 10. As illustrated in Fig. 6, the locking projections 512 project from the inside walls 511a of a bottom surface, a top surface, and side surfaces. Then, an area (rectangular area in this embodiment) obtained by coupling distal end sides of these locking projections 512 is made slightly smaller than a cross-sectional shape of the core 21. Thus, the core 21 is in a state of being held tight favorably by the locking projections 512 without a backlash.

[0039] Note that in the structure illustrated in Fig. 6, one locking projection 512 projects from each side face, but two locking projections 512 are formed to project from each of the top surface and the bottom surface which have a larger area than the side face. Further, as illustrated in Fig. 2, the locking projections 512 are provided to have a long shape which is long in the X direction.

[0040] Further, the case main body 51 is provided with recessed parts 513. The recessed parts 513 are provided on both end sides of the longitudinal direction (X direction) of the case main body 51, and each formed by recessing from an outer peripheral side of the case main body 51. Here, as illustrated in Fig. 5, the bobbin 30 is provided with positioning projections 31a, and distal ends of these positioning projections 31a abut on portions projecting on insides of a mold (mold inside walls or inserts). Thus, the position of the bobbin 30 is determined inside the mold, and parts corresponding to the projecting portions are the recessed parts 513. In this embodiment, the recessed parts 513 are provided respectively in end portion sides in a width direction (Y direction) of the case main body 51, and also provided respectively in end portions in a longitudinal direction (X direction) (four in total).

[0041] Further, the case main body 51 is provided with a fitting hole 514. The fitting hole 514 is located to be biased to the end portion of the one end side (X1 side) in a top surface of the case main body 51, and moreover, when the core body 20 is inserted in the insertion hole 511, it is disposed to be located on the upper side of the block part 221. This fitting hole 514 is a hole which the above-described fitting projection 224 fits in. With an inside wall on the X1 side of this fitting hole 514, the above-described orthogonal face 224a comes in contact to restrict movement of the core body 20 toward the X1 side. Thus, it is possible to prevent the core body 20 from being pulled out of the insertion hole 511.

[0042] Further, flange parts 52 are provided continuously on the case main body 51. The flange parts 52 are parts which come in contact with an attachment area of a vehicle or the like when the antenna device 10 is attached to the attachment area. At this time, it is possible to separate the case main body 51 from the attachment area of the vehicle or the like. To enable such separation of the case main body 51, a lower surface of the flange part 52 is provided to project further downward from the lower surface of the case main body 51. The flange parts 52 are provided to project toward the one end side (X1 side) and the other end side (X2 side), respectively, from the case main body 51. Further, an attachment hole 521 is provided in each flange part 52. The attachment hole 521 penetrates the flange part 52, and a fastening means such as a screw is inserted therein. Thus, it is possible to fix the antenna device 10 to the attachment area of a vehicle or the like. Note that in the structure illustrated in Fig. 2, one of the pair of attachment holes 521 is provided to have a long hole shape.

[0043] Further, as illustrated in Fig. 1, a side projecting part 53 is formed to project from a side on the Y1 side of the case main body 51. The side projecting part 53 is a part to cover the terminal attachment part 32. Note that the side projecting part 53 also covers the connection terminals 60. That is, the bobbin 30 is placed inside the mold in a state that the connection terminals 60 are inserted in the holes of the terminal attachment part 32. The case 50 is injection molded in this state, and thus the side projecting part 53 is in a state of covering the connection terminals 60 also. In the following description, the portion in the side projecting part 53 extending in the Y direction to cover the terminal attachment part 32 will be referred to as a side cover part 531.

[0044] Further, a connector connecting part 532 is provided in the side projecting part 53. The connector connecting part 532 is a part projecting toward the X1 side from the side cover part 531. This connector connecting part 532 is a cylindrical part having a connector hole 533, and pin-like portions on the X1 side of the connection

terminals 60b, 60c project inside the connector hole 533. Thus, when an external connector is inserted in the connector hole 533, this connector and the connection terminals 60b, 60c are electrically connected, thereby allowing conduction of electric current through the coil 40.

