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

(11) **EP 4 528 936 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
26.03.2025 Bulletin 2025/13

(21) Application number: **23807478.5**

(22) Date of filing: **08.05.2023**

(51) International Patent Classification (IPC):
H01R 12/91 *(2011.01)*

(52) Cooperative Patent Classification (CPC):
H01R 12/716; H01R 12/57; H01R 12/91;
H01R 12/727; H01R 12/73; H01R 13/6474

(86) International application number:
PCT/JP2023/017340

(87) International publication number:
WO 2023/223874 (23.11.2023 Gazette 2023/47)

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **17.05.2022 JP 2022081182**

(71) Applicant: **Kyocera Corporation**
Kyoto-shi, Kyoto 612-8501 (JP)

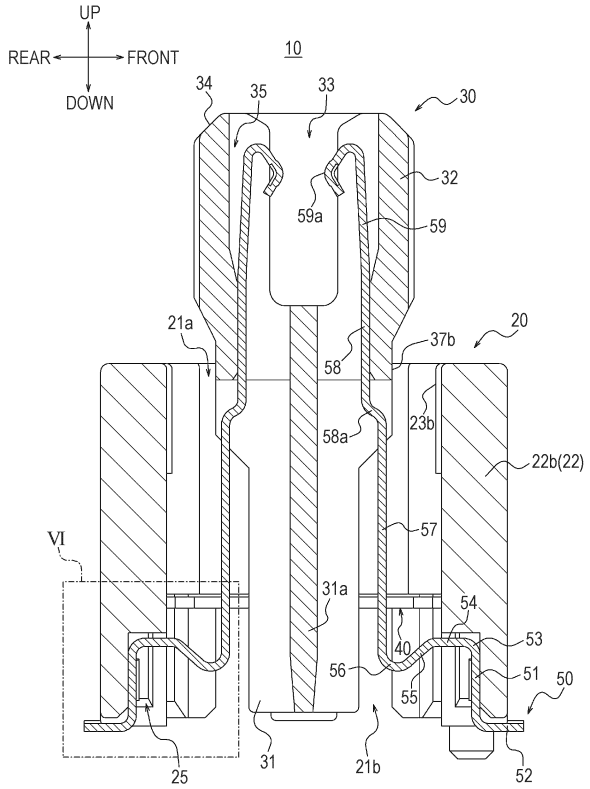
(72) Inventor: **YAMAZAKI Genta**
Kyoto-shi, Kyoto 612-8501 (JP)

(74) Representative: **Viering, Jentschura & Partner mbB**
Patent- und Rechtsanwälte
Am Brauhaus 8
01099 Dresden (DE)

(54) CONNECTOR AND ELECTRONIC DEVICE

(57) A connector 10 according to the present disclosure includes multiple contacts 50 attached to a first insulator 20 and a second insulator 30. The contacts 50 each include a mounting portion 52, a holding portion 51 attached to the first insulator 20, a bent portion 53 bent from the holding portion 51 and extending toward the second insulator 30, a first extending portion 54 extending from an end of a bend in the bent portion 53 toward the second insulator 30, a curved portion 56 curved toward a removal side, and a second extending portion 57 extending from the curved portion 56 toward the removal side. The curved portion 56 including a first end on a mating side is bent and curved with the first end located on the mating side relative to the first extending portion 54. The first end is narrower than the first and second extending portions 54 and 57.

FIG. 5



EP 4 528 936 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Japanese Patent Application No. 2022-081182, filed on May 17, 2022, which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a connector and an electronic device.

BACKGROUND OF INVENTION

[0003] A connector with a floating structure has been known as a technology for improving the reliability of connection with a connection object. Such a connector absorbs misalignment between the connector and a connection object by using movement of a movable insulator as a component of the connector, for example, during and even after mating of the connector with the connection object. Patent Literature 1 discloses a connector that ensures smooth movement of such a movable insulator.

CITATION LIST

PATENT LITERATURE

[0004] Patent Literature 1: Japanese Patent No. 5946804

SUMMARY

[0005] In an embodiment of the present disclosure, a connector includes a first insulator, a second insulator, and multiple contacts. The first insulator has a frame shape. The second insulator is disposed within the first insulator and is movable relative to the first insulator. The second insulator is to be mated with a connection object. The multiple contacts are attached to the first insulator and the second insulator. The multiple contacts each include a mounting portion, a holding portion, a bent portion, a first extending portion, a curved portion, and a second extending portion. The holding portion extends from the mounting portion along the first insulator and is attached to the first insulator. The bent portion is bent from the holding portion and extends toward the second insulator. The first extending portion extends from an end of a bend in the bent portion toward the second insulator. The curved portion is curved toward a removal side opposite to a mating side where the connection object is mated with the second insulator. The second extending portion extends from the curved portion toward the removal side. The curved portion includes a first end on the mating side and is bent and curved with the first end located on the mating side relative to the first extending portion. The first end has a smaller width than the first and second extending portions.

[0006] In an embodiment of the present disclosure, an electronic device includes the above-described connector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a top perspective view of a connector according to an embodiment connected to a connection object.
FIG. 2 is a top perspective view of a connector according to an embodiment separated from a connection object.
FIG. 3 is a top perspective view of the connector alone in FIG. 1.
FIG. 4 is an exploded top perspective view of the connector of FIG. 3.
FIG. 5 is a cross-sectional view taken along arrow line V-V in FIG. 3.
FIG. 6 is an enlarged view of part VI surrounded by an alternate long and short dash line in FIG. 5.
FIG. 7 is an enlarged top perspective view of parts of contacts in FIG. 4.
FIG. 8 is a top perspective view of a connection object to be connected to the connector of FIG. 3.
FIG. 9 is an exploded top perspective view of the connection object of FIG. 8.
FIG. 10 is a cross-sectional view taken along arrow line X-X in FIG. 1.
FIG. 11A is a schematic diagram illustrating a first example of elastic deformation of a contact.
FIG. 11B is a schematic diagram illustrating a second example of elastic deformation of the contact.
FIG. 12A is an enlarged side view of part of the contact in FIG. 4.
FIG. 12B is an enlarged side view of part of a contact in an alternative embodiment.
FIG. 13 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a cross-section of a connector according to an alternative embodiment.

DESCRIPTION OF EMBODIMENTS

[0008] In a connector with a floating structure, as a movable insulator moves, contacts attached to the movable insulator deform elastically. The elastic deformation of the contacts causes a restoring force, which in turn applies stress to mounting portions of the contacts on a circuit board. Under large stress loads on the mounting portions, the mounting portions are likely to break. For example, solder joints between the mounting portions and the circuit board may crack.

[0009] Such a problem related to loads on the mounting portions becomes more pronounced as the connector

is reduced in size. As various electronic devices have recently been miniaturized, connectors to be connected to connection objects are also required to achieve area savings and have a lower profile. Achieving area savings in a connector involves a reduction in distance between elastically deformable portions of contacts and mounting portions thereof. Thus, the mounting portions are more likely to experience a larger load.

[0010] In an embodiment of the present disclosure, a connector and an electronic device can reduce a load that is applied to mounting portions of contacts even when reduced in size.

[0011] An embodiment of the present disclosure will be described in detail below with reference to the accompanying drawings. In the following description, front-rear, left-right, and up-down directions are based on directions of arrows in the figures. The directions of the arrows in different figures, FIGs. 1 to 7 and FIGs. 10 to 13, are consistent with each other. The directions of the arrows in FIGs. 8 and 9 are consistent with each other. For simplification of illustration, circuit boards CB1 and CB2, which will be described later, are not illustrated in some of the figures.

[0012] FIG. 1 is a top perspective view of a connector 10 according to an embodiment connected to a connection object 60. FIG. 2 is a top perspective view of the connector 10 according to an embodiment separated from the connection object 60. As illustrated in FIG. 2, for example, the connector 10 includes a first insulator 20 as a fixed insulator, a second insulator 30 as a movable insulator, fittings 40, and contacts 50. The connection object 60 includes an insulator 70, fittings 80, and contacts 90.

[0013] In an embodiment, for example, the connector 10 will be hereinafter described as a receptacle connector, and the connection object 60 will be hereinafter described as a plug connector. In the connector 10 described as a receptacle connector, a portion of each of the contacts 50 that is in contact with a respective one of the contacts 90 is elastically deformed in a mated state in which the second insulator 30 of the connector 10 and the connection object 60 are mated with each other. On the other hand, in the connection object 60 described as a plug connector, a portion of each of the contacts 90 that is in contact with a respective one of the contacts 50 is not elastically deformed in the mated state. The types of the connector 10 and the connection object 60 are not limited to those in this example. For example, the connector 10 may serve as a plug connector, and the connection object 60 may serve as a receptacle connector.

[0014] In the following description, the connector 10 is mounted on the circuit board CB1, and the connection object 60 is mounted on the circuit board CB2. The connector 10 electrically connects the circuit board CB1 to the circuit board CB2, on which the connection object 60 is mounted, via the connection object 60 mated with the second insulator 30 of the connector 10. Each of the circuit boards CB1 and CB2 may be a rigid board or may be any other circuit board. For example, at least one of the circuit board CB1 or the circuit board CB2 may be an FPC (flexible printed circuit board).

[0015] In the following description, the connector 10 and the connection object 60 are connected to each other in a direction perpendicular to the circuit boards CB1 and CB2. For example, the connector 10 and the connection object 60 are connected to each other in the up-down direction. A mating direction in which the second insulator 30 and the connection object 60 are mated with each other is orthogonal to the circuit board CB1.

[0016] The manner of connection is not limited to this example. The connector 10 and the connection object 60 may be connected to each other in a direction parallel to the circuit boards CB1 and CB2. The connector 10 and the connection object 60 may be connected to each other such that one of the connector 10 and the connection object 60 is perpendicular to the circuit board on which the one of them is mounted and such that the other one of the connector 10 and the connection object 60 is parallel to the circuit board on which the other one of them is mounted.

[0017] As used herein, the "mating direction" refers to, for example, the up-down direction. A "lateral direction of the connector 10" refers to, for example, the front-rear direction. A "longitudinal direction of the connector 10" refers to, for example, the left-right direction. An "array direction of the multiple contacts 50" refers to, for example, the left-right direction. A "mating side" refers to, for example, a lower side. A "removal side" refers to, for example, an upper side.

[0018] The "mated state" refers to a state in which the second insulator 30 of the connector 10 and the connection object 60 are mated with each other and in which each contact 50 is elastically deformed in contact with the corresponding contact 90. An "unmated state" refers to a state in which the second insulator 30 of the connector 10 and the connection object 60 are not mated with each other and in which each contact 50 is not elastically deformed by an external force.

[0019] In an embodiment, the connector 10 includes a floating structure. The connector 10 allows the connection object 60 connected to the connector 10 to move relative to the circuit board CB1 in six directions, or upward, downward, frontward, rearward, leftward, and rightward directions. Even while being connected to the connector 10, the connection object 60 is movable relative to the circuit board CB1 in the six directions, or the upward, downward, frontward, rearward, leftward, and rightward directions, within a predetermined range. In addition to the six directions, or the upward, downward, frontward, rearward, leftward, and rightward directions, the connection object 60 is movable in, for example, oblique directions between the respective directions within the predetermined range.

[0020] FIG. 3 is a top perspective view of the connector 10 alone in FIG. 1. FIG. 4 is an exploded top perspective view of the connector 10 of FIG. 3. FIG. 5 is a cross-

sectional view taken along arrow line V-V in FIG. 3. FIG. 6 is an enlarged view of part VI surrounded by an alternate long and short dash line in FIG. 5. FIG. 7 is an enlarged top perspective view of parts of the contacts 50 in FIG. 4.

[0021] As illustrated in FIG. 4, the connector 10 is assembled in the following manner, for example. The fittings 40 are press-fitted from below into the first insulator 20. The second insulator 30 is disposed from below into the first insulator 20 with the fittings 40. The contacts 50 are press-fitted from below into the first insulator 20 and the second insulator 30, which is disposed within the first insulator 20.

[0022] The configurations of components of the connector 10 in the unmated state will be primarily described below. First, the configuration of the first insulator 20 will be primarily described with reference primarily to FIG. 4.

[0023] As illustrated in FIG. 4, the first insulator 20 is a member made of an insulating heat-resistant synthetic resin material formed by injection molding, and extends in the left-right direction. The first insulator 20 is frame-shaped. The first insulator 20 is hollow and includes an opening 21a at an upper surface of the first insulator 20 and an opening 21b at a lower surface thereof. The first insulator 20 includes an outer peripheral wall 22 including four sides and surrounding an internal space of the first insulator 20. More specifically, the outer peripheral wall 22 includes a pair of lateral walls 22a disposed one each at opposite sides in the left-right direction and a pair of longitudinal walls 22b disposed one each at opposite sides in the front-rear direction. The pair of lateral walls 22a and the pair of longitudinal walls 22b are orthogonal to each other, thus forming the outer peripheral wall 22.

[0024] The first insulator 20 includes first restricting portions 23a extending in the up-down direction on inner surfaces of the lateral walls 22a. Each of the first restricting portions 23a is located at the middle of an upper end portion of the inner surface of the lateral wall 22a in the front-rear direction and has a predetermined width in the front-rear direction. The first restricting portion 23a protrudes inward from the inner surface of the lateral wall 22a in the left-right direction and is formed as a stepped portion on the inner surface. The first insulator 20 includes second restricting portions 23b extending in the up-down direction on inner surfaces of the longitudinal walls 22b. The second restricting portions 23b are located one each at opposite ends of an upper end portion of the inner surface of each of the longitudinal walls 22b in the left-right direction. Each of the second restricting portions 23b has a predetermined width in the left-right direction. The second restricting portion 23b protrudes inward from the inner surface of the longitudinal wall 22b in the front-rear direction and is formed as a stepped portion on the inner surface.

