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(54) **CONNECTOR AND CAMERA DEVICE EQUIPPED THEREWITH**

(57) The invention provides a connector which, while allowing a displaceable circuit board to be displaced readily, is capable, by way of a simple constitution, of connecting adequately and stably a connector terminal to the circuit terminal of the circuit board. A circuit terminal part (16) is attached to the circuit board (11), which is housed inside a casing (15) so as to be displaceable and whereon an imaging element (12) is mounted, and comprises the terminal (16a), which is connected to the imaging element (12). The connector terminal (21) is an electrically conductive rod-shaped body provided so as to pass through a planar connector housing (141), the connector housing (141) constituting one wall portion of the casing (15) and disposed so as to face, in the circuit board (11) thickness direction, the surface among the circuit board (11) whereon the circuit terminal part (16) is attached; and, the connector terminal (21) contacts the circuit terminal part (16) via an extremity surface (212) on the circuit board (11) side. The contact point portion of the circuit terminal part (16) is biased to the connector housing (141) side by elastic deformation portions (166, 167), is displaceable in the circuit board (11) thickness direction, and contacts while pushing the connector terminal (21) extremity surface (212) to the connector housing (141) side.

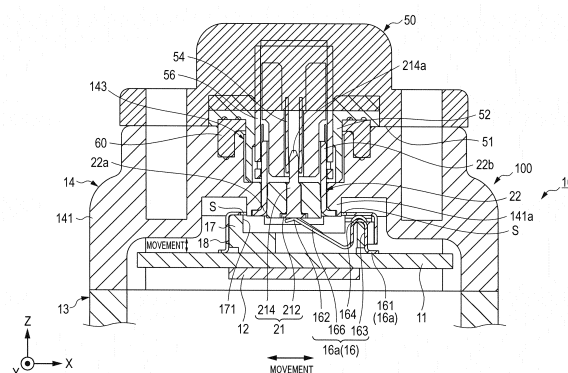


FIG. 3

Description

Technical Field

[0001] The present invention relates to a connector used for connecting a cable to electronic equipment and a camera device equipped therewith.

Background Art

[0002] In a conventional onboard camera device serving, for example, as a rear-view monitor that is mounted in an automobile and captures rear-view images, an imaging element such as a charge coupled device (CCD) is mounted on a circuit board housed in a case. An optical system such as a lens is disposed on the front side of the case. Light introduced into the inside of the case from the outside of the case via this optical system is received by the imaging element, so that the camera device performs an imaging operation.

[0003] An input/output terminal (hereinafter referred to as "circuit terminal") which outputs and inputs electric signals such as imaging signals from the imaging element is formed on the circuit board. The circuit terminal is connected to a connector terminal penetrating a part of the case and the connector terminal is connected to a mating connector provided to a cable, so that the circuit terminal is electrically connected to an external apparatus located outside of the camera device, such as a display device in an automobile.

[0004] In such an onboard camera device, the positional relationship between the optical axis of the optical system and the optical axis of the imaging element mounted on the circuit board may be adjusted. For this purpose, the onboard camera device is configured such that the positional relationship between the optical axis of the imaging element and the optical axis of the optical system can be adjusted by supporting the circuit board inside the case with a mechanism by which the circuit board is moved in a plane perpendicular to the optical axis of the optical system (well-known floating mechanism). For this reason, it has been impossible to fixedly connect the circuit terminal of the circuit board to the connector terminal, and a harness, flexible flat cable (FFC), flexible printed circuits (FPC), and/or the like, or a conductive elastic body having a block shape as disclosed in Patent Literature (hereinafter, referred to as "PTL") 1 has been used to connect the circuit terminal to the connector terminal.

[0005] In a camera device of the PTL 1, the conductive elastic body is put between a circuit terminal of a circuit board in which an imaging element is mounted, and a harness as an external terminal. The conductive elastic body includes a conductor consisting of thin metal wires, and a columnar insulating elastic body in which the conductor is embedded, and the conductor is fitted in and fixed to the columnar insulating elastic body in such a manner as to be exposed on both end surfaces of the

columnar insulating elastic body on the side of a housing part for housing the circuit board and on the side of a housing part for housing the external terminal, respectively. The conductor consisting of the thin metal wires is in contact with the circuit terminal at its end located at the end surface of the columnar insulating elastic body on the side of the housing part housing the circuit board, and the circuit terminal and the harness are electrically connected to each other via the conductor. In this manner, even when the circuit board provided with the circuit terminal moves within a case in the plane perpendicular to an optical axis of an optical system, connection between the circuit terminal and the connector terminal is maintained on condition that the displacement of the circuit terminal and the conductor connected to the connector terminal is relatively minute.

Citation List

20 Patent Literature

[0006] PTL 1

Japanese Patent Application Laid-Open No. 2014-075229

25 Summary of Invention

Technical Problem

[0007] In the meantime, it has been desired to achieve a structure of a camera device in which, in a simple configuration without using the complex columnar conductive elastic body in which the thin metal wires are embedded as disclosed in PTL 1, a floating amount (positional adjustment amount) of a circuit board is increased, so that positions of the optical axis of an optical system and the optical axis of an imaging element can easily be adjusted while a contact state between a circuit terminal of the circuit board and a connector terminal to be connected to an external terminal is maintained. In addition, floating of the circuit terminal with respect to the thin metal wires, in particular in the direction in which the circuit terminal and the thin metal wires face each other (the contact direction) is not disclosed in PTL 1. In addition, the thickness in the thickness direction of the board is comparatively greater in PTL 1 since the conductive elastic body has a columnar shape.

[0008] An object of the present invention is to provide a connector which enables, in a simple configuration, stable and suitable connection between a circuit terminal of a circuit board and a connector terminal while allowing easy displacement of the displaceable circuit board and which is capable of contributing to miniaturization and weight reduction, and to provide a camera device equipped with the connector.

Solution to Problem

[0009] In one aspect of a connector of the present invention, a configuration is adopted in which the connector includes: a circuit terminal part to be attached to a circuit board on which an imaging element is mounted, the circuit board being housed in such a manner as to be displaceable within a case, and the circuit terminal part including a terminal to be connected to the imaging element; a planar connector housing disposed in such a manner as to face, in a thickness direction of the circuit board, a surface of the circuit board to which the circuit terminal part is attached, the planar connector housing constituting one wall portion of the case; and a connector terminal being a conductive rodlike body installed through the planar connector housing, the connector terminal being in contact with the circuit terminal part at an end surface of the connector terminal on a circuit board side, in which: the circuit terminal part includes a contact part urged by an elastic deformation portion of the circuit terminal part in a direction of the planar connector housing so as to be displaceable in the thickness direction of the circuit board, and the contact part is in contact with the end surface of the connector terminal while pressing the end surface in the direction of the planar connector housing.

[0010] In one aspect of a camera device of the present invention, a configuration is adopted in which the camera device is equipped with the connector including the above configuration, the camera device including: a boxlike camera front case in which an optical system including a lens and a holding part holding the optical system are housed; and a boxlike camera rear case closing an opening in the boxlike camera front case and housing the circuit board, in which: the planar connector housing of the connector is formed as a rear surface portion of the boxlike camera rear case, the circuit board is disposed in such a manner as to be perpendicular to an optical axis of the optical system and to abut on the holding part at an outer peripheral region of the circuit board with respect to the optical axis, the connector terminal is disposed along the optical axis of the optical system, and the contact part of the circuit terminal part presses the circuit board against the holding part in a direction along the optical axis by pressing the end surface of the connector terminal in a direction of the planar connector housing along the optical axis of the optical system.

Advantageous Effects of Invention

[0011] According to the present invention, an end surface of a rodlike connector terminal to be connected to a cable abuts, in the thickness direction of a circuit board, on the circuit terminal attached to a displaceable circuit board, so as to elastically deform the circuit terminal in the thickness direction. It is possible in this way to stably suitably electrically connect the circuit terminal of the circuit board to the connector terminal in a simple configuration

while allowing displacement of the circuit board along the thickness direction of the circuit board as well as along the directions orthogonal to the thickness direction of the circuit board, and it is further possible to obtain an overall compact and thin structure, so that miniaturization and weight reduction can be achieved.

Brief Description of Drawings

[0012]

FIG. 1 is a sectional view of a camera device including a connector in one embodiment according to the present invention;

FIG. 2 is an exploded perspective view illustrating a configuration of main parts of the camera device including the connector in one embodiment according to the present invention;

FIG. 3 is a fragmentary sectional view of the camera device, in which a configuration of main parts of the connector in one embodiment according to the present invention is illustrated;

FIG. 4 is an exploded perspective view illustrating a configuration of main parts of the connector in one embodiment according to the present invention;

FIG. 5 illustrates the positional relationship between a circuit terminal part and a connector terminal of the connector in contact with each other in one embodiment according to the present invention;

FIG. 6 is a sectional view illustrating a state where the circuit board is displaced in the camera device provided with the connector in one embodiment according to the present invention;

FIG. 7 is a sectional view illustrating a configuration of main parts in the state where the circuit board is displaced;

FIG. 8 is a sectional view illustrating a configuration of main parts in the state where the circuit board is displaced;

FIGS. 9A to 9C are explanatory illustrations for characteristic impedances of contact pins; and

FIG. 10 schematically illustrates a configuration of main parts of a variation of a connector in one embodiment according to the present invention.

Description of Embodiments

[0013] Hereinafter, an embodiment of the present invention is described in detail with reference to the drawings.

[0014] FIG. 1 is a sectional view of a camera device including a connector in one embodiment according to the present invention, and FIG. 2 is an exploded perspective view illustrating a configuration of main parts of the camera device including the connector in one embodiment according to the present invention. Descriptions for the present embodiment are given based on camera device 10 to which connector 100 is provided as a part of

camera device 10. In addition, in the present embodiment, directions related to camera device 10 including connector 100 are described using an orthogonal coordinate system (X, Y, Z). In camera device 10, the side of connector 100 on which an optical system (lens part in this case) such as a lens is disposed is the front side, the side of connector 100 to which a cable is connected is the rear side, the direction along optical axis L of the optical system (lens part 31 in this case) is the Z direction (also referred to as the thickness direction of circuit board 11), and the directions orthogonal to optical axis L are the X and Y directions.