<Regarding a manufacturing method>

[0045] A manufacturing method of the antenna device 10 structured as above will be described below. When the antenna device 10 is produced, the bobbin 30 is formed by, for example, molding in advance. Then, the connection terminals 60 are inserted in the holes of the terminal attachment part 32 of the bobbin 30. Next, one end of a conducting wire is bound on a binding part 60a1, the conducting wire is routed through the guide trench 315 and further routed through the vertical trench 316, and after the conducting wire is routed around the lower side of the flange part 317, the conducting wire is guided to the winding frame part 312. Then the conducting wire is wound on the winding frame part 312 to form the coil 40.

[0046] After forming the coil 40, the conducting wire is routed around the lower side of the flange part 319, and the conducting wire is routed through the wiring trench 318 and guided to the connection terminal 60b. Then, the conducting wire is bound on a binding part 60b1. On the winding frame part 312, the conducting wire is wound to be a single layer winding (in a state of being wound by one layer) to form the coil 40. However, on the winding frame part 312, the conducting wire may be wound to be a multilayer winding to form the coil 40. Note that before and after forming this coil 40, the capacitor 61 may be attached to the terminal attachment part 32.

[0047] Next, in a state that the core body 20 is not inserted in the insertion through hole 311 of the bobbin 30, the bobbin 30 is set inside the mold. At this time, the positioning projections 31a are made to abut on the portions projecting on the insides of the mold (mold inside walls or inserts) to position the bobbin 30 inside the mold. Then, a core corresponding to the insertion hole 511 is inserted in the insertion through hole 311, and other preparations before injection molding are completed.

[0048] Thereafter, a molten thermoplastic resin is poured into the mold with a predetermined injection pressure, so as to perform molding. Then, the temperature in the mold is lowered to cure the resin poured in, thereby forming the case 50. Thereafter, an upper die and a lower die of the mold are released to take out the antenna device 10 in a state that the case 50 is formed.

[0049] Further, separately from the above-described formation of the coil 40 and formation of the case 50, the cap 22 is attached to the core 21 to form the core body 20. Thereafter, the core body 20 is inserted in the insertion hole 511. At this time, as the core body 20 is inserted in the deep side of the insertion hole 511, the deep side of the core 21 is brought into a state of being held tight by the plural locking projections 512. As the core body 20 is further inserted in the insertion hole 511, the fitting projection 224 fits in the fitting hole 514. Thus, insertion of the core body 20 is completed. As described above, the antenna device 10 in which the core body 20 is inserted in the insertion hole 511 (insertion through hole 311) is formed after the case 50 is molded.

<Regarding effects>

[0050] In the antenna device 10 structured as above, the core body 20 is inserted in the insertion hole 511 of the case 50 after the case 50 is formed by molding, and after this insertion, the core body 20 is retained inside the insertion hole 511. Thus, a structure is made possible in which the core body 20 does not exist in the insertion hole 511 during molding of the case 50, and a state that pressure (such as injection pressure) is not applied to the core body 20 (core 21) can be created during molding of the case 50. Further, when the case 50 contracts after molding the case 50 made of resin, it is possible to prevent application of pressure by this contraction to the core body 20 (core 21). Thus, variations of characteristics of the core 21, such as inductance, can be suppressed, and fluctuation of characteristics of the antenna device 10 can be suppressed.

[0051] Further, since the antenna device 10 can be formed in a state that high pressure (injection pressure or the like) during molding of the case 50 is not applied, it is possible to prevent cracking of the core 21.

[0052] Moreover, the vicinity of the coil 40 is covered with the molded case 50, and thus waterproof property of the coil 40 can be enhanced.

[0053] Further, in this embodiment, the core body 20 (core 21) is locked in a pressed state by the locking projections 512 inside the insertion hole 511, and a portion excluding the part retained by the locking projections 512 and the cap 22 in the core 21 exists with a gap from the inside walls 511 a of the insertion hole 511. Thus, pressure to be applied to the core 21 can be reduced, and variations of characteristics of the core 21, such as inductance, can be suppressed more reliably.