[0025] The first insulator 20 includes a fitting attachment groove 24 located in a lower portion of each of the lateral walls 22a and recessed in the first insulator 20. The fitting 40 is attached to the fitting attachment groove 24.

[0026] The first insulator 20 includes multiple contact attachment grooves 25 located in a lower end portion of the inner surface of each of the longitudinal walls 22b and extending in the up-down direction. Each of the multiple contacts 50 is attached to a respective one of the multiple contact attachment grooves 25. The multiple contact attachment grooves 25 are spaced apart from each other at predetermined intervals in the left-right direction and are recessed.

[0027] The configuration of the second insulator 30 will be described with reference primarily to FIG. 4. The second insulator 30 is disposed into the internal space surrounded by the outer peripheral wall 22 of the first insulator 20 through the opening 21b, and is movable relative to the first insulator 20. The second insulator 30 is to be mated with the connection object 60.

[0028] The second insulator 30 is a member made of an insulating heat-resistant synthetic resin material formed by injection molding, and extends in the left-right direction. The second insulator 30 is inverted T-shaped as viewed from the front. The second insulator 30 includes a base 31, serving as a lower portion of the second insulator 30, extending in the left-right direction. The second insulator 30 includes a wall portion 31a located in the base 31 and having a small width in the front-rear direction. The wall portion 31a extends across the base 31 in the up-down direction. The wall portion 31a extends substantially across the base 31 in the left-right direction, except for opposite ends of the base 31 in the left-right direction. As illustrated in FIG. 5, a lower end part of the wall portion 31a tapers toward the mating side in the up-down direction.

[0029] As illustrated in FIG. 4, the second insulator 30 includes a mating protrusion 32 protruding upward from the base 31 and being to be mated with the connection object 60. The mating protrusion 32 is slightly larger than the base 31 in the left-right direction, and protrudes from opposite sides of the base 31 in the left-right direction.

[0030] The second insulator 30 includes a mating depression 33 recessed from an upper surface of the mating protrusion 32. The second insulator 30 includes a guide 34 extending across an upper edge of the mating protrusion 32 and surrounding the mating depression 33. The guide 34 is defined by a sloping face that slopes obliquely downward and outward from the upper edge of the mating protrusion 32.

[0031] The second insulator 30 includes multiple contact attachment grooves 35 located in the mating protrusion 32 and extending substantially across the mating protrusion 32 in the up-down direction. Each of the multiple contacts 50 is attached to the respective one of the multiple contact attachment grooves 35. The contact attachment grooves 35 are spaced apart from each other at predetermined intervals in the left-right direction and are recessed.

[0032] As illustrated in FIG. 5, the contact attachment grooves 35 extend from the bottom of the mating protrusion 32 to the top thereof, or through the mating protru-

sion 32. A lower end of each of the contact attachment grooves 35 is exposed on the bottom of the mating protrusion 32 and is continuous with the wall portion 31a. Portions of the contact attachment grooves 35 that extend upward from the lower ends of the contact attachment grooves 35 are formed and recessed from both inner surfaces of the mating depression 33 in the front-rear direction.

[0033] As illustrated in FIG. 4, the second insulator 30 includes retaining protrusions 36 located one each on opposite ends of a lower end of the base 31 in the left-right direction and protruding outward in the left-right direction. The second insulator 30 includes first restricted portions 37a defined by outer surfaces of the second insulator 30 in the left-right direction. The first restricted portions 37a include outer surfaces of the base 31 in the left-right direction and outer surfaces of an inward-stepped lower end of the mating protrusion 32 in the left-right direction. The inward-stepped lower end is reduced in dimension in the front-rear and left-right directions. The second insulator 30 includes second restricted portions 37b defined by outer surfaces of the second insulator 30 in the front-rear direction. The second restricted portions 37b include outer surfaces of outward-stepped portions of the base 31 located at opposite ends of an upper end portion of the base 31 in the left-right direction and protruding outward in the front-rear direction, and further include outer surfaces of the inward-stepped lower end, which is reduced in dimension in the front-rear and left right directions, of the mating protrusion 32 in the front-rear direction.

[0034] The configuration of each fitting 40 will be described with reference primarily to FIG. 4.

[0035] The fitting 40 is formed by shaping a sheet of any metal material into a form illustrated in FIG. 4 with a progressive die (stamping). The method of forming the fitting 40 includes, after stamping, bending a workpiece in a thickness direction of the workpiece. The fitting 40 is substantially inverted U-shaped as viewed in the left-right direction.

[0036] The fitting 40 includes mounting portions 41 located at lower ends of the fitting 40 at opposite sides thereof in the front-rear direction and extending outward to define an L-shape. The fitting 40 includes engaging portions 42 each extending upward from an upper end of a respective one of the mounting portions 41. The fitting 40 includes a base 43 extending in the front-rear direction to couple the engaging portions 42 at the opposite sides of the fitting 40 in the front-rear direction. The fitting 40 includes a restricting portion 44 located at the middle of the base 43 in the front-rear direction, protruding outward in the left-right direction, and having a relatively large width in the left-right direction.

[0037] The configuration of each contact 50 will be described with reference primarily to FIGs. 4 to 7.

[0038] The contact 50 is formed by shaping a sheet of, for example, a copper alloy containing, for example, phosphor bronze, beryllium copper, or titanium copper, and having spring elasticity or a Corson alloy into a form illustrated in FIGs. 4 to 7 with a progressive die (stamping). The contact 50 is formed by stamping the sheet into a workpiece and then bending the workpiece in a thickness direction of the workpiece. The method of forming the contact 50 is not limited to this example. The method may include only stamping. The contact 50 is made of, for example, a metal material having a low elastic modulus, to produce a significant change in shape associated with elastic deformation. The contact 50 is plated with nickel, serving as an undercoat layer, and is then plated with, for example, gold or tin.

[0039] As illustrated in FIG. 4, the multiple contacts 50 are arrayed in the longitudinal direction of the connector 10. As illustrated in FIG. 5, the contacts 50 are attached to the first insulator 20 and the second insulator 30. A pair of contacts 50 arrayed at the same position in the left-right direction are symmetrically shaped and arranged in the front-rear direction. The pair of contacts 50 are shaped and arranged symmetrically with respect to a centerline or axis extending therebetween in the up-down direction.

[0040] Each of the contacts 50 includes a first holding portion 51 extending in the up-down direction and supported by the first insulator 20. The contact 50 includes a mounting portion 52 extending outward from a lower end of the first holding portion 51 to define an L-shape. The first holding portion 51 extends from the mounting portion 52 along the first insulator 20 and is disposed along the first insulator 20. The contact 50 includes a bent portion 53 bent from an upper end of the first holding portion 51 and extending toward the second insulator 30.

[0041] The contact 50 includes a first extending portion 54 extending from an end of a bend in the bent portion 53 toward the second insulator 30. The first extending portion 54 extends horizontally from an end of the bent portion 53 adjacent to the second insulator 30 toward the second insulator 30. An end part of the first extending portion 54 adjacent to the second insulator 30 is bent toward the mating side where the connection object 60 is mated with the second insulator 30.

[0042] The contact 50 includes a coupling portion 55 sloping linearly from the end part of the first extending portion 54 adjacent to the second insulator 30 toward the mating side. The contact 50 includes a curved portion 56 curved from a lower end of the coupling portion 55 toward the removal side opposite to the mating side. The curved portion 56 is coupled to the first extending portion 54 by the coupling portion 55.

[0043] The contact 50 includes a second extending portion 57 extending from the curved portion 56 toward the removal side. The second extending portion 57 has a linear shape and is parallel to the up-down direction. The contact 50 includes a second holding portion 58 bent inward in the front-rear direction from an upper end of the second extending portion 57 and extending linearly upward. The second holding portion 58 includes a bent part 58a smoothly bent in a crank-shape from the upper end of the second extending portion 57. The second holding portion 58 includes a wide part located directly on the

bent part 58a and having a large width in the left-right direction. The second holding portion 58 is supported by the second insulator 30.

[0044] The contact 50 includes an elastic contact piece 59 extending upward from an upper end of the second holding portion 58 and slightly inclined inward in the front-rear direction. The elastic contact piece 59 includes an upper end portion and an innermost portion. The upper end portion is bent obliquely downward and inward in the front-rear direction. The innermost portion is located at an innermost position in the front-rear direction and is bent obliquely downward and outward in the front-rear direction. The elastic contact piece 59 includes a contact part 59a located at the innermost position in the front-rear direction.

[0045] As illustrated in FIG. 6, the first holding portion 51 of the contact 50 engages the contact attachment groove 25 located in the longitudinal wall 22b of the first insulator 20. The first holding portion 51 is attached to the first insulator 20. As illustrated in FIG. 5, the second holding portion 58 of the contact 50 engages the contact attachment groove 35 located in the mating protrusion 32 of the second insulator 30.

[0046] Once the multiple contacts 50 are attached to the first insulator 20 and the second insulator 30, the contact part 59a of each of the contacts 50 is located in the mating depression 33 of the second insulator 30. The elastic contact piece 59 of each contact 50 is disposed in the contact attachment groove 35 of the second insulator 30 and is elastically deformable in the front-rear direction. Each contact 50 supports the second insulator 30 such that the second insulator 30 is floating apart from the first insulator 20 in the internal space surrounded by the outer peripheral wall 22 of the first insulator 20.

[0047] Once the second insulator 30 is held relative to the first insulator 20 by the contacts 50, the second insulator 30 is located apart from the first insulator 20 in the internal space surrounded by the outer peripheral wall 22 of the first insulator 20. More specifically, the base 31 of the second insulator 30 is located in the internal space, surrounded by the pair of longitudinal walls 22b and the pair of lateral walls 22a, of the first insulator 20. The base 31 of the second insulator 30 is surrounded by the outer peripheral wall 22 of the first insulator 20.

[0048] The mating protrusion 32 of the second insulator 30 protrudes upward through the opening 21a of the first insulator 20 and is located outside the internal space of the first insulator 20. The mating protrusion 32 of the second insulator 30 is located above the outer peripheral wall 22 of the first insulator 20 such that the mating protrusion 32 can be mated with the connection object 60.

[0049] At this time, the second restricted portions 37b of the second insulator 30 face, from inside, the second restricting portions 23b located on the longitudinal walls 22b of the first insulator 20 in the front-rear direction. As illustrated in FIG. 3, the first restricted portions 37a of the second insulator 30 face, from inside, the first restricting portions 23a located on the lateral walls 22a of the first insulator 20 in the left-right direction. The retaining protrusions 36 of the second insulator 30 face, from below, the restricting portions 44 of the fittings 40.

[0050] The engaging portions 42 of each of the fittings 40 engage the fitting attachment groove 24 of the first insulator 20. The fittings 40 are press-fitted in the fitting attachment grooves 24 of the first insulator 20 and are located one each at the opposite ends of the first insulator 20 in the left-right direction.

[0051] The bases 43 of the fittings 40 attached to the first insulator 20 are located at opposite ends of the internal space of the first insulator 20 in the left-right direction. Once the second insulator 30 is held relative to the first insulator 20 by the contacts 50, a lower surface of the restricting portion 44 of each of the bases 43 faces an upper surface of the respective one of the retaining protrusions 36 of the second insulator 30 in the up-down direction.

[0052] As illustrated in FIG. 6, the bent portion 53 is bent at an angle of 90° from the upper end of the first holding portion 51. The bent portion 53 is shaped like an arc of a sector having a central angle of 90°. The end part of the first extending portion 54 adjacent to the second insulator 30 is bent at an obtuse angle greater than 90°. This end part has a shape like an arc of a sector having an acute central angle less than 90°. The curved portion 56 is bent at an acute angle less than 90° from the lower end of the coupling portion 55 sloping linearly, and includes an arc-shaped end part bent upward. The curved portion 56 is shaped like an arc of a sector having an obtuse central angle greater than 90°.

[0053] In each of the contacts 50, the mounting portion 52, the first holding portion 51, the bent portion 53, and part of the first extending portion 54 are arranged along the first insulator 20. The first insulator 20 is located between these elements of one contact 50 and these elements of another contact 50 adjacent to the one contact 50 in the left-right direction.

[0054] In the contact 50, the end part of the first extending portion 54 adjacent to the second insulator 30, the coupling portion 55, the curved portion 56, and the second extending portion 57 are located between the first insulator 20 and the second insulator 30. The first insulator 20 is not located between these elements of one contact 50 and these elements of another contact 50 adjacent to the one contact 50 in the left-right direction.

[0055] The curved portion 56 includes a first end on the mating side and is bent and curved with the first end located on the mating side relative to the first extending portion 54. The first extending portion 54 includes a second end on the removal side. A first distance L1 in the mating direction from the second end to the first end of the curved portion 56 on the mating side is equal to or less than half a second distance L2 in the mating direction from the circuit board CB1, or a lower surface of the mounting portion 52, to the second end. For example, the first distance L1 may be approximately 0.35 times the second distance L2.

[0056] As illustrated in FIG. 7, a width direction of each contact 50 is parallel to the array direction of the multiple contacts 50. A thickness direction of the contact 50 is any direction orthogonal to the left-right direction and is included in planes in the up-down and front-rear directions. The thickness of the contact 50 is substantially uniform at any point in the contact 50. On the other hand, the width of the contact 50 in the left-right direction varies at different points in the contact 50.

[0057] The first holding portion 51 of the contact 50 has a large width in the left-right direction so that the first holding portion 51 can engage the contact attachment groove 25 of the first insulator 20. The bent portion 53 has a smaller width than the first holding portion 51 in the left-right direction. The first extending portion 54 has a larger width than the bent portion 53 in the left-right direction. The coupling portion 55 has the same width as that of the first extending portion 54 and is continuous with the first extending portion 54, and has a larger width than the bent portion 53 in the left-right direction.