[0015] Camera device 10 is used as an onboard camera device, such as a front-view monitor, rear-view monitor, side-view monitor, or the like which captures an image of an external scene from the vehicle, by being provided on a region of the vehicle that forms the front, rear, right, or left side of the vehicle. It is preferable that the vehicle be a transport apparatus, such as an automobile, train, or the like. When the vehicle is an automobile, camera device 10 is, for example, provided on a front bumper, a rear bumper, a front grille, or the like. Camera device 10 is connected to external electric equipment, such as a power source, display device in a vehicle interior, via mating connector 50 (see FIG. 3) connected to an end of a cable. Here, descriptions are given with the cable being taken as a coaxial cable which output digital signals of captured images from camera device 10. The camera device may be configured such that a cable for inputting and outputting analogue signals can be connected to the camera device.

[0016] Camera device 10 includes camera case 15 including connector 100, circuit board 11 on which imaging element 12 is mounted, lens part 31, and holder part 35 for holding lens part 31.

[0017] Camera case 15 is composed of front case 13 and rear case 14. Front case 13 and rear case 14 are here made of an insulating resin or the like. Here, the camera case has the shape of a hollow thin-walled rectangular parallelepiped which is square in the front view.

[0018] Front case 13 has the shape of a box having an opening on the rear surface side, and includes a drilled lens hole at the central portion of the front surface. The lens hole is formed in front case 13 in such a manner as to pass through from the inside of front case 13 to the outside on the front side, and front portion 31a of lens part 31 is fit in the lens hole via gasket (O-ring) 33. In this way, front case 13 is airtightly closed by lens part 31.

[0019] In front case 13, front portion 31a of lens part 31 which is present at the opening on the front surface side allows external light to be introduced onto a light receiving surface of imaging element 12 within camera case 15.

[0020] Holder part 35 is tubular and is housed in front case 13. Holder part 35 includes holder tube 351 surrounding the outer periphery of the lens part (optical system), holder flange 352 integrally joined with the holder tube at the rear end side of the holder tube and radially

protruding from the rear end side, and legs 353.

[0021] Holder tube 351 supports lens part 31, and makes it possible for front case 13 to hold lens part 31 via holder flange 352. Optical axis L of lens part 31 is disposed in such a manner as to coincide with the axis of front case 13.

[0022] Holder flange 352 is fixed to front case 13 at its outer peripheral surface, and rear surface portion 31b of lens part 31 is disposed inside the through hole in holder flange 352 in such a manner as to face rearward.

[0023] Legs 353 are provided in such a manner as to protrude rearward from the rear surface of holder flange 352. Here, the external shape of holder flange 352 is rectangular (specifically square) in the sectional view along the direction perpendicular to the optical axis direction, and thus legs 353 are provided at four corners of the rear surface of holder flange 352.

[0024] The rear end surfaces of legs 353 are surfaces perpendicular to the optical axis. One surface (front-side surface) of circuit board 11 abuts on these rear end surfaces, and in this way, circuit board 11 is disposed to be perpendicular to the optical axis.

[0025] In this manner, holder part 35 allows imaging element 12 on circuit board 11 and lens part 31 exposed on the rear surface of holder flange 352 to face each other in the optical axis direction with a predetermined distance (length of leg 353 along the front-rear direction) therebetween. In the meantime, legs 353 are fixed to circuit board 11 with a binding material, resin, and/or the like.

[0026] Rear case 14 is airtightly closed with a sealant in the vicinity of where rear case 14 and mating connector 50 of rear case 14 are fitted to each other.

[0027] Circuit board 11 is housed within front case 13 and rear case 14. Circuit board 11 is disposed in such a manner as to face lens part 31 along the optical axis direction of lens part (optical system) 31. Imaging element 12, such as a CCD element or the like, is mounted on one surface (front-side surface) of circuit board 11 in such a manner as to face lens part 31 (optical system). Here, circuit board 11 is formed in a square shape in plan view, and imaging element 12 is mounted at the central portion of circuit board 11 and is located at a position in which the optical axis of lens part 31 runs through imaging element 12. It is preferable that the optical axis of imaging element 12 be located at or in the vicinity of the center of circuit board 11 in plan view. A power supply circuit, a signal-processing circuit, and the like related to imaging element 12 are formed on circuit board 11.

[0028] In addition, circuit board 11 is disposed to be spaced apart from the internal circumferential surface of camera case 15. Circuit board 11 is supported such that circuit board 11 can be relatively displaced with respect to camera case 15 in the X, Y, and Z directions within camera case 15 in order to adjust the positional relationship between optical axis L of the optical system (lens part 31) and optical axis L1 of imaging element 12. Here, circuit board 11 is supported during assembly by being

pressed on holder part 35 in the Z direction by an urging force of receptacle pin 16 mentioned below. In this way, circuit board 11 can be two-dimensionally moved in the plane perpendicular to optical axis L within camera case 15, and can also be moved in the direction of optical axis L or the Z direction (also referred to as the thickness direction of circuit board 11) along the direction of optical axis L, so as to allow positional adjustment thereof.

[0029] Rear surface portion 141 of rear case 14 forming the rear-side surface of rear case 14 is disposed in such a manner as to face the opposite surface (rear-side surface) of circuit board 11.

[0030] Rear case 14 includes a peripheral wall portion protruding on the front surface side from the periphery of rear surface portion 141, has the shape of a box having an opening in the front-surface-side end, and closes, with this front-surface-side opening, the opening (opening portion) of front case 13 on the rear surface side. For example, the opening end surfaces of rear case 14 and front case 13 abut on each other via a sealing material (not illustrated), and are joined via an adhesive agent, screw, or the like. Front and rear cases 13 and 14 thus constitute a camera case airtightly integrated as one piece.

[0031] FIG. 3 is a fragmentary sectional view of the camera device, in which a configuration of main parts of the connector in one embodiment according to the present invention is illustrated. FIG. 4 is an exploded perspective view illustrating a configuration of main parts of the connector in one embodiment according to the present invention.

[0032] Camera device 10 illustrated in FIGS. 3 and 4 includes connector 100 including rear surface portion 141 of rear case 14. Connector 100 is fit to mating connector 50 connected to an end of a cable (coaxial cable in this case) which is not illustrated.

[0033] Connector 100 includes rear surface portion (planar connector housing) 141 which also serves as a part of rear case 14 of the camera case, receptacle pin 16, contact pin 21, shell 22, and housing 23.

[0034] Receptacle pin (circuit terminal part) 16 is attached to the opposite surface (rear-side surface) of circuit board 11 via receptacle housing (hereinafter referred to as "rece-housing") 17. Here, receptacle pin 16 includes a plurality of (for example, three) terminals. It is via contact pin 21 in contact with receptacle pin (circuit terminal part) 16 that electricity can be supplied to circuit board 11 from the outside, and an electric signal can be transmitted and received between circuit board 11 and the outside. The details about receptacle pin 16 are described later.

[0035] Rece-housing 17 is disposed at the central portion of the rear surface side of circuit board 11, and supports each terminal of receptacle pin 16 attached thereto.

[0036] Rece-housing 17 is formed in a tubular shape and made of an insulating material which insulates each terminal of receptacle pin 16, and connects one end of each terminal of receptacle pin 16 to a corresponding

circuit of circuit board 11. Here, rece-housing 17 is formed in a rectangular tubular shape, and opening 171 is formed in a square shape. Receptacle pin 16 often includes, correspondingly to the configuration of a coaxial cable, receptacle contact pin 16a as a signal terminal for output of an imaging signal output by imaging element 12, and receptacle ground pin 16b connected to the ground of circuit board 11 and to contact piece portion 22a1 of shell 22.

[0037] FIG. 5 illustrates the positional relationship between circuit terminal part (receptacle contact pin) 16 and the connector terminal (contact pin 21, shell 22) in contact with each other in the connector according to one embodiment of the present invention, and is a rear view of the contacting parts in which rear surface portion 141 is removed.

[0038] As illustrated in FIGS. 3 to 5, rece-housing 17 has a rectangular tubular shape and is covered, at its outer peripheral surface and its rear end surface (upper-side surface in FIG. 4), with shield 18 having a rectangular frame shape. Rece-housing 17 is fixed to circuit board 11 by mounting (by soldering in this case), to circuit board 11, legs 18a provided at a lower end portion of this shield 18.

[0039] As illustrated in FIGS. 4 and 5, receptacle pin 16 (receptacle contact pin 16a, receptacle ground pin 16b) includes base ends 161 respectively connected to corresponding parts of circuit pattern in circuit board 11 by soldering, and top ends 162 and 168 being in contact with contact pin 21 and one end 22a (especially contact piece portion 22a1) of shell 22 while urging contact pin 21 and one end 22a in the Z direction by an urging force caused by elastic deformation. It is to be noted that the same name and the same reference sign are provided to the same elements of receptacle contact pin 16a and receptacle ground pin 16b of receptacle pin 16 to describe such elements. In addition, receptacle pin 16 presses circuit board 11 onto holder part 35 to hold circuit board 11 by urging contact pin 21 and one end 22a (especially contact piece portion 22a1) of shell 22 in the Z direction which are fixed on the side of rear surface portion 141 (that is, the side of fitting part 143).

[0040] Here, receptacle pin 16 is formed by processing a long platelike conductive material (copper plate or the like), in which two ends thereof are respectively formed as base end 161 and top ends 162 and 168. Receptacle pin 16 includes fixed piece 163, deformable bending portion 164, and elastically deformable arm portions 166 and 167 continuously formed between base end 161 and top ends 162 and 168 in the presented order from the side of base end 161 to the side of top end 162. In receptacle pin 16, the shapes of arm portions 166 and 167 are different from each other, and the shapes of top ends 162 and 168 are different from each other between receptacle contact pin 16a and receptacle ground pin 16b.