[0054] Moreover, in this embodiment, the deep side (X2 side) with a bottom in the insertion hole 511 is provided with the locking projections 512 supporting the core body 20 in a tightly held state. Accordingly, it is possible to reliably hold the core body 20 (core 21) in a state that the core body 20 has no backlash in the insertion hole 511. Further, it is possible to reduce contact portions of the case 50 with the core 21 by the structure such that the locking projections 512 abut on the core 21, and thus variations of characteristics of the core 21, such as inductance, can be suppressed more reliably.

[0055] Further, in this embodiment, the fins 314 are provided on the outer peripheral side of the bobbin 30, and the fins 314 form the integrated part M with the inside walls 511 a of the case 50. The existence of the fins 314 hinders formation of a gap between the bobbin 30 and the case 50. In addition, it is possible to suppress separation of the bobbin 30 and the case 50. Thus, it is pos-

sible to improve waterproof property from the outside with respect to the coil 40 existing between the bobbin 30 and the case 50. That is, the existence of the fins 314 makes it possible to further improve waterproof property of the coil 40.

[0056] Moreover, in this embodiment, the core body 20 is provided with the cap 22, and between the case 50 and the cap 22, the fitting projection 224 and the fitting hole 514 constituting a pulling-out restriction part are provided. Thus, it is possible to favorably prevent the core body 20 from being pulled out of the insertion hole 511.

<Modification example>

[0057] In the foregoing, one embodiment of the present invention has been described, but the invention can be changed variously other than this embodiment. Such changes will be described below.

[0058] In the above-described embodiment, the case main body 51 is provided to be cylindrical with a bottom with the opening on the other end side (X2 side) of the insertion hole 511 being blocked. However, in the case main body, the other end side may be opened without being blocked.

[0059] Further, in the above-described embodiment, the locking projections 512 locking the core 21 are provided to project from the inside walls of the insertion hole 511 of the case main body 51. However, such locking projections may be provided inside the insertion through hole 311 of the bobbin 30. Also by such a structure, the core body 20 can be held favorably. Note that the locking projections may be provided only in the insertion through hole 311, or may be provided in both the insertion hole 511 and the insertion through hole 311.

[0060] Further, in the above-described embodiment, the core body 20 is formed of the core 21 and the cap 22. However, the core body 20 may be formed only of the core 21. Further, a projecting part similar to the fitting projection may be provided on the core 21, allowing this projecting part to function as a pulling-out restriction part.

[0061] Further, although the bobbin 30 is provided with fins 314 in the above-described embodiment, a structure in which these fins 314 are omitted may be employed. Further, the fins 314 need not be provided to have an annular form, and may be provided to have, for example, a form other than the annular form, such as a spiral form or an arch form.

[0062] Further, in the above-described embodiment, the locking projections 512 are in a state of being pressed against the core 21 without adhering thereto. That is, the interface between the core 21 and the locking projections 512 is not bonded, and is in a state that they can be easily separated when the pressing force is released. However, a structure in which an adhesive layer formed by applying an adhesive intervenes between the core 21 and the locking projections 512 may be employed. Note that the adhesive layer may employ a structure to exist in a portion other than the portion to abut on the locking projections 512 of the core 21 in the core body 20.