[0058] The curved portion 56 has a smaller width than the first extending portion 54 and the coupling portion 55 in the left-right direction. The second extending portion 57 has a larger width than the curved portion 56 in the left-right direction and extends upward continuously from the curved portion 56. For example, the second extending portion 57 has substantially the same width as those of the first extending portion 54 and the coupling portion 55. The curved portion 56 is narrower in the left-right direction than the second extending portion 57 in addition to the first extending portion 54 and the coupling portion 55.

[0059] Of the elements of the contact 50 located between the first insulator 20 and the second insulator 30, the curved portion 56 has the smallest width in the left-right direction. In a portion of the contact 50 that is located between the first insulator 20 and the second insulator 30, only a bend corresponding to the curved portion 56, which couples the second extending portion 57 to the first extending portion 54 and the coupling portion 55, has a small width in the left-right direction. The first extending portion 54 and the coupling portion 55, which is next to the bend, and the second extending portion 57, which is next to the bend, have a larger width than the curved portion 56 in the left-right direction.

[0060] In the contact 50, the bent portion 53 is narrow. The first extending portion 54, which is next to the bent portion 53, and the coupling portion 55 are wide. The curved portion 56, which is next to the coupling portion 55 and the first extending portion 54, is narrow. In addition, as illustrated in FIG. 4, the curved portion 56 is narrow, the second extending portion 57 next to the curved portion 56 is wide, and the bent part 58a of the second holding portion 58 next to the second extending portion 57 is narrow. As described above, the contact 50 includes two portions in each of which a narrow part, a wide part, and a narrow part are arranged in that order, and the two portions are continuously formed.

[0061] The connector 10 with the above-described structure is mounted on, for example, a circuit formation surface formed on a mounting surface of the circuit board CB1. More specifically, the mounting portions 41 of the fittings 40 are placed on a solder paste applied to a pattern on the circuit board CB1. The mounting portions 52 of the contacts 50 are placed on the solder paste applied to the pattern on the circuit board CB1. The mounting portions 41 and the mounting portions 52 are soldered to the pattern by heating and melting the solder paste in, for example, a reflow furnace. Thus, the mounting of the connector 10 on the circuit board CB1 is completed. For example, electronic components different from the connector 10 and including a CPU (central processing unit), a controller, and a memory are mounted on the circuit formation surface of the circuit board CB1.

[0062] The structure of the connection object 60 will be described with reference primarily to FIGs. 8 and 9.

[0063] FIG. 8 is a top perspective view of the connection object 60 to be connected to the connector 10 of FIG. 3. FIG. 9 is an exploded top perspective view of the connection object 60 of FIG. 8.

[0064] As illustrated in FIG. 9, the connection object 60 includes, as large components, the insulator 70, the fittings 80, and the contacts 90. The connection object 60 is assembled by press-fitting the fittings 80 from above into the insulator 70 and press-fitting the contacts 90 from below into the insulator 70.

[0065] The insulator 70 is a rectangular prism-shaped member made of an insulating heat-resistant synthetic resin material formed by injection molding. The insulator 70 includes a mating depression 71 recessed from an upper surface of the insulator 70. The insulator 70 includes a mating protrusion 72 located in the mating depression 71. The insulator 70 includes a guide 73 extending across an upper edge of the mating depression 71 and surrounding the mating depression 71. The guide 73 is defined by a sloping face that slopes obliquely downward and inward from the upper edge of the mating depression 71.

[0066] The insulator 70 includes fitting attachment grooves 74 located at opposite ends of a lower portion of the insulator 70 in the left-right direction and recessed in the up-down direction. Each of the fittings 80 is attached to a respective one of the fitting attachment grooves 74. The insulator 70 includes multiple contact attachment grooves 75 located on front and rear inner surfaces of the lower portion and front and rear surfaces of the mating protrusion 72. Each of the multiple contacts 90 is attached to a respective one of the multiple contact attachment grooves 75. The multiple contact attachment grooves 75 are spaced apart from each other at predetermined intervals in the left-right direction.

[0067] Each of the fittings 80 is formed by shaping a sheet of any metal material into a form illustrated in FIG. 9 with a progressive die (stamping). The fitting 80 is disposed on each of the opposite ends of the insulator 70 in the left-right direction. The fitting 80 includes a mounting portion 81 located at a lower end of the fitting 80 and

extending outward in the left-right direction to define an L-shape. The fitting 80 includes an engaging portion 82 extending upward continuously from the mounting portion 81 and being to engage the insulator 70.

[0068] Each of the contacts 90 is formed by shaping a sheet of, for example, a copper alloy containing, for example, phosphor bronze, beryllium copper, or titanium copper, and having spring elasticity or a Corson alloy into a form illustrated in FIG. 9 with a progressive die (stamping). The contact 90 is formed by stamping the sheet into a workpiece and then bending the workpiece in a thickness direction of the workpiece. The method of forming the contact 90 is not limited to this example. The method may include only stamping. The contact 90 is plated with nickel, serving as an undercoat layer, and is then plated with, for example, gold or tin.

[0069] The multiple contacts 90 are arrayed in the left-right direction. Each of the contacts 90 includes an L-shaped mounting portion 91 extending outward in the front-rear direction. The contact 90 includes a first engaging portion 92 formed continuously with the mounting portion 91. The contact 90 includes a coupling portion 93 extending upward in a crank-shape from the first engaging portion 92. The contact 90 includes a second engaging portion 94 linearly extending upward from an upper end of the coupling portion 93. The contact 90 includes a contact portion 95 linearly extending upward from an upper end of the second engaging portion 94.

[0070] As illustrated in FIG. 8, the fittings 80 are attached to the fitting attachment grooves 74 of the insulator 70. For example, the engaging portions 82 of the fittings 80 engage the fitting attachment grooves 74 of the insulator 70. The fittings 80 are disposed one each on the opposite ends of the insulator 70 in the left-right direction.

[0071] Each of the multiple contacts 90 is attached to the respective one of the multiple contact attachment grooves 75 of the insulator 70. For example, the first engaging portion 92 and the second engaging portion 94 of the contact 90 engage the contact attachment groove 75 of the insulator 70. At this time, the contact portion 95 of the contact 90 is located on the mating protrusion 72 of the insulator 70. The contact portion 95 of the contact 90 faces outward in the front-rear direction within the mating depression 71.

[0072] The connection object 60 with the above-described structure is mounted on, for example, a circuit formation surface formed on a mounting surface of the circuit board CB2. More specifically, the mounting portions 81 of the fittings 80 are placed on a solder paste applied to a pattern on the circuit board CB2. The mounting portions 91 of the contacts 90 are placed on the solder paste applied to the pattern on the circuit board CB2. The mounting portions 81 and the mounting portions 91 are soldered to the pattern by heating and melting the solder paste in, for example, a reflow furnace. Thus, the mounting of the connection object 60 on the circuit board CB2 is completed. For example, electronic components different from the connection object 60 and including a camera module and a sensor are mounted on the circuit formation surface of the circuit board CB2.

[0073] FIG. 10 is a cross-sectional view taken along arrow line X-X in FIG. 1. Operation of the connector 10 with the floating structure will be primarily described with reference primarily to FIG. 10.

[0074] Soldering the mounting portions 52 of the contacts 50 to the circuit board CB1 fixes the first insulator 20 to the circuit board CB1. Elastic deformation of the contacts 50 enables the second insulator 30 to be movable relative to the first insulator 20 fixed to the circuit board CB 1.

[0075] As illustrated in FIG. 3, the second restricting portions 23b of the first insulator 20 restrict excessive movement of the second insulator 30 relative to the first insulator 20 in the front-rear direction. For example, when the second insulator 30 significantly moves to an extent that exceeds a design value in the front-rear direction in response to elastic deformation of the contacts 50, the second restricted portions 37b of the second insulator 30 contact the second restricting portions 23b. Thus, the second insulator 30 does not further move outward in the front-rear direction.

[0076] The first restricting portions 23a of the first insulator 20 restrict excessive movement of the second insulator 30 relative to the first insulator 20 in the left-right direction. For example, when the second insulator 30 significantly moves to an extent that exceeds a design value in the left-right direction in response to elastic deformation of the contacts 50, the first restricted portions 37a of the second insulator 30 contact the first restricting portions 23a. Thus, the second insulator 30 does not further move outward in the left-right direction.

[0077] The restricting portions 44 of the fittings 40 reduce upward removal of the second insulator 30 from the first insulator 20. The restricting portions 44 of the fittings 40 restrict excessive upward movement of the second insulator 30 relative to the first insulator 20. For example, when the second insulator 30 significantly moves upward to an extent that exceeds a design value in response to elastic deformation of the contacts 50, the retaining protrusions 36 of the second insulator 30 contact the restricting portions 44. Thus, the second insulator 30 does not further move upward. The connector 10 can restrict excessive upward movement of the second insulator 30 with high-strength members like the fittings 40.

[0078] The connection object 60 inverted in the up-down direction is positioned to face the connector 10 including the above-described floating structure in the up-down direction while the connection object 60 is being substantially aligned with the connector 10 in the front-rear and left-right directions. Then, the connection object 60 is moved downward. If the connector 10 and the connection object 60 are slightly misaligned with each other in, for example, the front-rear and/or left-right direction, the guide 34 of the connector 10 and the guide 73 of the connection object 60 will contact each other.

[0079] Thus, the floating structure of the connector 10

allows the second insulator 30 to move relative to the first insulator 20. More specifically, the mating protrusion 32 of the second insulator 30 is guided into the mating depression 71 of the insulator 70. As the connection object 60 is further moved downward, the mating protrusion 32 of the second insulator 30 and the mating depression 71 of the insulator 70 are mated with each other. At this time, the mating depression 33 of the second insulator 30 and the mating protrusion 72 of the insulator 70 are mated with each other.

[0080] As illustrated in FIG. 10, each of the contacts 50 of the connector 10 contacts the respective one of the contacts 90 of the connection object 60 in the mated state in which the second insulator 30 of the connector 10 and the insulator 70 of the connection object 60 are mated with each other. More specifically, the contact part 59a of the contact 50 contacts the contact portion 95 of the contact 90. At this time, the elastic contact piece 59 of the contact 50 is slightly elastically deformed outward in the front-rear direction, and is elastically displaced outward in the front-rear direction in the contact attachment groove 35.

[0081] The connector 10 and the connection object 60 are completely connected in the above-described manner. At this time, the circuit board CB1 and the circuit board CB2 are electrically connected by the contacts 50 and the contacts 90.

[0082] In such a state, one pair of elastic contact pieces 59 of the contacts 50 pinch one pair of contacts 90 of the connection object 60 on the opposite sides in the front-rear direction with elastic forces acting inward in the front-rear direction. Thus, reaction of pressing forces applied to the contacts 90 causes the second insulator 30 to experience a force acting in a removal direction, or the upward direction, via the contacts 50 when the connection object 60 is removed from the connector 10.

[0083] Thus, if the second insulator 30 moves upward, the restricting portions 44 of the fittings 40 press-fitted in the first insulator 20, illustrated in FIG. 3, can reduce the removal of the second insulator 30. Each of the restricting portions 44 in the first insulator 20 is located directly above the respective one of the retaining protrusions 36 of the second insulator 30. Therefore, when the second insulator 30 begins to move upward, the retaining protrusions 36 protruding outward contact the restricting portions 44. Thus, the second insulator 30 does not further move upward.

[0084] FIG. 11A is a schematic diagram illustrating a first example of elastic deformation of the contact 50. FIG. 11B is a schematic diagram illustrating a second example of elastic deformation of the contact 50. Although FIGs. 11A and 11B each illustrate one contact 50 located on the rear side in FIG. 5, the other contact 50 at the same position in the front-rear direction elastically deforms in the same and/or similar manner. As for FIG. 11A, elastic deformation of the relevant contact 50 on the front side corresponds to a depiction of FIG. 11B reversed in the front-rear direction. As for FIG. 11B, elastic deformation of the relevant contact 50 on the front side corresponds to a depiction of FIG. 11A reversed in the front-rear direction.

[0085] Motions of the components of the contact 50 during elastic deformation will be described in detail with reference to FIGs. 11A and 11B. In FIGs. 11A and 11B, a chain double-dashed line represents a state of the contact 50 that is not elastically deformed. A portion of the contact 50 that extends from the curved portion 56 toward the removal side is elastically deformed as the second insulator 30 moves.

[0086] In FIG. 11A, for example, it is assumed that the second insulator 30 is moved rearward by any external factor.

[0087] As the second insulator 30 is moved rearward, the second holding portion 58 of the contact 50 engaging the contact attachment groove 35 of the second insulator 30 is displaced rearward. At this time, the portion of the contact 50 extending upward from the curved portion 56 is significantly elastically displaced rearward about the center, serving as a fulcrum, of a curve defined by the curved portion 56. On the other hand, the positions of the components located on the rear side relative to the curved portion 56 in the contact 50 hardly change before and after the movement of the second insulator 30.

[0088] In FIG. 11B, for example, it is assumed that the second insulator 30 is moved frontward by any external factor.

[0089] As the second insulator 30 is moved frontward, the second holding portion 58 of the contact 50 engaging the contact attachment groove 35 of the second insulator 30 is displaced frontward. At this time, the portion of the contact 50 extending upward from the curved portion 56 is significantly elastically displaced frontward about the center, serving as the fulcrum, of the curve defined by the curved portion 56. On the other hand, the positions of the components located on the rear side relative to the curved portion 56 in the contact 50 hardly change before and after the movement of the second insulator 30.

[0090] The following description will primarily focus on the connector 10. Advantages of the connector 10 will be described below. The same and/or similar description applies to an electronic device including the connector 10.

[0091] In an embodiment, the connector 10 can reduce a load that is applied to the mounting portion 52 of each contact 50 even when reduced in size.