[0041] Fixed piece 163 is formed in such a manner as to extend upright rearward (toward the connector side) from base end 161 on circuit board 11 along the Z direc-

tion. Fixed piece 163 is fixed inside of one wall portion of a peripheral wall portion of framelike rece-housing 17. Bending portion 164 extending toward an inner surface of one wall portion along the rear end surface of one wall portion is continuously formed at the rear-side end of fixed piece 163.

[0042] Arm portions 166 and 167 which function as a plate spring together with bending portion 164 extend in the direction of on the lower end side of the one wall portion (in the front direction of camera device 10) and bend there, and then projects toward the upper end of the opposite wall of the one wall portion (in the rear direction of camera device 10).

[0043] Top ends 162 and 168 of inclined pieces of arm portions 166 and 167 are formed.

[0044] Arm portion 166 and top end 162 of receptacle contact pin 16a continuously extending from bending portion 164 are bifurcated.

[0045] Top end 162 of receptacle contact pin 16a is formed in such a manner as to be displaced along the Z direction so as to make contact with contact pin 21 while pressing contact pin 21 at a bending portion bending with respect to the extending direction of the inclined piece of arm portion 166. At top end 162 of receptacle contact pin 16a, the bending portion continuing from the inclined piece of arm portion 166 forms a contact part making contact with contact surface portion 212 which is an end surface of contact pin 21.

[0046] In addition, top end 168 of receptacle ground pin 16b is provided in such a manner as to bend with respect to the extending direction of the inclined piece of arm portion 167, and is formed in such a manner as to be displaced along the Z direction so as to make contact with one end 22a (in particular, contact piece portion 22a1) of shell 22 while pressing contact pin 21 at the bending portion continuing from the inclined piece.

[0047] Top end 168 is disposed at a position at the same height level as top end 162.

[0048] Top ends 162 and 168 of receptacle contact pin 16a and receptacle ground pin 16 configured in this way include the contact parts which are to be urged by arm portions (elastic deformation portions) 166 and 167 in the direction of rear surface portion 141 in such a manner as to be displaceable in the thickness direction of circuit board 11.

[0049] In addition, receptacle contact pin 16a in receptacle pin 16 is supported by rece-housing 17 such that bending portion 164, arm portion 166, and top end 162 are located substantially in the middle of the opening in rece-housing 17.

[0050] In addition, receptacle contact pin 16a is disposed such that the axial center of contact pin 21 is located between the bifurcated pieces of top end 162. In this respect, it is preferable that the axial center of this contact pin 21 be disposed to coincide with the optical axis of the optical system.

[0051] In addition, receptacle ground pins 16b and 16b are supported by rece-housing 17 such that top ends 168

and 168 of receptacle ground pins 16b and 16b are located equidistant from top end 162 of receptacle contact pin 16a on opposite sides of top end 162.

[0052] Contact pin 21 and tubular shell 22 correspond to the connector terminal, and are installed through rear surface portion 141 of rear case 14. In particular, contact pin 21 and tubular shell 22 are fixed to rear surface portion 141 of rear case 14 such that contact pin 21 and tubular shell 22 protrude to the outside of rear case 14 at their rear-side ends (shaft tip 214a and opposite end 22b), and are exposed inside rear case 14 at their front-side ends (contact surface portion 212 and one end 22a).

[0053] Here, contact pin 21 and tubular shell 22 are disposed in a through hole formed in the central portion of rear surface portion 141.

[0054] In particular, the front-side end (contact surface portion 212) of contact pin 21 and the front-side end (one end 22a) of tubular shell 22 are disposed in the camera case in a state where these front-side ends are inserted into opening 171 of rece-housing 17 attached to circuit board 11. In the meantime, the rear-side end (shaft tip 214a) of contact pin 21 and rear-side end (opposite end) 22b of shell 22 are disposed in such a manner as to be exposed within fitting part 143 formed to be recessed on the rear-side surface of rear surface portion 141 (rear surface of camera case).

[0055] Contact pin 21 is a long rodlike body made of a conductive material and has conductivity. Contact pin 21 is, for example, a copper pin, or a member including a base material such as an annealed copper, in which the base material is Sn-plated.

[0056] Contact pin 21 includes contact surface portion 212 being in surface contact with receptacle contact pin 16a, and shaft portion 214 formed integrally with contact surface portion 212 and extending such that the central axis of contact surface portion 212 (central axis of contact pin 21) runs through shaft portion 214. Here, shaft portion 214 is provided upright in the direction perpendicular to contact surface portion 212.

[0057] In addition, as illustrated in FIGS. 3 to 5, it is preferable that the outer peripheral surface of contact pin 21 be circumferentially equidistant from the central axis of contact pin 21 in a sectional view perpendicular to the direction of the central axis running in the extending direction. In a case where the outer periphery of contact pin 21 is located circumferentially equidistant from the central axis, impedance changes caused by positional shifts in that receptacle contact pin 16a is in contact with contact surface portion 212 at a position shifted from the center of contact surface portion 212 in any direction of the X-axis and Y-axis directions can be made as similar as possible (can be similar values). In particular, contact pin 21 is formed in a circular shape in a sectional view, contact surface portion 212 is formed in a circular shape, and shaft portion 214 extending in the direction perpendicular to circular contact surface portion 212 is formed in a columnar shape concentric with contact surface portion 212. This makes it easier to set the characteristic

impedance of contact pin 21.

[0058] In addition, in the present embodiment, contact surface portion 212 having a circular shape in a sectional view is formed as a flange projecting radially from and perpendicularly to the outer periphery of the one end of shaft portion 214 having a circular shape in a sectional view. That is, contact surface portion 212 has a greater outer diameter than the outer diameter of shaft portion 214.

[0059] Contact pin 21 is inserted (press-fit, in this case) in a central hole of cylindrical housing 23.

[0060] Housing 23 is made of an insulating material and its outer peripheral surface is covered with shell 22.

[0061] Accordingly, contact pin 21 is fit in shell 22 via housing 23, and shell 22 is disposed in such a manner as to surround contact pin 21 via the insulating material, so as to function as an electromagnetic shield for contact pin 21.

[0062] Tubular shell 22 is formed by processing a conductive metal plate. One end 22a of tubular shell 22 includes a flange portion projecting radially with respect to the central axis of tubular shell 22. Radially-protruding contact piece portion 22a1 is formed at the flange portion of one end 22a. Contact piece portion 22a1 is formed at a position corresponding to receptacle ground pin 16b.

[0063] As illustrated in FIG. 3, frame portion 141a having an opening which continues from the opening in fitting part 143, and protruding from the inner surface of rear surface portion 141 is formed at the central portion of the inner surface of rear surface portion 141.

[0064] Shell 22 is press-fit in frame portion 141a from the inner side of rear surface portion 141, in which the flange portion of one end 22a engages with the front end surface of frame portion 141a, and opposite end 22b is exposed in fitting part 143 of rear case 14.

[0065] One end 22a of shell 22 is disposed within receptacle housing 17, in which the rear surface of the flange portion of one end 22a is disposed in such a manner as to be flush or substantially flush with the surface of receptacle housing 17 having the opening. In addition, clearance S (see FIG. 3) is formed in all directions between the outer peripheral edge of one end 22a of shell 22 and the edge of the opening in receptacle housing 17.

[0066] As illustrated in FIG. 3, fitting part 143 includes the opening extending through rear surface portion 141, and shell 22 is fit into this opening. Fitting part 143 is formed in such a manner as to be recessed on the rear surface side, and protruding fitted part (part to be fitted) 52 of mating connector 50 to be connected to an end of a cable is fit to the recess.

[0067] Packing material 60 is attached to the edge of the opening in fitting part 143 such that packing material 60 surrounds the opening, so as to improve the airtightness of an electrical connection part during fitting to mating connector 50.

[0068] In mating connector 50, fitted part 52 is provided in such a manner as to protrude from abutting part 51 abutting on the circular rear surface of rear surface por-

tion 141. Fitted part 52 has a cylindrical shape, in which mating contact pin 54 to be connected to a central conductor of a coaxial cable and tubular mating shell 56 surrounding mating contact pin 54 are provided.

[0069] Mating contact pin 54 is made of a conductive material in such a manner as to have a long tubular shape, and is, for example, a copper pin, or a tubular member including a base material such as an annealed copper, in which the base material is Sn-plated.

[0070] Mating contact pin 54 is connected at its one end to the central conductor of the coaxial cable, and is provided in such a manner as to protrude at its opposite end within fitted part 52. Contact pin 21 is inserted in mating contact pin 54, so that mating contact pin 54 is fit at the outside of contact pin 21, and is electrically connected to contact pin 21.

[0071] Mating shell 56 is made of a conductive metal. Mating shell 56 is connected at its one end to a conductor of the cable (external conductor (braided copper wire) of the coaxial cable, in this case).

[0072] Mating shell 56 is disposed within fitted part 52 in such a manner as to be circumferentially equidistant from mating contact pin 54, and fits to shell 22 to be electrically connected to shell 22. Mating shell 56 is provided along the internal circumferential surface of fitted part 52, and is fit at the outside of shell 22 in this case.

[0073] By fitting and connecting camera device 10 constructed in this way to mating connector 50, receptacle pin 16 as the circuit terminal is brought into contact with and electrically connected to contact pin 21 and shell 22 that are the connector terminal. In this way, camera device 10 is connected to an external apparatus via a cable connected to mating connector 50.

[0074] Hereinafter, detailed descriptions are given for the positional relationship among receptacle contact pin 16a, receptacle ground pin 16b, contact pin 21, and one end 22a of shell 22 (in particular, contact piece portion 22a1 of the flange portion).