Description of Reference Numerals

[0063]

10	antenna device
20	core body
21	core
22	cap
30	bobbin
31	cylindrical body part
32	terminal attachment part
40	coil
50	case
51	case main body
52	flange part
31a	positioning projection
53	side projecting part
60	connection terminal
61	capacitor
60a to 60c	connection terminal
60a1, 60b1	binding part
221	block part
222	cylindrical part
223	fin
224	fitting projection (corresponding to part of a pulling-out restriction part)
224a	orthogonal face
224b	slope
311	insertion through hole
312	winding frame part
313	sealing part
313a, 313b	sealing part
314	fin (corresponding to a projecting part)
315	guide trench
316	vertical trench
317	flange part
318	wiring trench
319	flange part,
511	insertion hole
511a	inside wall
512	locking projection
513	recessed part
514	fitting hole (corresponding to part of a pulling-out restriction part)
521	attachment hole
531	side cover part
532	connector connecting part
533	connector hole
M	integrated part

Claims

1. An antenna device, comprising:

a core body having a core formed of a magnetic

material;
a bobbin having an insertion through hole in which the core body is inserted;
a coil disposed in a vicinity of the bobbin; and
a case which covers the coil in the vicinity of the bobbin in a state of sealing from an outside, has an insertion hole allowing the core body to be inserted therein in a state of communicating with the insertion through hole, and retains the core body inside the insertion hole after the core body is inserted.

2. The antenna device according to claim 1, wherein the core body is provided to have a long shape, and at least one of one end side and another end side in a longitudinal direction of the core body is locked in a pressed state inside the insertion hole, and a portion between the one end side and the other end side in the longitudinal direction of the core body exists separately with a gap from an inside wall surface of the insertion hole.

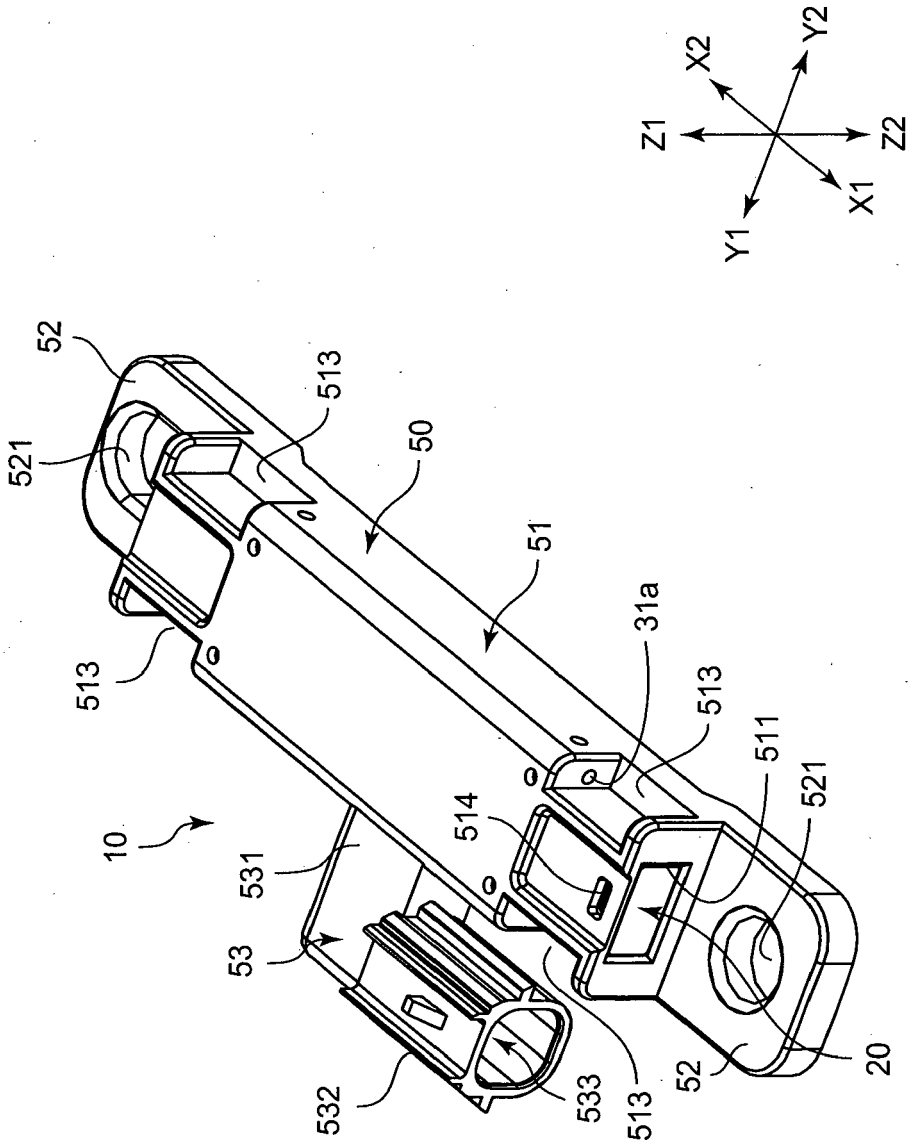
3. The antenna device according to claim 2, wherein either one of the one end side and the other end side of the insertion hole is blocked, and locking projections supporting the core body in a tightly holding state are provided on a blocked deep side in the insertion hole.