[0092] The connector 10 includes the first extending portion 54 including the end part located adjacent to the second insulator 30 and bent toward the mating side and the curved portion 56 curved toward the removal side opposite to the mating side. This increases the length of an elastically deformable portion, serving as a spring, of the contact 50. This results in improved flexibility of the contact 50 in the connector 10. This facilitates elastic deformation of the contact 50. This leads to a reduction in load that is applied to the mounting portion 52 of the contact 50.

[0093] In the connector 10, the curved portion 56 is narrower than the first extending portion 54 and the second extending portion 57. Limiting a narrow portion of the contact 50 to the curved portion 56 can reduce the length of the narrow portion. Thus, when the contact 50 elastically deforms in response to movement of the second insulator 30, the fulcrum of elastic deformation can be easily determined at a specific position in the curved portion 56. For example, the center of the curve of the curved portion 56 is easily and stably determined as the fulcrum. Therefore, the connector 10 can achieve stable movement of the second insulator 30 with the stable fulcrum of elastic deformation of the contact 50.

[0094] The contact 50 is elastically deformed, as illustrated as examples in FIGs. 11A and 11B, due to compatibility between the above-described two advantages, or the improved flexibility of the contact 50 and the ease of determining the fulcrum of elastic deformation. As illustrated as examples in FIGs. 11A and 11B, the portion of the contact 50 extending from the curved portion 56 toward the removal side significantly elastically deforms about the center, serving as the fulcrum, of the curve of the curved portion 56, whereas the portion of the contact 50 located outside relative to the curved portion 56 in the front-rear direction hardly elastically deforms. Such a portion of the contact 50 that is to significantly elastically deform and the fulcrum of elastic deformation are at a long distance from the mounting portion 52 in the contact 50. Therefore, even if the connector 10 is reduced in size and the contact 50 is accordingly reduced in size, the connector 10 can reduce a load that is applied to the mounting portion 52 as the contact 50 undergoes elastic deformation.

[0095] The contact 50 further includes the coupling portion 55 coupling the first extending portion 54 and the curved portion 56, resulting in a longer distance from the mounting portion 52 to the portion that is to significantly elastically deform and the fulcrum of elastic deformation in the contact 50. Therefore, even if the connector 10 is reduced in size and the contact 50 is accordingly reduced in size, the connector 10 can further reduce a load that is applied to the mounting portion 52 as the contact 50 undergoes elastic deformation.

[0096] The coupling portion 55 slopes linearly from the end part of the first extending portion 54 adjacent to the second insulator 30 toward the mating side, so that the first extending portion 54 and the curved portion 56 can be coupled by the shortest distance. Thus, the connector 10 can reduce an unnecessary increase in distance between the first extending portion 54 and the curved portion 56 in the contact 50, thus reducing loss in signal transmission. Therefore, the connector 10 can reduce, for example, a decrease in transmission characteristics for high-capacity and high-speed transmission.

[0097] Since the coupling portion 55 has the same width as that of the first extending portion 54, the second extending portion 57 and the combination of the first extending portion 54 and the coupling portion 55 in front of and behind the curved portion 56 are wider than the curved portion 56. Thus, a narrow portion of the contact 50 is limited to the curved portion 56. In the connector 10, since the narrow portion of the contact 50 is limited to the curved portion 56, the length of the narrow portion can be further reduced. Therefore, when the contact 50 elastically deforms in response to movement of the second insulator 30, the fulcrum of elastic deformation can be more easily determined at a specific position in the curved portion 56. For example, the center of the curve of the curved portion 56 can be more stably determined as the fulcrum. Therefore, the connector 10 can achieve more stable movement of the second insulator 30 with a more stable fulcrum of elastic deformation of the contact 50.

[0098] The portion of the contact 50 extending from the curved portion 56 toward the removal side elastically deforms as the second insulator 30 moves. This provides the above-described advantage in that a load that is applied to the mounting portion 52 of the contact 50 can be reduced even after miniaturization.

[0099] In the contact 50, the first distance L1 is equal to or less than half the second distance L2. This reduces the proximity of the coupling portion 55 to the curved portion 56 when the connector 10 is reduced in size in the lateral direction. The coupling portion 55 slopes more gently than in a case where the first distance L1 is increased while the length of the coupling portion 55 in the lateral direction of the connector 10 is maintained constant. The curved portion 56 is curved at a greater angle than in the above-described case. Thus, the connector 10 can reduce a decrease in the ease of forming the contact 50.

[0100] In addition, the length of the coupling portion 55 coupling the first extending portion 54 and the curved portion 56 is further reduced. Thus, the connector 10 can reduce an unnecessary increase in distance between the first extending portion 54 and the curved portion 56 in the contact 50, thus reducing loss in signal transmission. Therefore, the connector 10 can reduce, for example, a decrease in transmission characteristics for high-capacity and high-speed transmission.

[0101] The width direction of each contact 50 is parallel to the array direction of the multiple contacts 50. This increases the strength of the contact 50 in the array direction. Therefore, the connector 10 can increase the robustness of the contact 50 against elastic deformation of the contact 50 caused by movement of the second insulator 30. Therefore, the connector 10 can achieve a stable floating operation. This results in improved reliability of the connector 10 as a product.

[0102] In the contact 50, the bent portion 53 is narrow, the first extending portion 54, which is next to the bent portion 53, and the coupling portion 55 are wide, and the curved portion 56 next to the combination of the first extending portion 54 and the coupling portion 55 is narrow. Such a shape allows the connector 10 to achieve good transmission characteristics for signal transmission. In the connector 10, since the contact 50 includes

the first extending portion 54 and the coupling portion 55, which are wider than the components in front of and behind these portions in the contact 50, impedance or electrical conductivity is adjusted based on the width of a transmission line, or the cross-sectional area of a transmission line.

[0103] For example, the electrical conductivity of the first extending portion 54 and the coupling portion 55 is higher than those of the bent portion 53 and the curved portion 56. Thus, the first extending portion 54 and the coupling portion 55 play a role in offsetting an increase in impedance in the bent portion 53 and the curved portion 56 so that the overall impedance approaches an ideal value. The connector 10 can contribute to impedance matching. Therefore, the connector 10 can obtain desired transmission characteristics for high-capacity and high-speed transmission. The connector 10 can exhibit improved transmission characteristics as compared with a related-art connector including no portions in which a narrow part, a wide part, and a narrow part are arranged in that order.

[0104] In addition, the contact 50 may be shaped such that the curved portion 56 is narrow, the second extending portion 57 next to the curved portion 56 is wide, and the bent part 58a of the second holding portion 58 next to the second extending portion 57 is narrow. Such a shape of the contact 50 including continuously arranged two portions in each of which a narrow part, a wide part, and a narrow part are arranged in that order allows the above-described effect on the improvement of transmission characteristics to become more pronounced.

[0105] In the connector 10, the narrow portions of the contact 50 allows the contact 50 to elastically deform more readily. The connector 10 also achieves a good floating structure. As described above, the connector 10 achieves both good transmission characteristics and a good floating structure.

[0106] The first insulator 20 is located between a portion of one contact 50 that includes the mounting portion 52, the first holding portion 51, the bent portion 53, and part of the first extending portion 54 and such a portion of another contact 50. This reduces characteristic impedance of the contact 50 in these components.

[0107] More specifically, one electroconductive contact 50 is disposed in proximity to another electroconductive contact 50 with the first insulator 20 therebetween. Thus, an effect that is the same as and/or similar to that of a capacitor can be provided between the contacts 50. Let C denote a capacitance. The characteristic impedance, Z, depends on the capacitance C. For example, the characteristic impedance Z is inversely proportional to the square root of the capacitance C or inversely proportional to the capacitance C.

[0108] Therefore, reducing the spacing corresponding to the capacitor increases the capacitance C, resulting in a decrease in characteristic impedance. Increasing the relative permittivity by using the first insulator 20 increases the capacitance C, resulting in a decrease in characteristic impedance. On the other hand, adjusting the width of the contact 50 can also adjust the characteristic impedance. As described above, both the width of the contact 50 and the configuration associated with the above-described capacitor can be adjusted in the connector 10. This allows the characteristic impedance to be readily adjusted to an ideal value. Therefore, the transmission characteristics of the connector 10 for signal transmission can be improved more readily.

[0109] The first insulator 20 is not located between a portion of one contact 50 that includes the end part of the first extending portion 54 adjacent to the second insulator 30, the coupling portion 55, the curved portion 56, and the second extending portion 57 and such a portion of another contact 50 adjacent to the one contact 50. Thus, the connector 10 can reduce a likelihood that the contact 50 made of metal may contact the first insulator 20 made of resin when the contact 50 elastically deforms in response to movement of the second insulator 30. This reduces breakage of the first insulator 20. Therefore, the connector 10 can achieve a stable floating operation, leading to improved reliability of the connector 10 as a product.

[0110] The second insulator 30 includes the guide 34. This facilitates guiding the mating protrusion 32 of the second insulator 30 into the mating depression 71 of the connection object 60. The connector 10 can achieve a good floating structure. An operation of inserting the connection object 60 into the connector 10 can be readily performed.

[0111] Each contact 50 is made of a metal material having a low elastic modulus. This allows the connector 10 to ensure a necessary movable distance for the second insulator 30 even when a small force is applied to the second insulator 30. The second insulator 30 can move smoothly relative to the first insulator 20. This allows the connector 10 to readily absorb misalignment when mated with the connection object 60.

[0112] The connector 10 absorbs vibration caused by any external factor with elastic deformation of the contacts 50. This reduces a likelihood that a large force may be applied to the mounting portions 52 of the contacts 50. This reduces breakage of joints between the circuit board CB1 and the mounting portions 52. This can reduce cracking of solder joints between the circuit board CB1 and the mounting portions 52. This improves connection reliability even while the connector 10 is connected to the connection object 60.

[0113] The fittings 40 are press-fitted in the first insulator 20, and the mounting portions 41 are soldered to the circuit board CB1. Thus, the fittings 40 enable the first insulator 20 to be stably fixed to the circuit board CB1. The fittings 40 increase the strength of mounting of the first insulator 20 on the circuit board CB1.

[0114] It will be apparent to those skilled in the art that the present disclosure can be implemented in other specific forms other than the above-described embodiments without departing from the spirit or essential characteristics thereof. Therefore, the above description is

illustrative and is not restrictive. The scope of the present disclosure is defined by the appended claims, rather than the foregoing description. Some variations that are within the range of equivalents of all variations are intended to be encompassed within the scope of the present disclosure.

[0115] For example, the shape, size, location, and orientation of each component described above and the number of components are not limited to those illustrated in the above description and the figures. Any number of components having any shape, size, location, and orientation may be used as long as the function of the component can be achieved.

[0116] The above-described assembly methods for the connector 10 and the connection object 60 are not limited to details in the above description. Each of the connector 10 and the connection object 60 may be assembled in any manner that allows the functions to be achieved.

[0117] For example, at least one of the fitting 40 or the contact 50 may be formed integrally with the first insulator 20 by insert molding, rather than press-fitting. For example, the contact 50 may be formed integrally with the second insulator 30 by insert molding, rather than press-fitting. For example, at least one of the fitting 80 or the contact 90 may be formed integrally with the insulator 70 by insert molding, rather than press-fitting.

[0118] In the above-described embodiment, the curved portion 56 is shaped such that the entire curved portion 56 including the first end on the mating side has a smaller width than the first extending portion 54 and the second extending portion 57 in the left-right direction. The configuration is not limited to this example. The curved portion 56 may be shaped such that one part of the curved portion 56, for example, the first end, has a smaller width than the first extending portion 54 and the second extending portion 57 in the left-right direction.

[0119] FIG. 12A is an enlarged side view of part of the contact 50 in FIG. 4. FIG. 12B is an enlarged side view of a contact 50 in an alternative embodiment. An enlarged part of the contact 50 in each of FIGs. 12A and 12B corresponds to that of the contact 50 in the enlarged side view of FIG. 6.

[0120] In the above-described embodiment, as illustrated in FIG. 12A, the contact 50 further includes the coupling portion 55 coupling the first extending portion 54 and the curved portion 56. The first extending portion 54 includes a part horizontally extending from the end of the bend in the bent portion 53 toward the second insulator 30 and the end part located adjacent to the second insulator 30 and bent toward the mating side. As illustrated in FIG. 12A, the first extending portion 54 includes a portion extending from two vertical lines next to the bent portion 53 to a sloping broken line. The coupling portion 55 includes a portion extending linearly from the broken line to two oblique lines.

[0121] The configuration is not limited to this example. In the connector 10, as illustrated in FIG. 12B, the contact 50 may include no coupling portion 55. In this case, the first extending portion 54 and the curved portion 56 may be connected directly to each other in the contact 50. Even in such an alternative embodiment, the first extending portion 54 includes the part horizontally extending from the end of the bend in the bent portion 53 toward the second insulator 30 and the end part located adjacent to the second insulator 30 and bent toward the mating side. In FIG. 12B, the first extending portion 54 includes a part extending from two vertical lines next to the bent portion 53 to two oblique lines.

[0122] The curved portion 56 is bent at an acute angle less than 90° from a lower end of the first extending portion 54 and includes an arc-shaped end part that is bent upward. The curved portion 56 is shaped like an arc of a sector having an obtuse central angle greater than 90°.

[0123] In the above-described embodiment, the coupling portion 55 slopes linearly from the end part of the first extending portion 54 toward the mating side. The configuration is not limited to this example. The coupling portion 55 may have any shape that can achieve the above-described function of the contact 50. For example, the coupling portion 55 may be curved between the first extending portion 54 and the curved portion 56.

[0124] In the above-described embodiment, the coupling portion 55 has the same width as that of the first extending portion 54. The configuration is not limited to this example. The coupling portion 55 may have any width larger than that of the curved portion 56. For example, the coupling portion 55 may have a width larger than that of the curved portion 56 and smaller than that of the first extending portion 54. For example, the coupling portion 55 may have a width larger than that of the first extending portion 54.