[0075] As illustrated in FIG. 5, it is desirable that contact pin 21 is disposed such that the axial center of contact pin 21 coincides with optical axis L of the lens system, and thus with optical axis L1 (see FIG. 1) of imaging element 12 mounted at the central portion of circuit board 11.

[0076] In addition, it is preferable that the contact part of top end 162 of receptacle contact pin 16a be also disposed in such a manner as to be located on optical axis L1 of imaging element 12 mounted at the central portion of circuit board 11, and therefore it is preferable that the contact part of top end 162 is disposed such that optical axis L of the lens system runs through an approximate center of the contact part of top end 162.

[0077] Accordingly, contact surface portion 212 of contact pin 21 has an area larger along the X-axis and Y-axis directions than the contact area of top end 162 of receptacle contact pin 16a in order that contact surface portion 212 is in contact, at its center, with receptacle contact pin 16a. The movable region of circuit board 11

along the X and Y directions can be displaced by a distance twice the distance of clearance S in both of the directions. Here, as illustrated in FIGS. 3 and 5, top end 162 of receptacle contact pin 16a is disposed in such a manner as to overlap with shaft portion 214 in the sectional view and such that the contact part of top end 162 is located at the center of contact pin 21.

[0078] In addition, as illustrated in FIG. 5, one end 22a of shell 22 is disposed such that top end 168 of receptacle ground pin 16b is in contact with contact piece portion 22a1 at the center of contact piece portion 22a1 along the X and Y directions.

[0079] In camera device 10 configured in this way, front case 13 and rear case 14 are assembled with circuit board 11 in-between. In this case, lens part 31 is mounted on front case via holder part 35 and gasket 33, rear case 14 includes contact pin 21, shell 22, and housing 23, and circuit board 11 includes imaging element 12 and receptacle pin 16.

[0080] In the meantime, circuit board 11 is electrically connected to contact pin 21 and shell 22 via receptacle pin 16 which is in contact with and urges contact pin 21 and shell 22. In addition, circuit board 11 is pressed in the front direction (in particular, onto leg 353 of holder part 35) by the urging force of receptacle pin 16 in camera case 15 (see FIG. 1) including front case 13 and rear case 14. In addition, circuit board 11 is electrically connected, via electrical connection of receptacle pin 16 to contact pin 21 and shell 22, to an external apparatus connected to contact pin 21 and shell 22.

[0081] In this way, connector 100 is in a positional state with respect to circuit board 11 where connector 100 has a floating function of electrically connecting circuit board 11 while holding circuit board 11 in such a manner as to allow circuit board 11 to freely move (float) in the X-axis, Y-axis, and Z-axis directions. With connector 100, even in a case where circuit board 11 is displaced in the X, Y, and Z directions in order that optical axis L1 of imaging element 12 can coincide with optical axis L of lens part 31 after camera device 10 is assembled, such a displacement can be followed, so that a reliable contact state can be maintained.

[0082] FIG. 6 is a sectional view illustrating a state where circuit board 11 is displaced in the camera device provided with the connector in one embodiment according to the present invention. FIGS. 7 and 8 are a sectional view illustrating a configuration of main parts in the state where circuit board 11 is displaced in the camera device provided with the connector in one embodiment according to the present invention.

[0083] FIG. 6 illustrates a state where circuit board 11 is displaced in the minus direction along the Z direction (the direction of minus floating). In particular, circuit board 11 is displaced further in the direction of rear surface portion 141 (the mating connector side) compared to the position of circuit board 11 along the optical axis direction (Z direction in this case) illustrated in FIG. 1 (circuit board 11 is displaced a length of N shorter than M, where

$N=1/2M$). Even when circuit board 11 is thus displaced in the minus direction along the Z axis (the direction toward contact pin 21), receptacle contact pin 16a of circuit board 11 slides on contact surface portion 212 of contact pin 21 with the contact part of top end 162, and is in reliable contact with contact surface portion 212 by elastic deformation of arm portion 166.

[0084] FIG. 7 illustrates a state where circuit board 11 is displaced in the plus directions along the X axis (the direction of plus floating) and the Z axis. Even when circuit board 11 is thus displaced in the plus direction along the X axis (the right direction in the figure) and in the plus direction along the Z axis (the direction toward contact pin 21), receptacle contact pin 16a of circuit board 11 slides on contact surface portion 212 of contact pin 21 with the contact part of top end 162, and is in reliable contact with contact surface portion 212 by elastic deformation of arm portion 166.

[0085] FIG. 8 illustrates a state where circuit board 11 is displaced in the plus direction along the X axis (the direction of floating). Even when circuit board 11 is thus displaced in the plus direction along the X axis (the right direction in the figure), receptacle contact pin 16a of circuit board 11 is in reliable contact with contact surface portion 212 at the contact part of top end 162. After circuit board 11 is displaced to adjust the position of optical axis L of lens part 31 and optical axis L1 of imaging element 12, circuit board 11 may be fixed to legs 353 of holder part 35 with an adhesive agent, resin, or the like.

[0086] In the meantime, contact pin 21 in connector 100 of the present embodiment may be of any outer diameter, but the characteristic impedance is different for outer diameters.

[0087] A characteristic impedance can be computed by applying a simple impedance equation.

[0088] FIGS. 9A to 9C are explanatory illustrations for characteristic impedances of contact pins. FIG. 9A is an explanatory illustration for the simple impedance equation, and FIGS. 9B and 9C illustrate examples of the shapes of the contact pins.

[0089] The simple impedance equation in conjunction with FIG. 9A is represented by following equation 1.

[1]

$$Z_0 \approx \frac{138}{\sqrt{\epsilon}} \log_{10} \frac{D}{d} \quad \dots \text{(Equation 1)}$$

D : Inner diameter of outer conductor

d : Diameter of inner conductor

ϵ : Permittivity of insulator

$$Z_0 = 138 / \sqrt{\epsilon} \log_{10} (D/d)$$

[0090] An exemplary characteristic impedance of contact pin 21A having a nail shape as illustrated in FIG. 9B which is similar in shape to contact pin 21 of the present embodiment can be computed by applying a pin diameter

of $d=0.5$ mm (outer diameter of shaft portion 214), an inner diameter of an outer conductor of $D=2.9$ mm, and a permittivity of an insulator of $\epsilon=3.7$ to the above simple impedance equation designated as Equation (1). It is to be noted that the outer diameter of a contact surface portion is $d=1.3$ mm. Then, a characteristic impedance of 54.8Ω is obtained. In addition, an exemplary characteristic impedance of contact pin 21B including shaft portion 214A having the same outer diameter as the outer diameter of contact surface portion 212 of contact pin 21A as illustrated in FIG. 9C is computed by applying a pin diameter (outer diameter of shaft portion 214A) of $d=1.3$ mm, an inner diameter of an outer conductor of $D=2.9$ mm, and a permittivity of an insulator of $\epsilon=3.7$. Then, a characteristic impedance of 25.0Ω was obtained.

[0091] In general, since the impedance of coaxial cables through which a signal is transmitted is approximately 50Ω , a transmission loss can be attenuated as much as possible by employing the shape in FIG. 9B.

[0092] In the meantime, a configuration is employed in the present embodiment, in which the coaxial cable is electrically connected via one contact pin 21 to circuit board 11 supported within the camera case with the floating mechanism, a connector may include two or more contact pins 21C as illustrated in FIG. 10.

[0093] FIG. 10 schematically illustrates a configuration of main parts of a variation of a connector in one embodiment according to the present invention. In FIG. 10, a plurality of contact pins 21C (6 contact pins in this case) are attached in rectangular framelike shell 22C at rear surface portion 141 of rear case 14 in such a manner as to have a structure the same as that in which contact pin 21 is attached to rear surface portion 141 in camera device 10 (see FIG. 3) of the above-described embodiment.

[0094] Each contact surface portion of these contact pins 21C abuts on a terminal similar to receptacle pin 16 attached to the circuit board supported with the floating mechanism while being pressed in the Z direction by the terminal.

[0095] In camera device 10 of the present embodiment, contact pin 21 joined at its one end to mating contact pin 54 of mating connector 50 is, at the end surface (contact surface portion 212) of its opposite end, electrically connected to receptacle contact pin 16a serving as the circuit terminal part while contact pin 21 and receptacle contact pin 16a are directly pressed against each other in the Z direction. Accordingly, it is not necessary to secure a housing space for a harness, FFC, FPC, or the like in the camera case, so that receptacle contact pin 16a (circuit terminal part) of displaceable circuit board 11 can be suitably connected to contact pin (connector terminal) 21 in a simple configuration, and additionally, an overall structure can be compact and thin.

[0096] According to the present embodiment, contact surface portion (end surface) 212 of rodlike contact pin (connector terminal) 21 to be connected to a cable thus abuts, in the thickness direction of circuit board 11, on receptacle pin 16 (in particular, receptacle contact pin

16a (circuit terminal part)) attached to displaceable circuit board 11, so as to elastically deform receptacle contact pin 16a (circuit terminal part). In this manner, it is possible to stably suitably electrically connect the circuit terminal part (receptacle pin 16) of circuit board 11 to the connector terminal (contact pin 21) in a simple configuration while allowing displacement of circuit board 11 along the thickness direction of circuit board 11 as well as along the directions orthogonal to the thickness direction of circuit board 11, and it is further possible to obtain an overall compact and thin structure, so that miniaturization and weight reduction can be achieved.

[0097] That is, a cable terminal (in particular mating contact pin 54) forming an end of a cable and receptacle contact pin 16a which is the circuit terminal part of circuit board 11 of camera device 10 are electrically connected to each other only via contact pin 21 in a simple configuration.