4. The antenna device according to any one of claims 1 to 3, wherein
an outer peripheral side of the bobbin is provided with a circumferential projecting part projecting toward the case for sealing the coil from an outside, and at least a distal end side of the projecting part is integrated with an inner peripheral side of the case to form an integrated part.

5. The antenna device according to any one of claims 1 to 4, wherein t
he core body is provided with a cap attached to the core, and
a pulling-out restriction part which restricts the core body from being pulled out of the insertion hole is provided between the case and the cap.

6. A manufacturing method of an antenna device, the method comprising:

a coil forming step of forming a coil by winding a conducting wire around a bobbin having an insertion through hole for inserting the core body having a core formed of a magnetic material;
a setting step of setting the bobbin to a predetermined position inside a mold after the coil forming step;
a case forming step of pouring a molten resin into the mold to form a case covering a vicinity of the bobbin in a state that the coil is sealed from an outside; and
a core body attaching step of inserting the core body in an insertion hole communicating with the insertion through hole in the case formed in the case forming step, to thereby retain the core body in the insertion hole.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X2
Z1
Z2
X1
Y1
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521
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513
31a
513
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514
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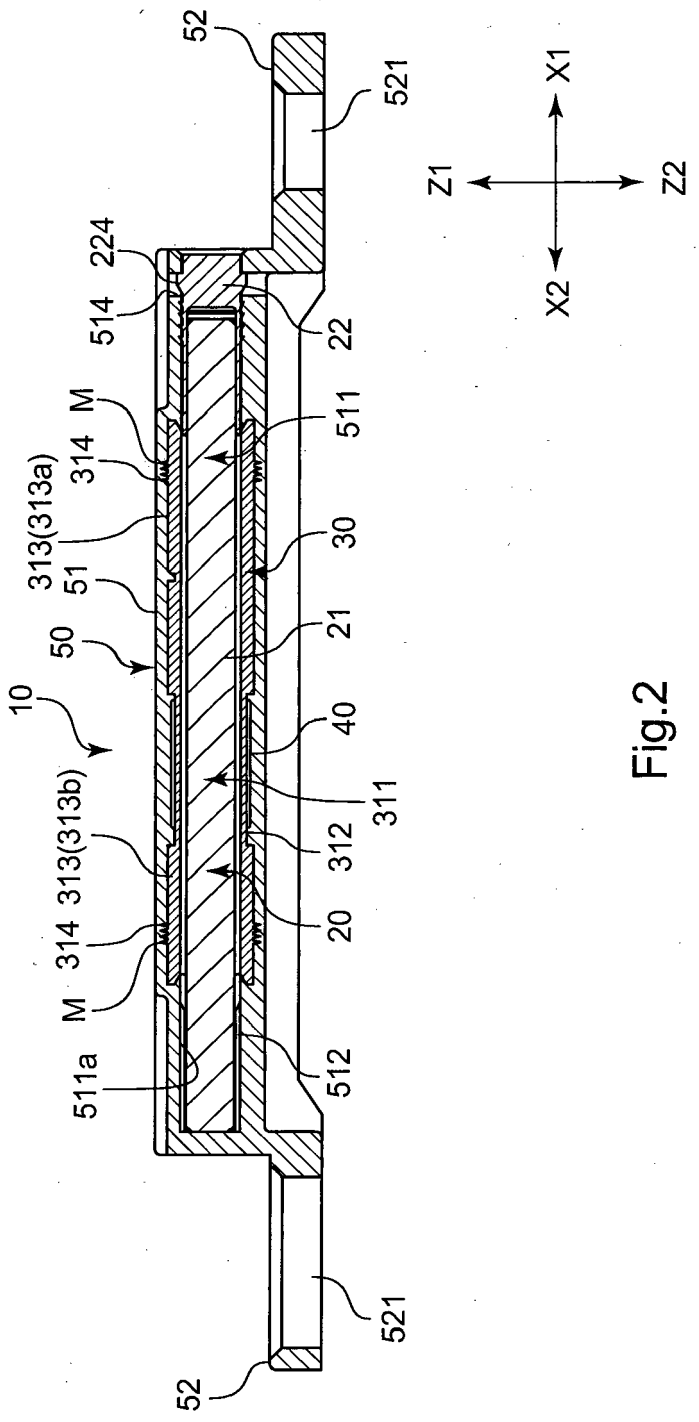
531
53
532
533
513
52
20