[0125] In the above-described embodiment, the portion of the contact 50 extending from the curved portion 56 toward the removal side deforms elastically in response to movement of the second insulator 30. The configuration is not limited to this example. Another portion of the contact 50 may deform elastically in response to movement of the second insulator 30 as long as a load that is applied to the mounting portion 52 of the contact 50 can be reduced even when the connector 10 is reduced in size.

[0126] In the above-described embodiment, the first distance L1 is equal to or less than half the second distance L2. The configuration is not limited to this example. The first distance L1 may be greater than half the second distance L2 as long as a decrease in the ease of forming the contact 50 and a decrease in transmission characteristics can be reduced.

[0127] In the above-described embodiment, the width direction of each contact 50 is parallel to the array direction of the multiple contacts 50. The configuration is not limited to this example. The width direction of each contact 50 may be parallel to any direction orthogonal to the array direction of the multiple contacts 50 as long as the above-described function of the contact 50 can be

achieved.

[0128] FIG. 13 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a cross-section of a connector 10 according to an alternative embodiment. In the above-described embodiment, the connector 10 has a height, as illustrated in FIG. 5, from the circuit board CB1, or the lower surfaces of the mounting portions 52 of the contacts 50, as a reference. The first insulator 20 has a height slightly larger than that of the mating protrusion 32 of the second insulator 30.

[0129] The configuration is not limited to this example. The connector 10 may have a height, as illustrated in FIG. 13, from the circuit board CB1, or the lower surfaces of the mounting portions 52 of the contacts 50, as a reference. In the alternative embodiment, the height of the connector 10 may be in the range of from 1.1 to 1.5 times the height of the connector 10 of FIG. 5. In the alternative embodiment, for example, the height of the connector 10 of FIG. 13 is approximately 1.4 times the height of the connector 10 of FIG. 5. In this case, the height of the mating protrusion 32 of the second insulator 30 is the same as that of the mating protrusion 32 in FIG. 5. The height of the first insulator 20 is approximately two times the height of the mating protrusion 32.

[0130] In the connector 10 of FIG. 13, a portion of each contact 50 that is to elastically deform in response to movement of the second insulator 30, or that extends from the curved portion 56 toward the removal side, is longer than that in the connector 10 of FIG. 5. Therefore, the contact 50 exhibits improved flexibility. This further facilitates elastic deformation of the contact 50. This results in a further reduction in load that is applied to the mounting portion 52 of the contact 50.

[0131] In the above-described embodiment, as illustrated in FIG. 4, the first insulator 20 includes a thick wall with, for example, no cut on its outer surface. The configuration is not limited to this example. The outer surface of the first insulator 20 may include at least one cut. For example, the first insulator 20 may include a cut extending in the up-down direction at a position between one contact 50 and another contact 50 adjacent to the one contact 50 in the left-right direction. Such a cut may extend from, for example, just above the contact attachment groove 25 to an upper surface of the outer peripheral wall 22. For example, such a cut may be recessed from the outer surface of the first insulator 20 in the front-rear direction and be formed in at least one portion of the width of the outer peripheral wall 22 in the front-rear direction.

[0132] In the above-described embodiment, the first extending portion 54 of each contact 50 horizontally extends from the end of the bent portion 53 adjacent to the second insulator 30 toward the second insulator 30. The configuration is not limited to this example. The first extending portion 54 may obliquely extend from the end of the bent portion 53 adjacent to the second insulator 30 toward the second insulator 30.

[0133] In the above-described embodiment, the second extending portion 57 of each contact 50 has a linear shape and is parallel to the up-down direction. The configuration is not limited to this example. The second extending portion 57 may be non-parallel to the up-down direction or may have a non-linear shape.

[0134] In the above-described embodiment, the first holding portion 51 of each contact 50 has a large width in the left-right direction so that the first holding portion 51 can engage the contact attachment groove 25 of the first insulator 20. The configuration is not limited to this example. The first holding portion 51 does not necessarily need to have a large width in the left-right direction for insert molding, rather than press-fitting.

[0135] Although the contact 50 is made of a metal material having a low elastic modulus as described above, the configuration is not limited to this example. The contact 50 may be made of a metal material having any elastic modulus that allows the contact 50 to elastically deform by a necessary amount.

[0136] The connection object 60 has been described as a plug connector connected to the circuit board CB2. The connection object 60 is not limited to this example. The connection object 60 may be any object other than a connector. For example, the connection object 60 may be an FPC, a flexible flat cable, a rigid board, or an edge connector of any circuit board.

[0137] The above-described connector 10 is mounted on an electronic device. Examples of the electronic device include any on-vehicle equipment such as a camera, a radar, a dashboard camera, and an engine control unit. Examples of the electronic device include any on-vehicle equipment used in on-vehicle systems such as a car navigation system, an advanced driver assistance system, and a security system. Examples of the electronic device include any information equipment such as a personal computer, a smartphone, a copier, a printer, a facsimile, and a multifunctional machine. Furthermore, examples of the electronic device include any industrial equipment.

[0138] In such an electronic device, the connector 10 with a floating structure can reduce a load that is applied to the mounting portions 52 of the contacts 50 even when reduced in size. This reduces breakage such as cracking of solder joints at the mounting portions 52 of the contacts 50. This reduces problems such as deformation and breakage of the contacts 50. This results in improved reliability of the electronic device, serving as a product, including the connector 10.

[0139] Furthermore, the connector 10 absorbs misalignment between circuit boards with a good floating structure, thus improving the ease of assembly of the electronic device. This facilitates manufacture of the electronic device. Since the connector 10 reduces breakage of joints between the circuit board CB1 and the connector 10, the reliability of the electronic device as a product is further improved.

[0140] The following concepts can be extracted from the present disclosure.

(1) A connector including:

a first insulator having a frame shape;
a second insulator disposed within the first insulator, the second insulator being movable relative to the first insulator and being to be mated with a connection object; and
multiple contacts attached to the first insulator and the second insulator,
the multiple contacts each including

a mounting portion,
a holding portion extending from the mounting portion along the first insulator, the holding portion being attached to the first insulator,
a bent portion bent from the holding portion and extending toward the second insulator,
a first extending portion extending from an end of a bend in the bent portion toward the second insulator,
a curved portion curved toward a removal side opposite to a mating side where the connection object is mated with the second insulator, and
a second extending portion extending from the curved portion toward the removal side, wherein

the curved portion includes a first end on the mating side and is bent and curved with the first end located on the mating side relative to the first extending portion, and
the first end has a smaller width than the first and second extending portions.

(2) The connector according to (1), wherein the curved portion including the first end as a whole has a smaller width than the first and second extending portions.
(3) The connector according to (1) or (2), wherein

the first insulator is located between the bent portion of one contact of the multiple contacts and the bent portion of another one of the multiple contacts that is adjacent to the one contact, and
the first insulator is not located between an end part of the first extending portion adjacent to the second insulator of one contact of the multiple contacts and the end part of the first extending portion adjacent to the second insulator of another one of the multiple contacts that is adjacent to the one contact.

(4) The connector according to any one of (1) to (3), wherein

the multiple contacts each further include a coupling portion coupling the first extending portion and the curved portion, and
the coupling portion slopes linearly from an end part of the first extending portion adjacent to the second insulator toward the mating side.

(5) The connector according to (4), wherein the coupling portion has the same width as that of the first extending portion.
(6) The connector according to any one of (1) to (5), wherein a portion of each of the multiple contacts that extends from the curved portion toward the removal side is to elastically deform in response to movement of the second insulator.
(7) The connector according to any one of (1) to (6),

wherein a mating direction in which the second insulator and the connection object are mated with each other is orthogonal to a circuit board on which the mounting portion is mounted, and
wherein the first extending portion includes a second end on the removal side, and a first distance from the second end to the first end of the curved portion on the mating side in the mating direction is equal to or less than half a second distance from the circuit board to the second end in the mating direction.

(8) The connector according to any one of (1) to (7), wherein a width direction of each of the multiple contacts is parallel to an array direction of the multiple contacts.
(9) An electronic device including the connector according to any one of (1) to (8).

REFERENCE SIGNS

[0141]

1	connector
20	first insulator
21a	opening
21b	opening
22	outer peripheral wall
22a	lateral wall
22b	longitudinal wall
23a	first restricting portion
23b	second restricting portion
24	fitting attachment groove
25	contact attachment groove
30	second insulator
31	base
31a	wall portion
32	mating protrusion
33	mating depression
34	guide
35	contact attachment groove

36	retaining protrusion
37a	first restricted portion
37b	second restricted portion
40	fitting
41	mounting portion
42	engaging portion
43	base
44	restricting portion
50	contact
51	first holding portion (holding portion)
52	mounting portion
53	bent portion
54	first extending portion
55	coupling portion
56	curved portion
57	second extending portion
58	second holding portion
58a	bent part
59	elastic contact piece
59a	contact part
60	connection object
70	insulator
71	mating depression
72	mating protrusion
73	guide
74	fitting attachment groove
75	contact attachment groove
80	fitting
81	mounting portion
82	engaging portion
90	contact
91	mounting portion
92	first engaging portion
93	coupling portion
94	second engaging portion
95	contact portion
CB1	circuit board (circuit board)
CB2	circuit board
L1	first distance
L2	second distance

Claims

1. A connector comprising:

a first insulator having a frame shape;
a second insulator disposed within the first insulator, the second insulator being movable relative to the first insulator and being to be mated with a connection object; and
multiple contacts attached to the first insulator and the second insulator,
the multiple contacts each comprising

a mounting portion,
a holding portion extending from the mounting portion along the first insulator, the holding portion being attached to the first insulator,
a bent portion bent from the holding portion and extending toward the second insulator,
a first extending portion extending from an end of a bend in the bent portion toward the second insulator,
a curved portion curved toward a removal side opposite to a mating side where the connection object is mated with the second insulator, and
a second extending portion extending from the curved portion toward the removal side, wherein

the curved portion includes a first end on the mating side and is bent and curved with the first end located on the mating side relative to the first extending portion, and
the first end has a smaller width than the first and second extending portions.

2. The connector according to claim 1, wherein the curved portion including the first end as a whole has a smaller width than the first and second extending portions.

3. The connector according to claim 1 or 2, wherein

the first insulator is located between the bent portion of one contact of the multiple contacts and the bent portion of another one of the multiple contacts that is adjacent to the one contact, and
the first insulator is not located between an end part of the first extending portion adjacent to the second insulator of one contact of the multiple contacts and the end part of the first extending portion adjacent to the second insulator of another one of the multiple contacts that is adjacent to the one contact.

4. The connector according to claim 1 or 2, wherein

the multiple contacts each further comprise a coupling portion coupling the first extending portion and the curved portion, and
the coupling portion slopes linearly from an end part of the first extending portion adjacent to the second insulator toward the mating side.

5. The connector according to claim 4, wherein the coupling portion has a same width as a width of the first extending portion.

6. The connector according to claim 1 or 2, wherein a portion of each of the multiple contacts that extends from the curved portion toward the removal side is to elastically deform in response to movement of the

second insulator.

7. The connector according to claim 1 or 2,

wherein a mating direction in which the second insulator and the connection object are mated with each other is orthogonal to a circuit board on which the mounting portion is mounted, and
wherein the first extending portion includes a second end on the removal side, and a first distance from the second end to the first end of the curved portion on the mating side in the mating direction is equal to or less than half a second distance from the circuit board to the second end in the mating direction.

8. The connector according to claim 1 or 2, wherein a width direction of each of the multiple contacts is parallel to an array direction of the multiple contacts.