[0098] Even when circuit board 11 on which imaging element 12 is mounted is displaced with respect to contact pin 21, for example, in order to adjust optical axis L of the optical system (lens part 31) and optical axis L1 of imaging element 12, receptacle pin 16 on the side of circuit board 11 can slide in the X and Y directions while being pressed against each of contact pin 21 and one end 22a (in particular, contact piece portion 22a1) of shell 22 in the Z direction. In the present embodiment, circuit board 11 can be moved in the X and Y directions (directions orthogonal to optical axis L), and is positioned within camera case 15 while being pressed toward lens part 31 (in particular, against holder part 35) along optical axis L of the optical system by elastic deformation of receptacle pin 16 in contact with contact pin 21 and shell 22 along the Z direction (which may also be referred to as the direction of optical axis L in this case).

[0099] Accordingly, continuous electrical connection between circuit board 11 and the cable can be stably maintained.

[0100] In addition, with this structure, it is possible with only one circuit board 11 to suitably electrically connect receptacle pin 16 of circuit board 11 to the connector terminal on the connector side while not only allowing floating circuit board 11 to freely move along the X-axis and Y-axis directions orthogonal to the optical axis but also allowing circuit board 11 to displace along the Z direction. In the meantime, as for receptacle contact pin 16a, top end (contact part) 162 is disposed at a position that coincides with optical axis L1 of imaging element 12 mounted on circuit board 11, and top end (contact part) 168 of receptacle ground pin 16b is disposed around the top end (contact part 162) of receptacle contact pin 16a. To be specific, arm portion 166 of receptacle contact pin 16a making contact with contact pin 21 to transmit a signal has a bipartite structure, contact piece portions 22a1 of shell 22 are disposed at two places along the diametral direction, and shell 22 makes contact with receptacle ground pins 16b via the two places. Accordingly, the signal terminals (contact pin 21, receptacle contact pin 16a)

and the ground terminals (shell 22, receptacle ground pins 16b) are stably connected to each other. In addition, receptacle contact pin 16a for transmission of signals is provided in the middle and receptacle ground pins 16b are provided at two places around receptacle contact pin 16a, so that a configuration resistant to noise is achieved.

[0101] The embodiments disclosed herein are merely an exemplification in all respects and should not be considered as limitative. The scope of the present invention is specified by the appended claims, and not by the above descriptions. The scope of the present invention is intended to include all modifications in so far as they are within the scope of the appended claims or the equivalents thereof.

[0102] The embodiments of the invention have been described above. The above descriptions are illustration of the preferred embodiments of the present invention, and the scope of the present invention is not limited to the descriptions. That is, the descriptions for the configuration of the above-mentioned device and for the shape of each part are by way of example, and it is clear that various modifications and additions to the example can be made within the scope of the present invention.

[0103] The disclosure of Japanese Patent Application No. 2015-039027 dated February 27, 2015 including the specification, drawings and abstract is incorporated herein by reference in its entirety.

Industrial Applicability

[0104] The connector and the camera device equipped with the connector according to the present invention have an advantageous effect of enabling in a simple configuration suitable and stable electrical connection between a circuit terminal of a circuit board and a connector terminal while allowing displacement of the displaceable circuit board, and is useful for electronic equipment provided with a circuit board supported with a floating mechanism.

Reference Signs List

[0105]

- 10 Camera device
- 11 Circuit board
- 12 Imaging element
- 14 Rear case (connector housing)
- 15 Camera case
- 16 Receptacle pin (circuit terminal part)
- 16a Receptacle contact pin (circuit terminal part)
- 16b Receptacle ground pin
- 17 Rece-housing
- 18 Shield
- 18a Leg
- 21, 21A, 21B, and 21C Contact pin (connector terminal)
- 22 and 22C Shell

- 22a One end
- 22a1 Contact piece portion
- 22b Opposite end
- 23 Housing
- 35 Holder part (holding part)
- 50 Mating connector
- 51 Abutting part
- 52 Fitted part
- 54 Mating contact pin
- 56 Mating shell
- 60 Packing material
- 100 Connector
- 141 Rear surface portion
- 141a Frame portion
- 143 Fitting part
- 161 Base end
- 162 and 168 Top end (contact part)
- 163 Fixed piece
- 164 Bending portion
- 166 and 167 Arm portion (elastic deformation portion)
- 212 Contact surface portion (end surface)
- 214 and 214A Shaft portion
- 214a Shaft tip

Claims

1. A connector comprising:

a circuit terminal part to be attached to a circuit board on which an imaging element is mounted, the circuit board being housed in such a manner as to be displaceable within a case, and the circuit terminal part including a terminal to be connected to the imaging element;
a planar connector housing disposed in such a manner as to face, in a thickness direction of the circuit board, a surface of the circuit board to which the circuit terminal part is attached, the planar connector housing constituting one wall portion of the case; and
a connector terminal being a conductive rodlike body installed through the planar connector housing, the connector terminal being in contact with the circuit terminal part at an end surface of the connector terminal on a circuit board side, wherein:

the circuit terminal part includes a contact part urged by an elastic deformation portion of the circuit terminal part in a direction of the planar connector housing so as to be displaceable in the thickness direction of the circuit board, and
the contact part is in contact with the end surface of the connector terminal while pressing the end surface in the direction of

the planar connector housing.

2. The connector according to claim 1, wherein:

the end surface of the connector terminal has an area larger than a contact area between the end surface and the contact part, and the connector terminal is, at a region of the end surface including a central portion of the end surface, in contact with the contact part in the thickness direction of the circuit board.

3. The connector according to claim 1, wherein:

the connector terminal has a circular cross-section, and the end surface of the connector terminal is circular.

4. The connector according to claim 1, wherein:

the connector terminal includes:

a shaft portion penetrating the planar connector housing; and a contact surface portion formed in such a manner as to project radially from an end of the shaft portion located on the circuit board side, the contact surface portion constituting the end surface of the connector terminal having an outer diameter larger than an outer diameter of the shaft portion.

5. The connector according to claim 1, wherein:

the elastic deformation portion of the circuit terminal part includes an arm portion in a form of a plate spring provided in such a manner as to protrude toward the end surface of the connector terminal from a lateral position in the circuit board relative to a position corresponding to the end surface, and the contact part is formed at a top end of the arm portion.

6. A camera device equipped with the connector according to claim 1, the camera device comprising:

a boxlike camera front case in which an optical system including a lens and a holding part holding the optical system are housed; and a boxlike camera rear case closing an opening in the boxlike camera front case and housing the circuit board, wherein:

the planar connector housing of the connector is formed as a rear surface portion of the boxlike camera rear case,

the circuit board is disposed in such a manner as to be perpendicular to an optical axis of the optical system and to abut on the holding part at an outer peripheral region of the circuit board with respect to the optical axis, the connector terminal is disposed along the optical axis of the optical system, and the contact part of the circuit terminal part presses the circuit board against the holding part in a direction along the optical axis by pressing the end surface of the connector terminal in a direction of the planar connector housing along the optical axis of the optical system.

7. The camera device according to claim 6, wherein:

the contact part of the circuit terminal part is disposed in such a manner as to be located on the optical axis of the optical system.

8. The camera device according to claim 7, wherein:

the contact part of the circuit terminal part is a contact part of a receptacle contact pin, and the contact part of the receptacle contact pin is disposed at a position that coincides with an optical axis of the imaging element mounted on the circuit board, and a contact part of a receptacle ground pin is disposed around the contact part of the receptacle contact pin.