Fig.1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521
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M
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M
511a
512
521
52
X1
Z1
Z2
X2

Fig.2

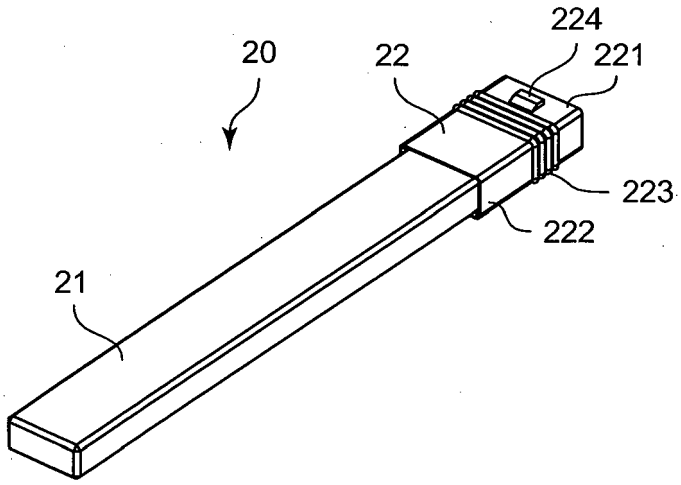


Fig.3

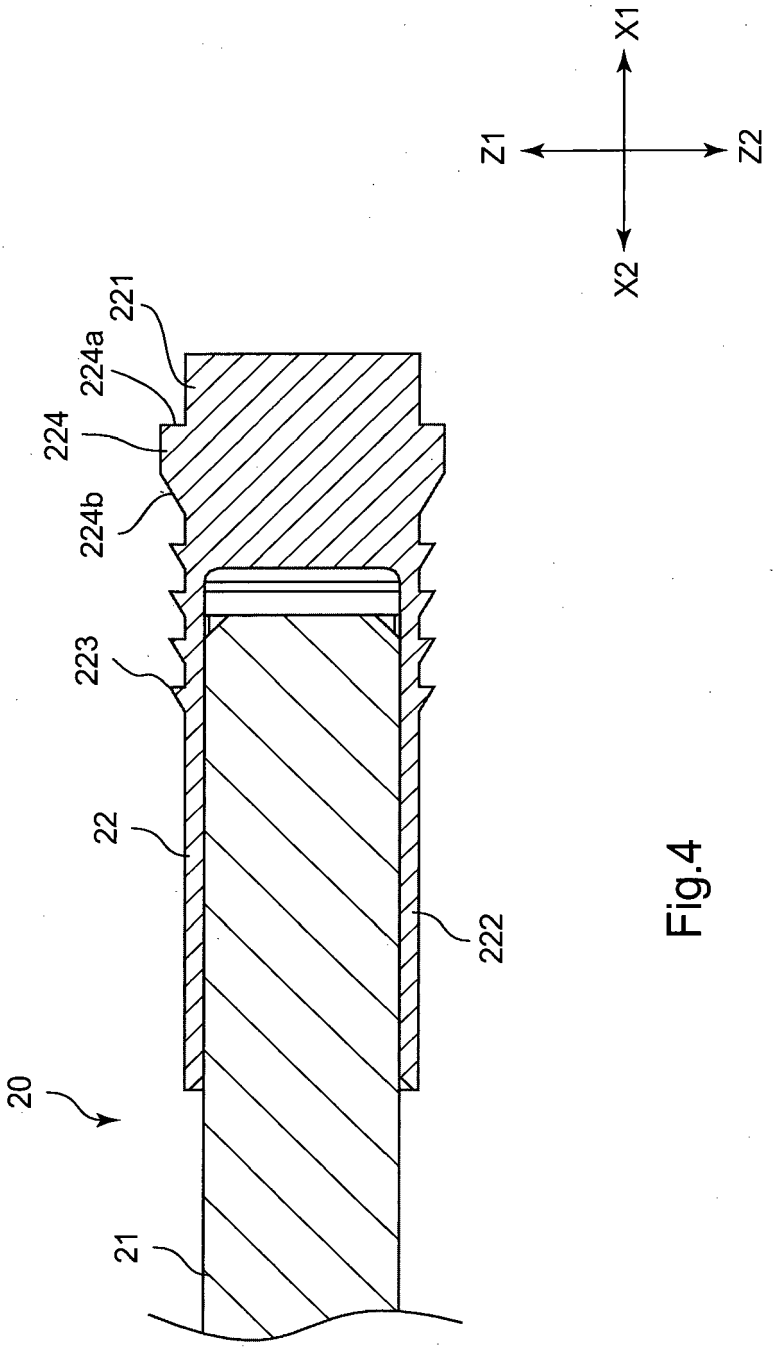
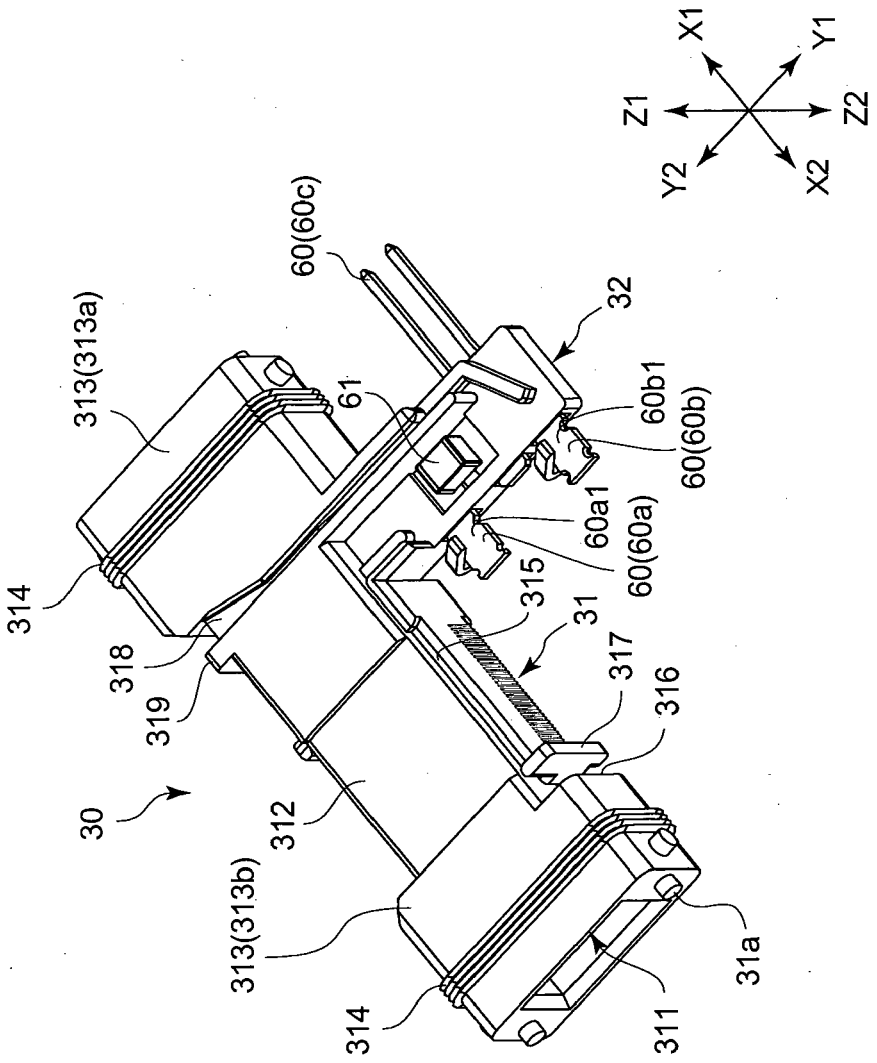