9. An electronic device comprising the connector according to claim 1 or 2.

FIG. 1

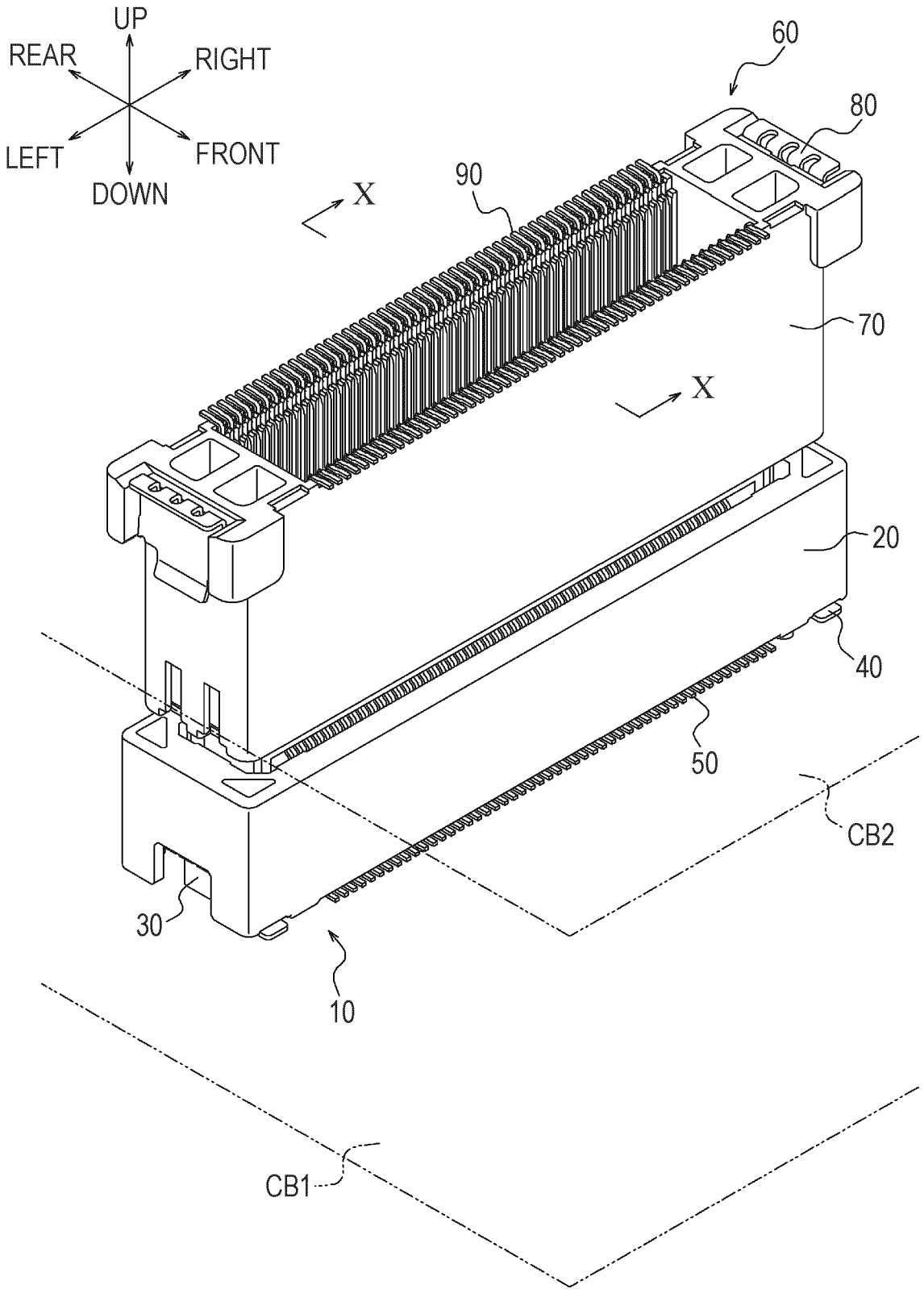

UP
REAR
RIGHT
LEFT
FRONT
DOWN
X
X
60
80
90
70
20
40
50
CB2
30
10
CB1

FIG. 2

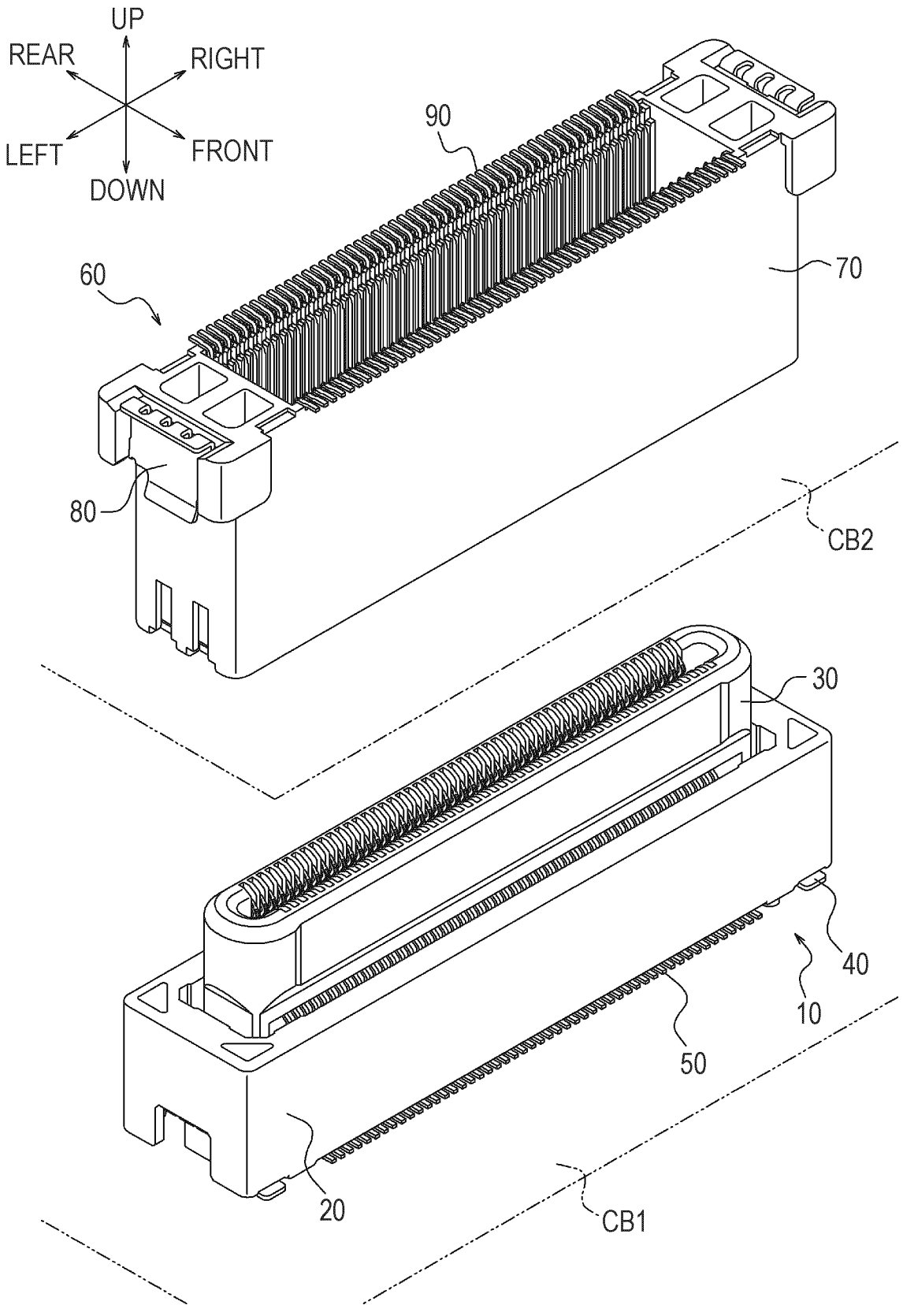


FIG. 3

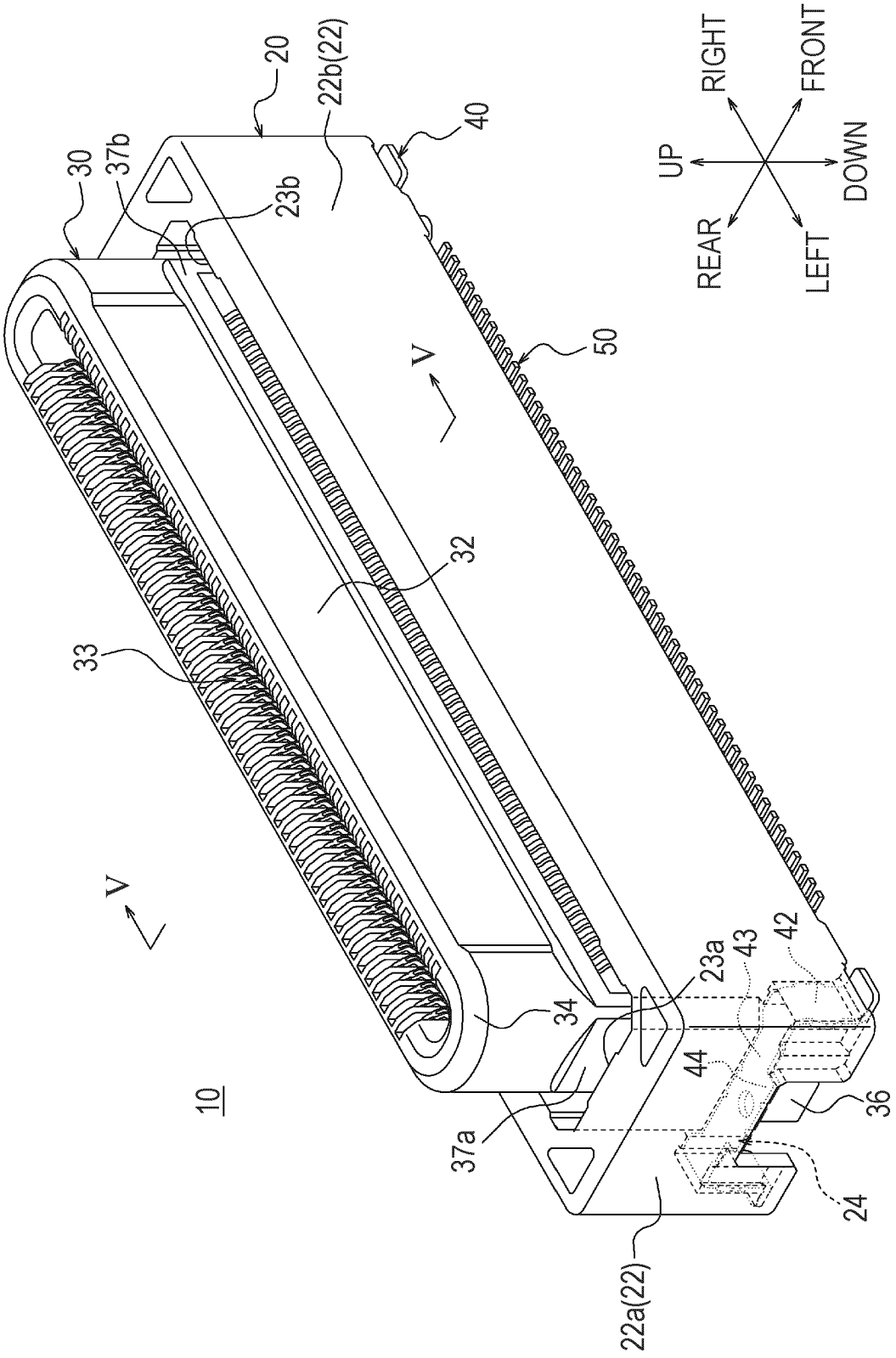

20
22b(22)
40
30
37b
23b
UP
RIGHT
FRONT
REAR
LEFT
DOWN
50
V
V
32
33
10
34
23a
43
42
44
36
37a
24
22a(22)

FIG. 4

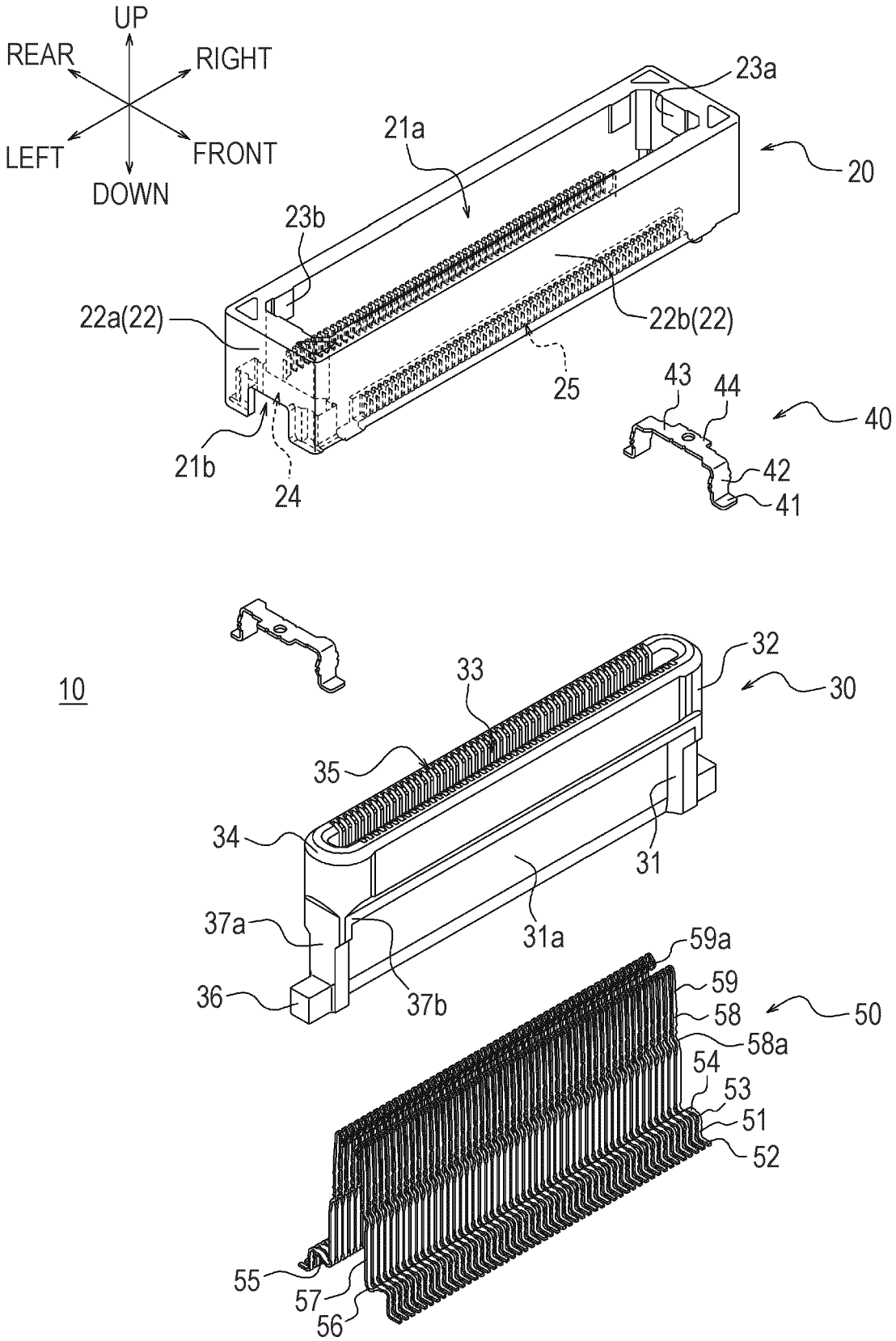

UP
REAR
RIGHT
LEFT
FRONT
DOWN
23a
21a
20
23b
22a(22)
22b(22)
25
43
44
40
21b
24
42
41
10
33
32
30
35
34
31
37a
31a
59a
59
36
37b
58
50
58a
54
53
51
52
55
57
56