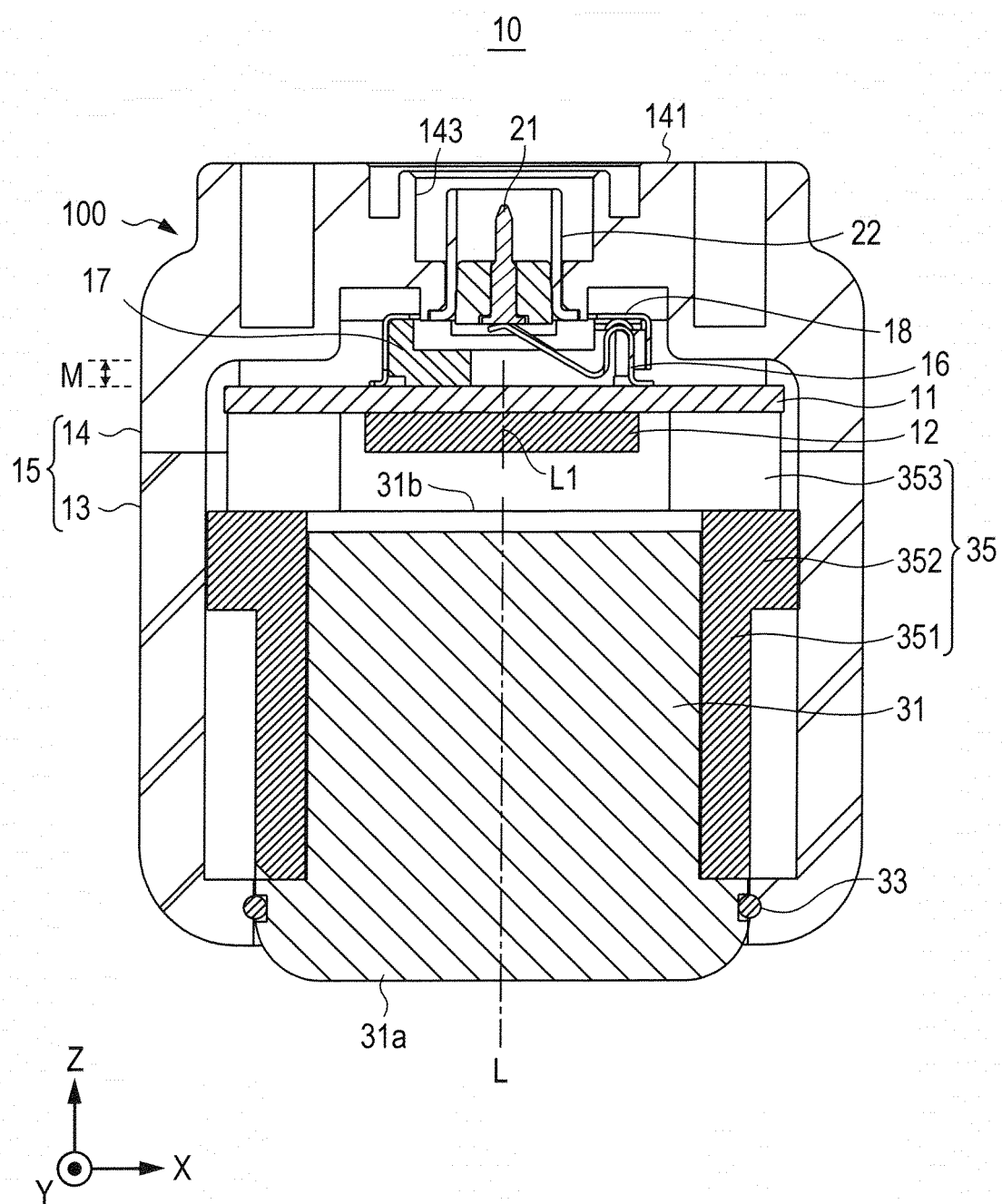


FIG. 1

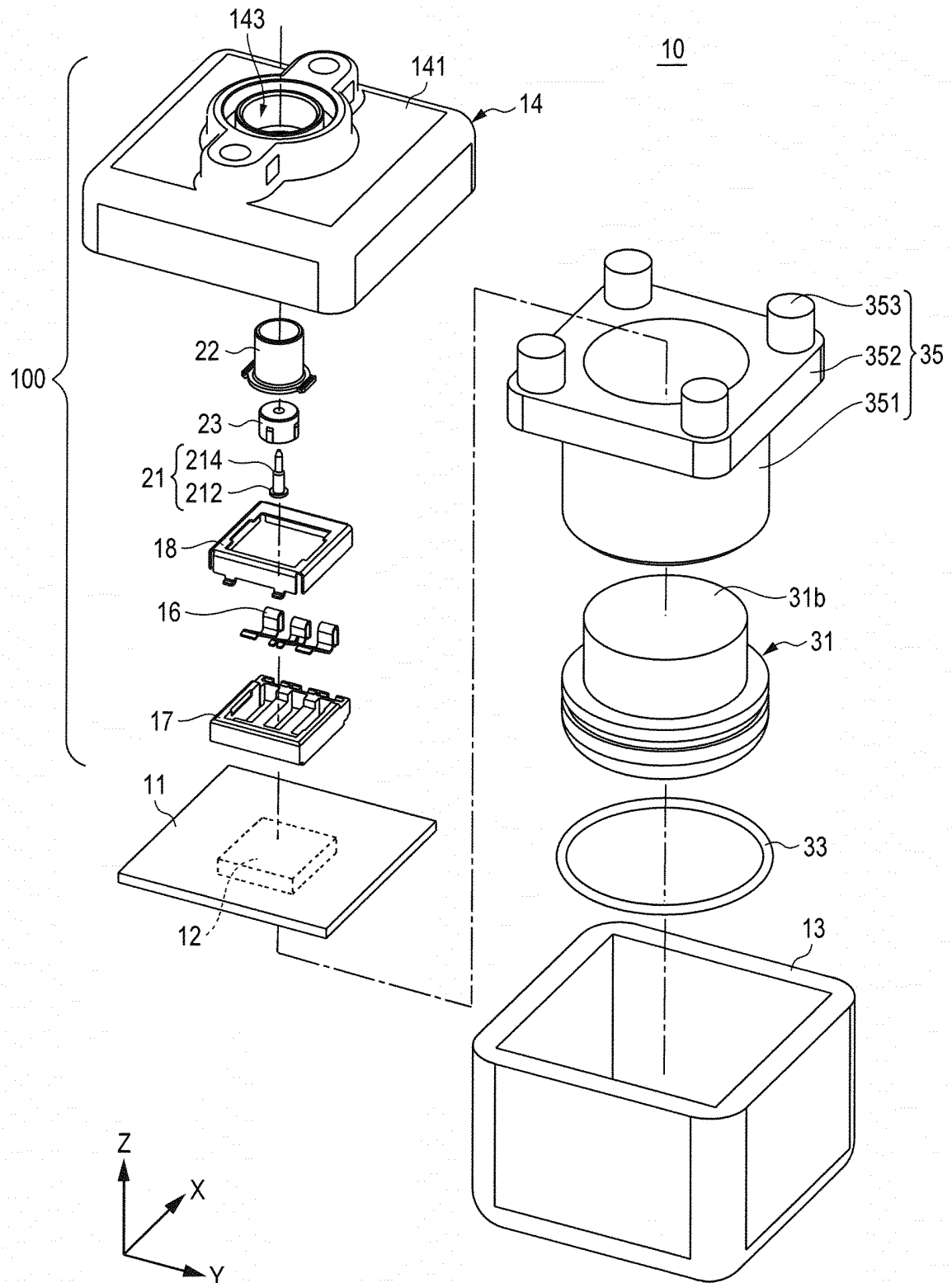


FIG. 2

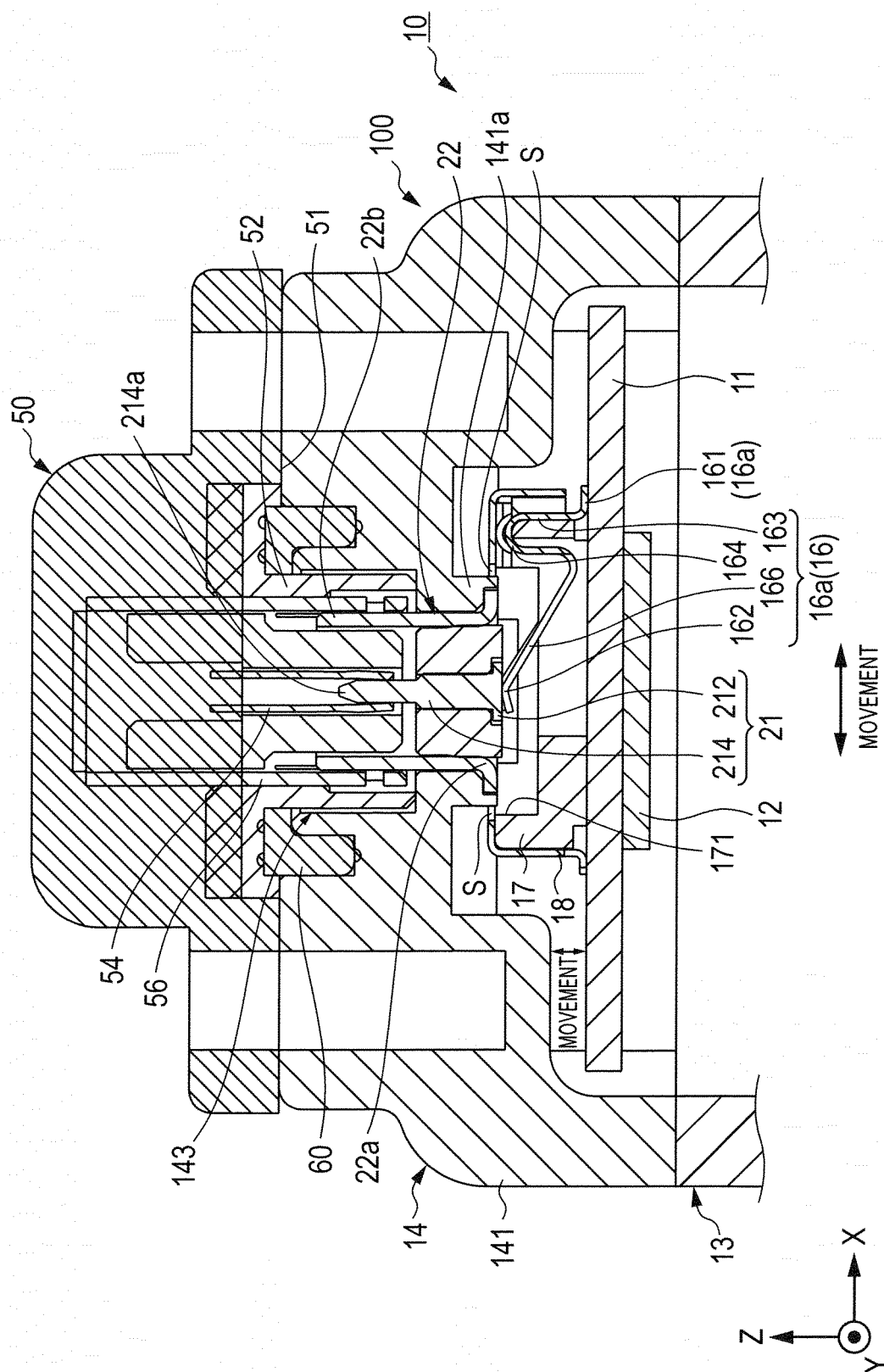