Fig.4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Z1
Z2
Y2
X2
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314
311
31a

Fig.5

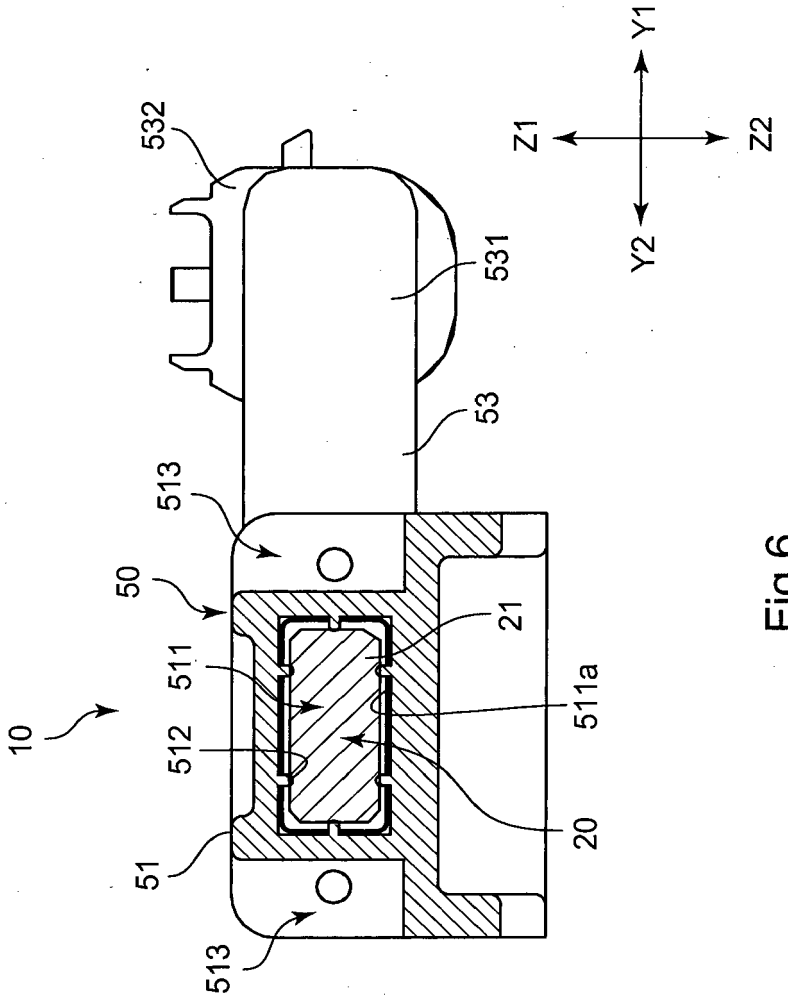

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 14 00 1751

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 September 2014	Cordeiro, J

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