FIG. 5

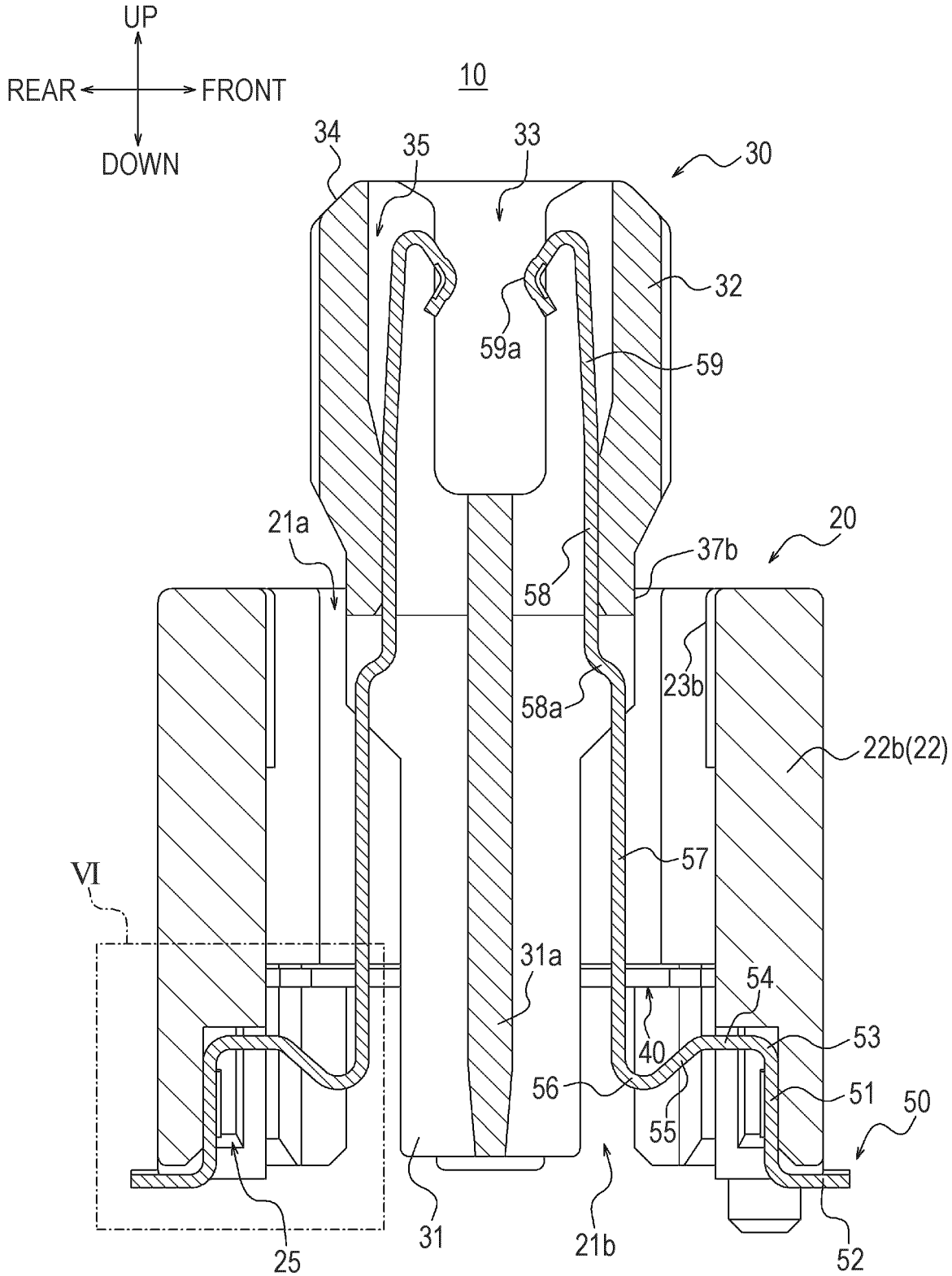

UP
REAR
FRONT
DOWN
10
34
35
33
30
32
59a
59
21a
20
37b
58
23b
58a
22b(22)
57
VI
31a
54
53
40
56
51
50
55
25
31
21b
52