FIG. 3

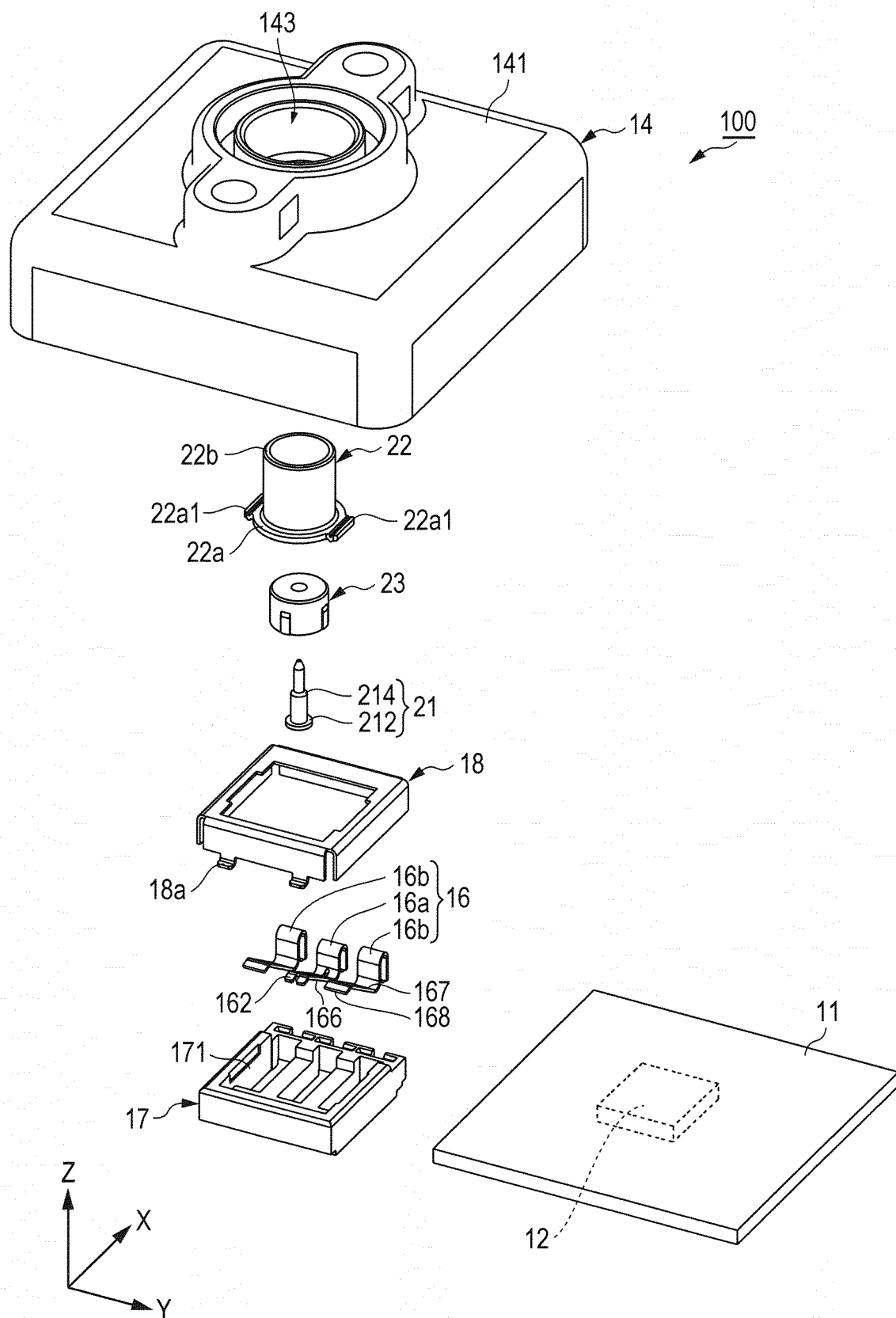


FIG. 4

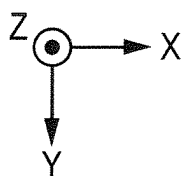
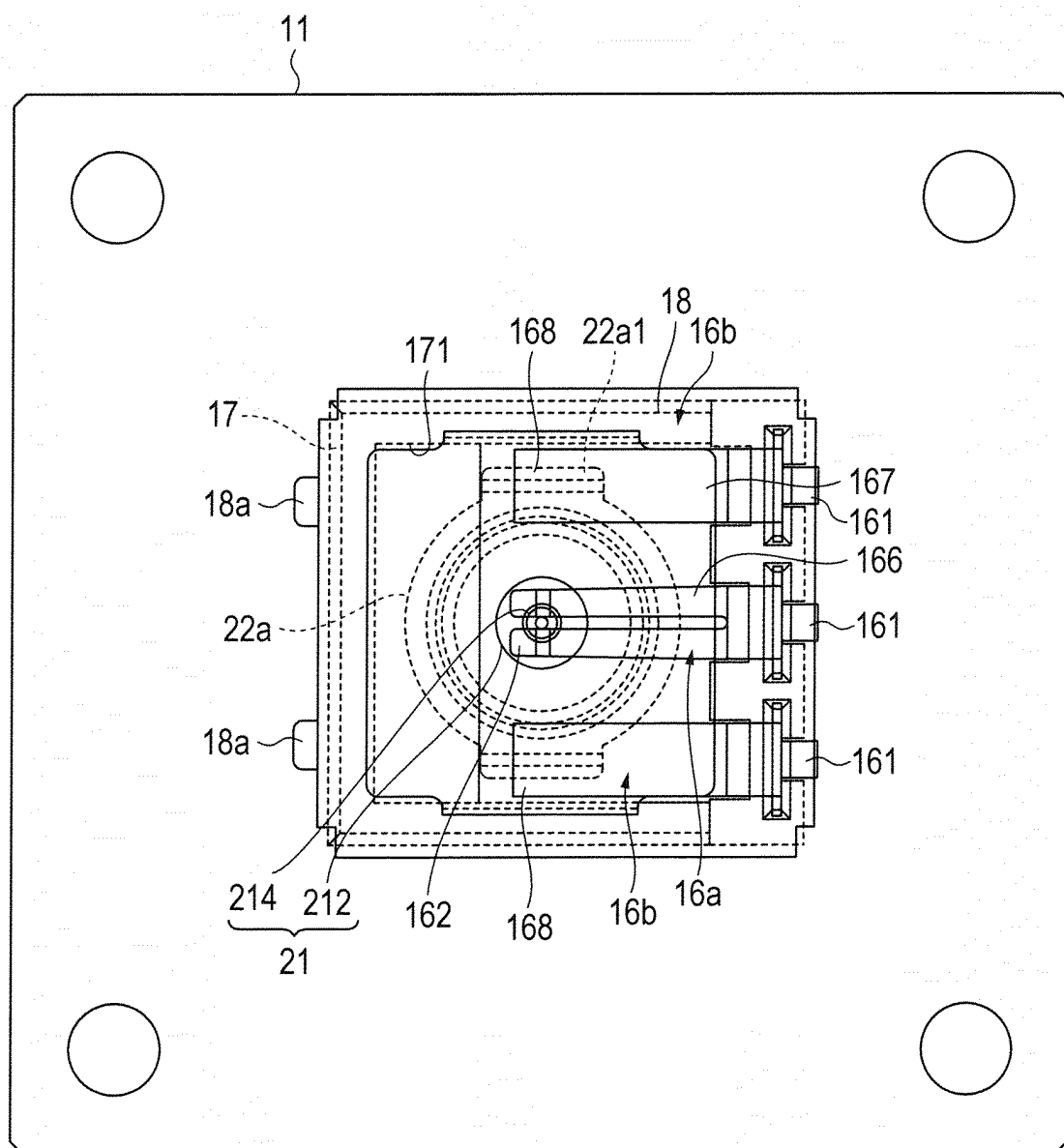


FIG. 5

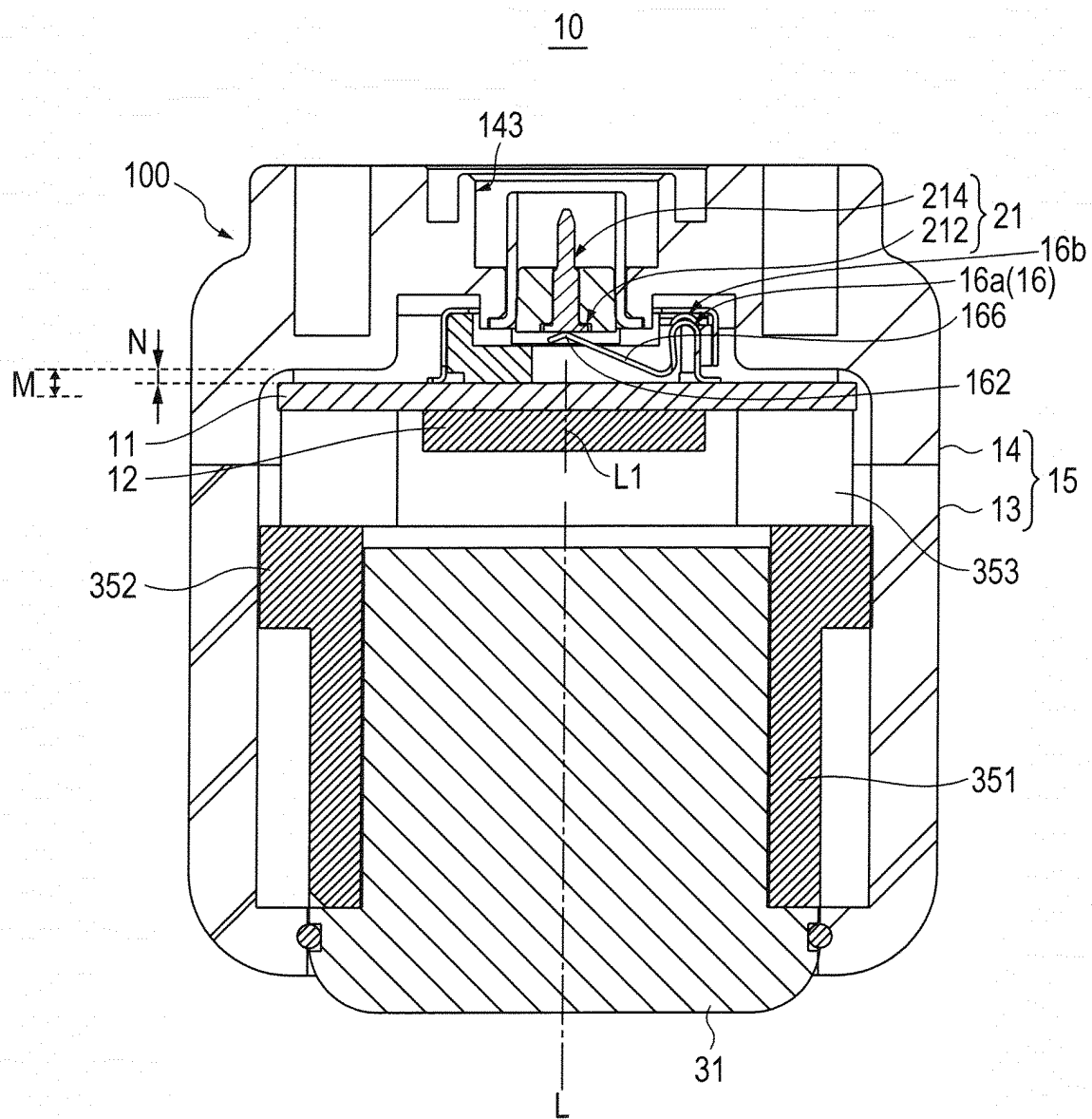


FIG. 6

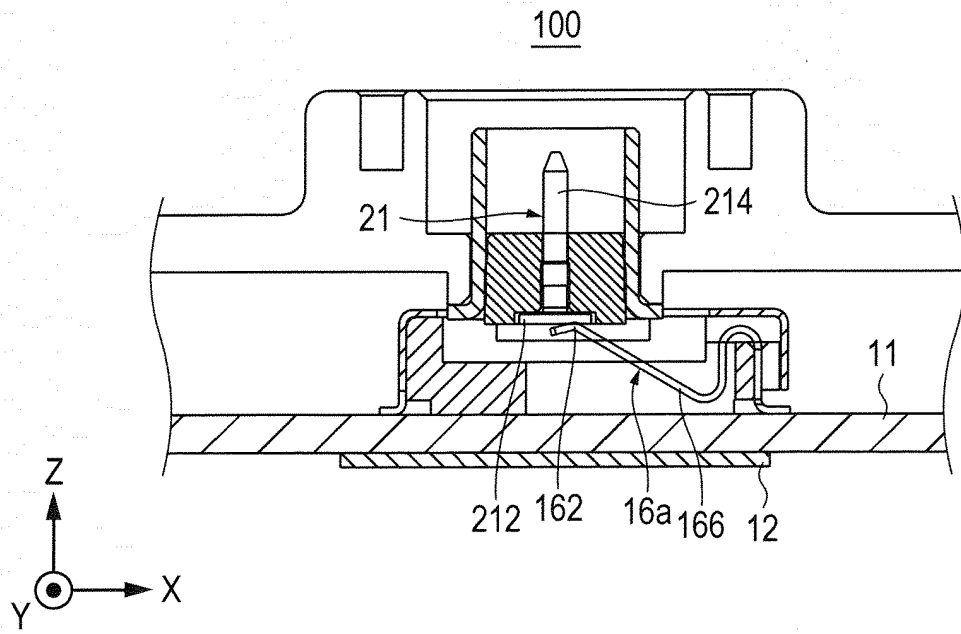


FIG. 7

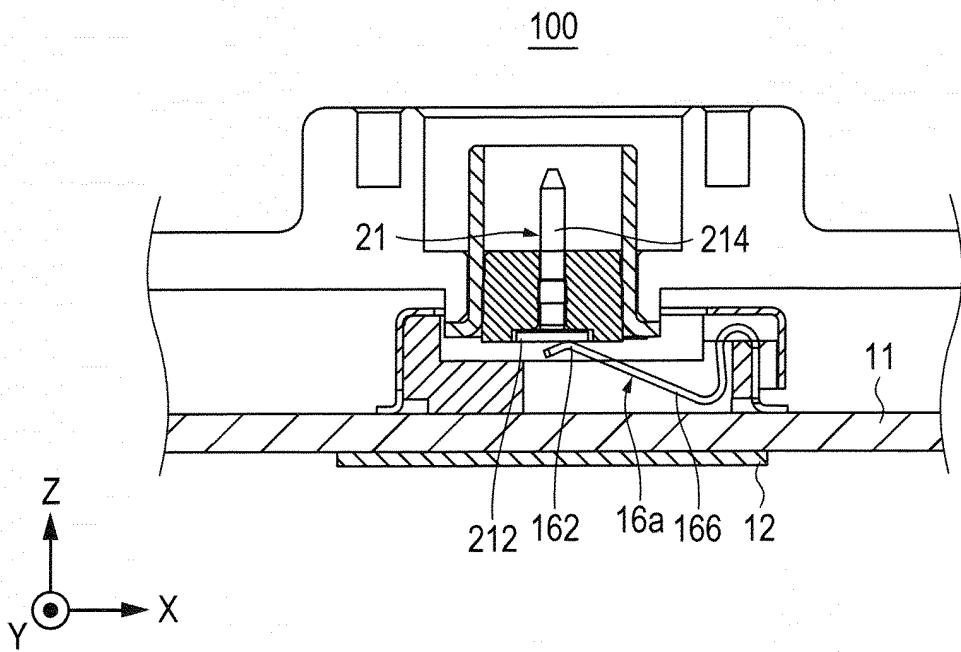


FIG. 8

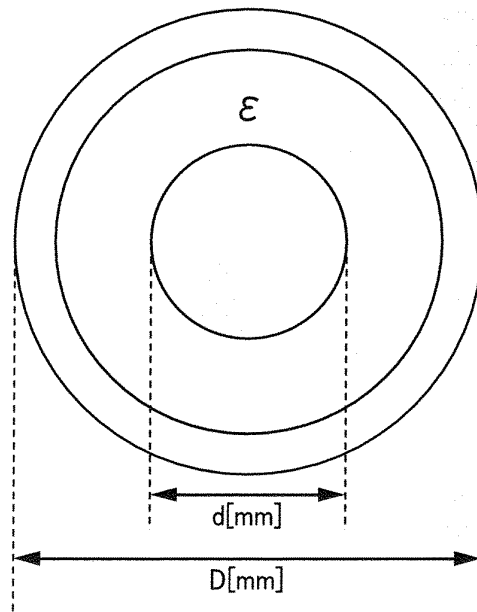


FIG. 9A

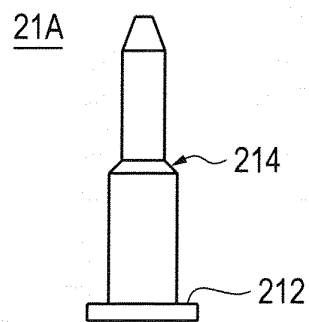


FIG. 9B

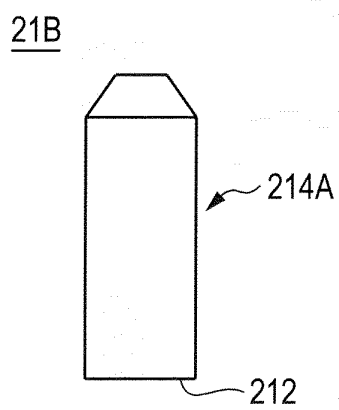


FIG. 9C

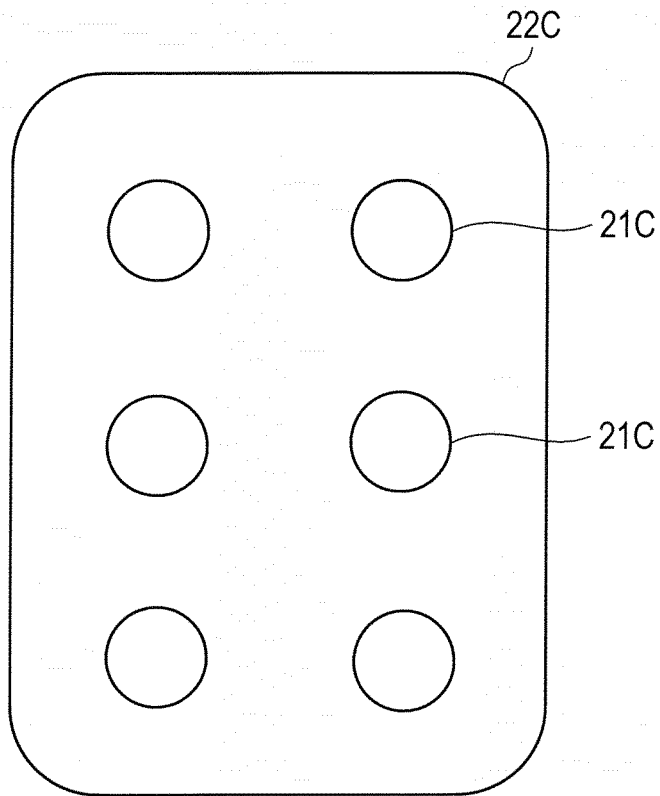


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/001036

A. CLASSIFICATION OF SUBJECT MATTER

H01R12/51(2011.01)i, H01R12/91(2011.01)i, H01R13/24(2006.01)i

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)

H01R12/51, H01R12/91, H01R13/24

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
 Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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.
Y	JP 2009-099411 A (Yazaki Corp.), 07 May 2009 (07.05.2009), paragraphs [0029] to [0038]; fig. 1 to 4 (Family: none)	1-8
Y	JP 2006-351210 A (Autonetworks Technologies, Ltd., Sumitomo Wiring Systems, Ltd., Sumitomo Electric Industries, Ltd.), 28 December 2006 (28.12.2006), paragraphs [0017], [0020]; fig. 1 (Family: none)	1-8
A	JP 08-236227 A (Yokowo Co., Ltd.), 13 September 1996 (13.09.1996), entire text; all drawings (Family: none)	1-8

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

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Date of the actual completion of the international search
14 April 2016 (14.04.16)Date of mailing of the international search report
26 April 2016 (26.04.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/001036

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2014-075229 A (Yazaki Corp.), 24 April 2014 (24.04.2014), entire text; all drawings (Family: none)	1-8

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014075229 A [0006]
- JP 2015039027 A [0103]