FIG. 6

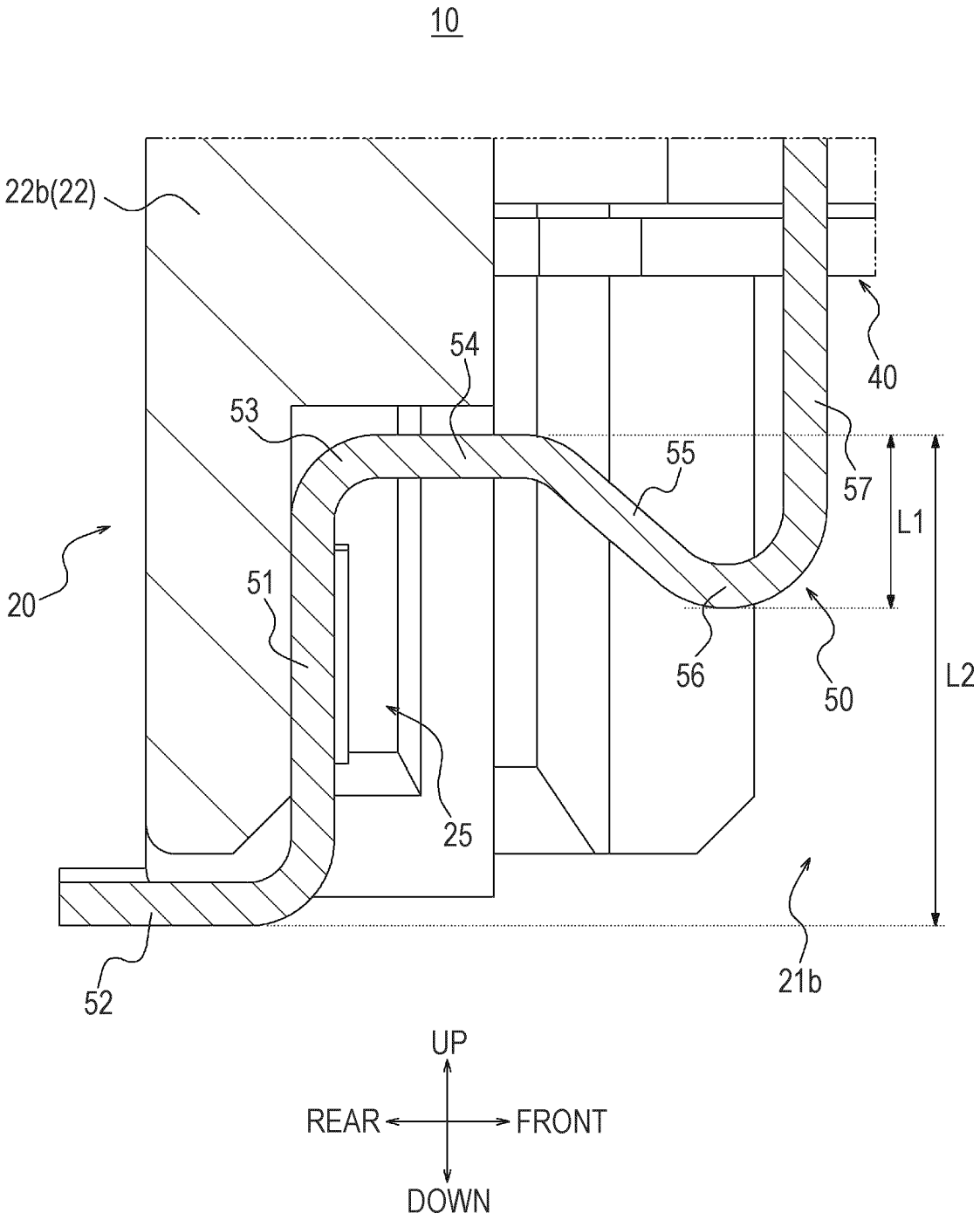

10
22b(22)
54
53
40
55
57
L1
20
51
56
50
L2
25
52
21b
UP
REAR
FRONT
DOWN

FIG. 7

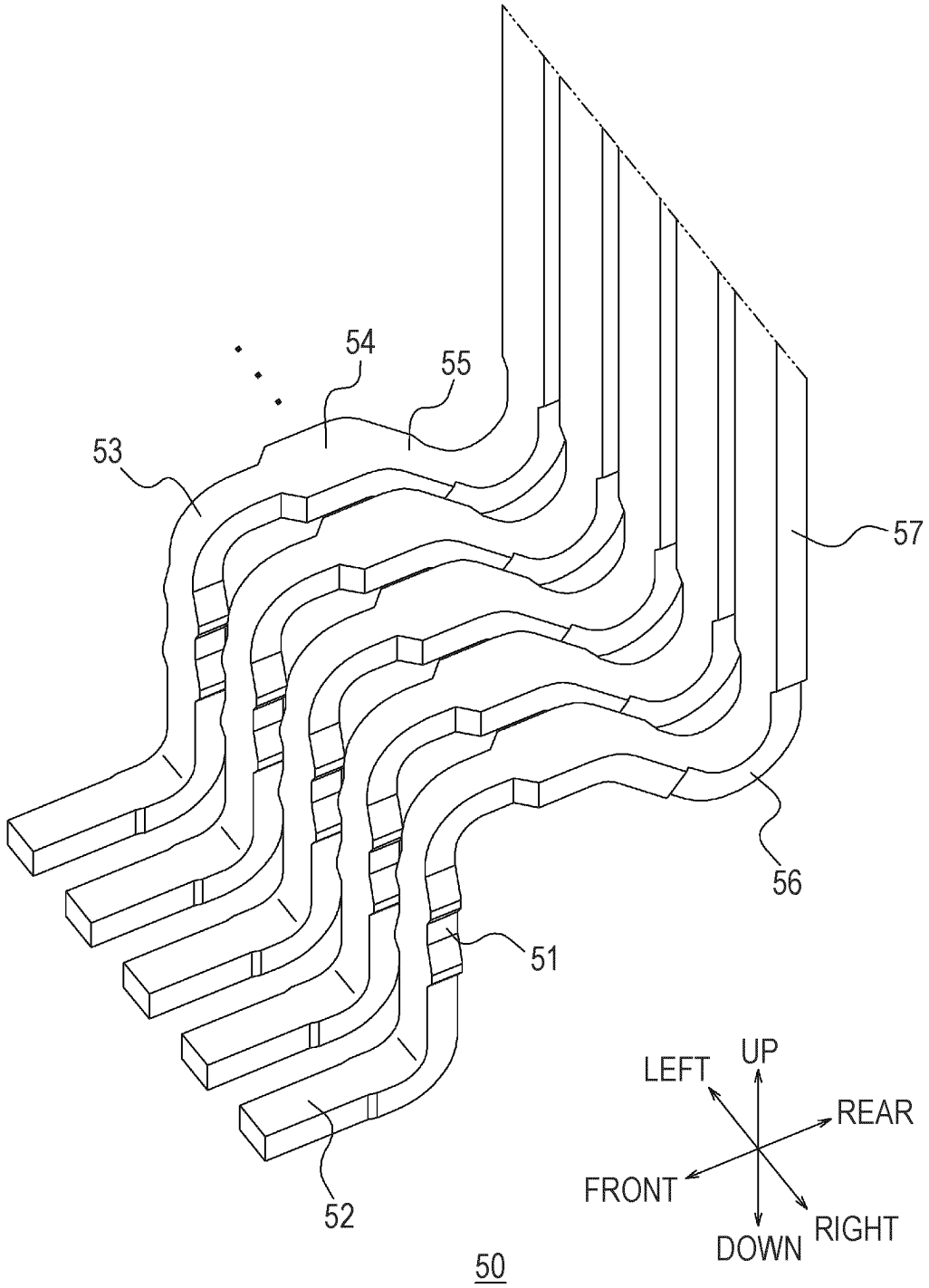


FIG. 8

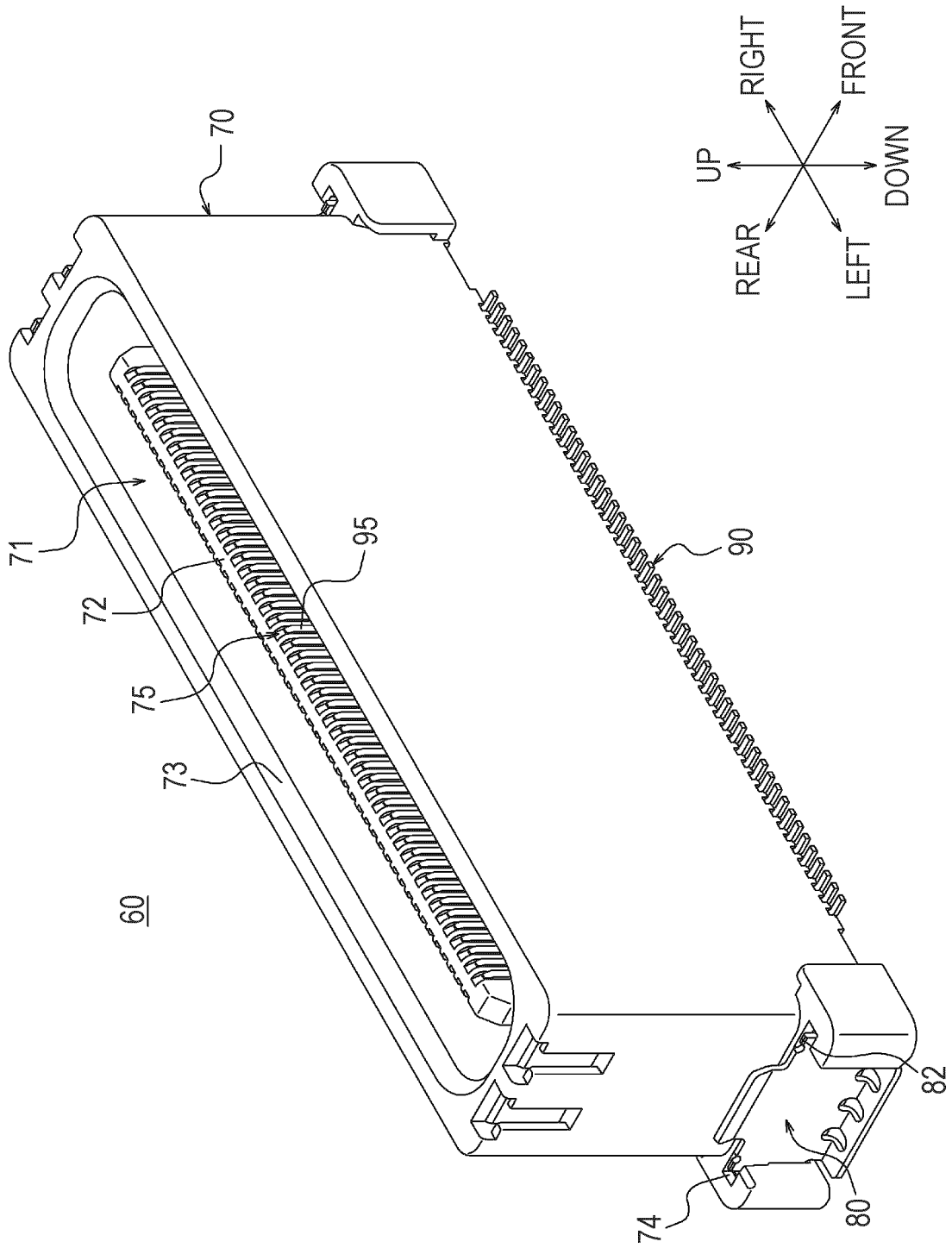


FIG. 9

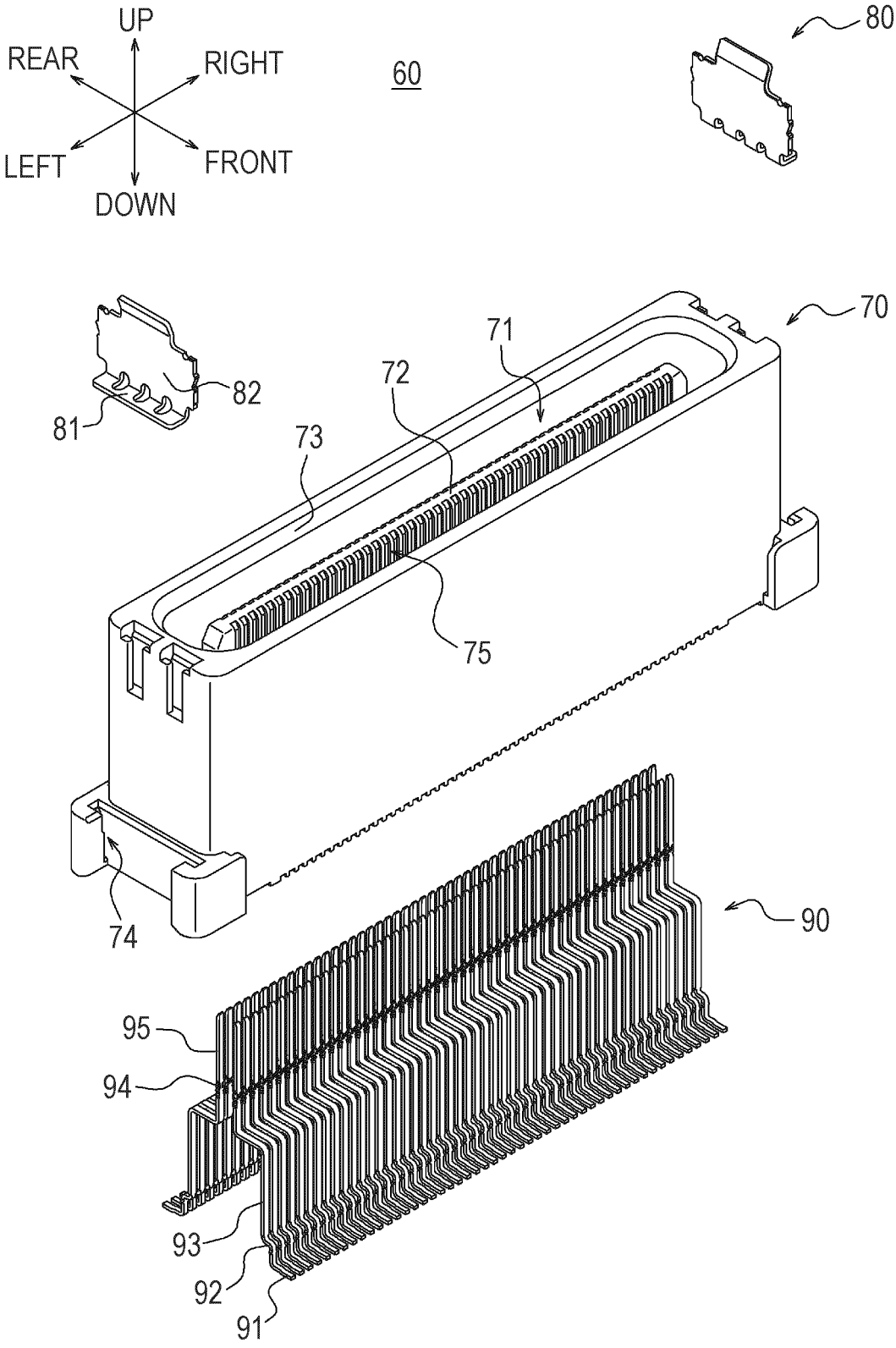

UP
REAR
RIGHT
LEFT
FRONT
DOWN
60
80
70
71
72
73
75
81
82
74
90
95
94
93
92
91

FIG. 10

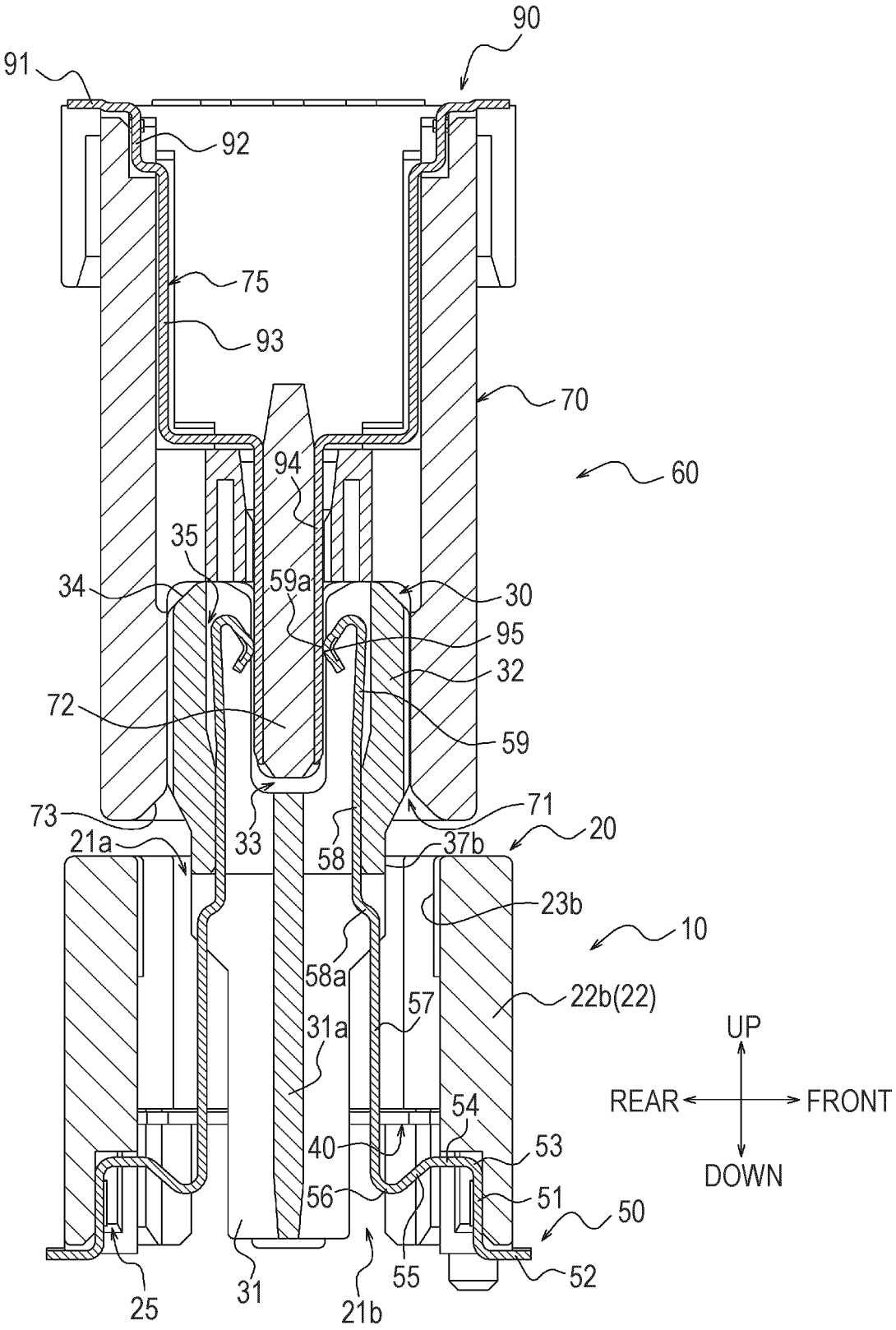

90
91
92
75
93
70
60
94
35
34
59a
30
95
32
72
59
73
71
21a
33
58
37b
20
23b
10
58a
57
22b(22)
31a
54
40
53
56
51
50
55
52
25
31
21b
UP
REAR
FRONT
DOWN

FIG. 11A

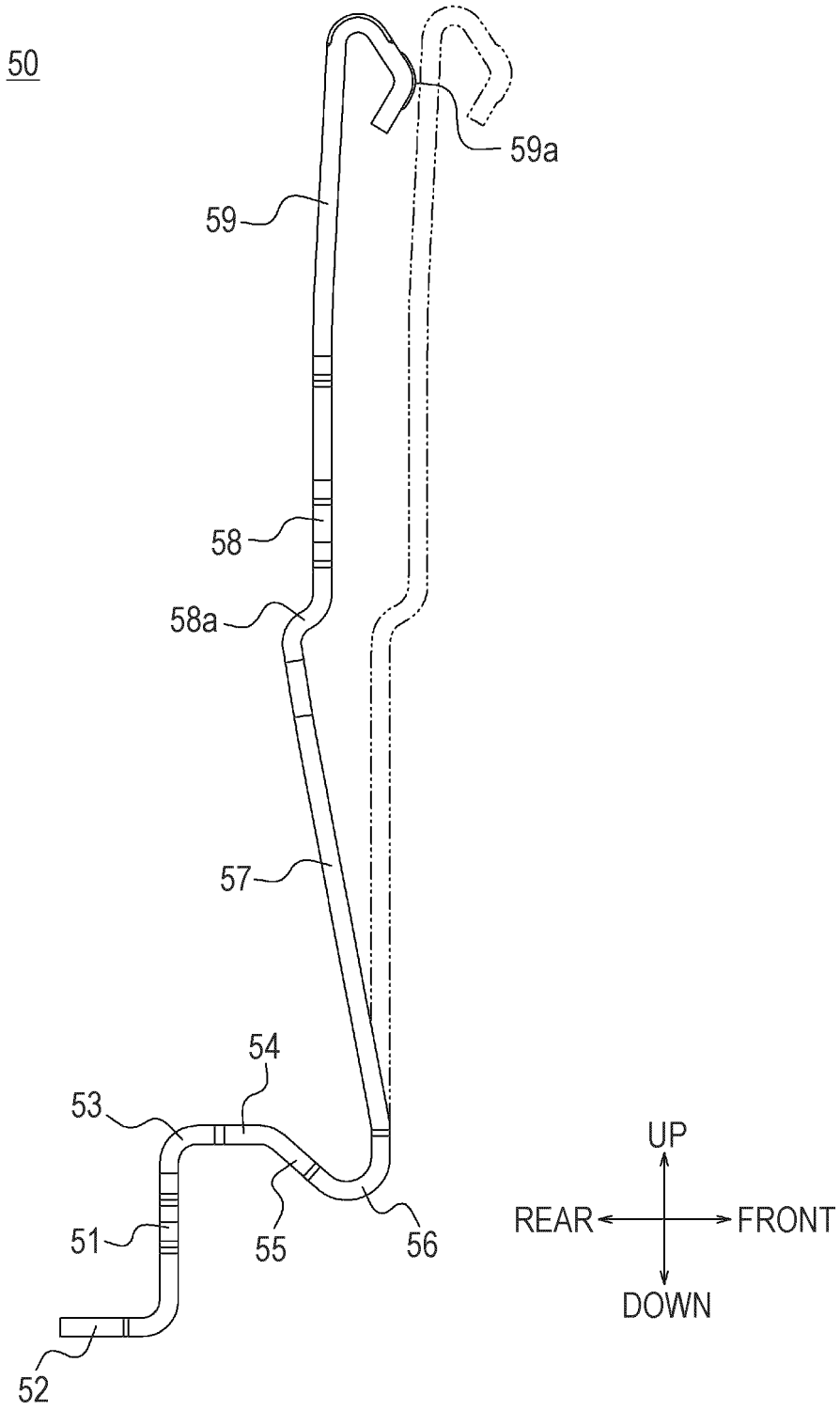


FIG. 11B

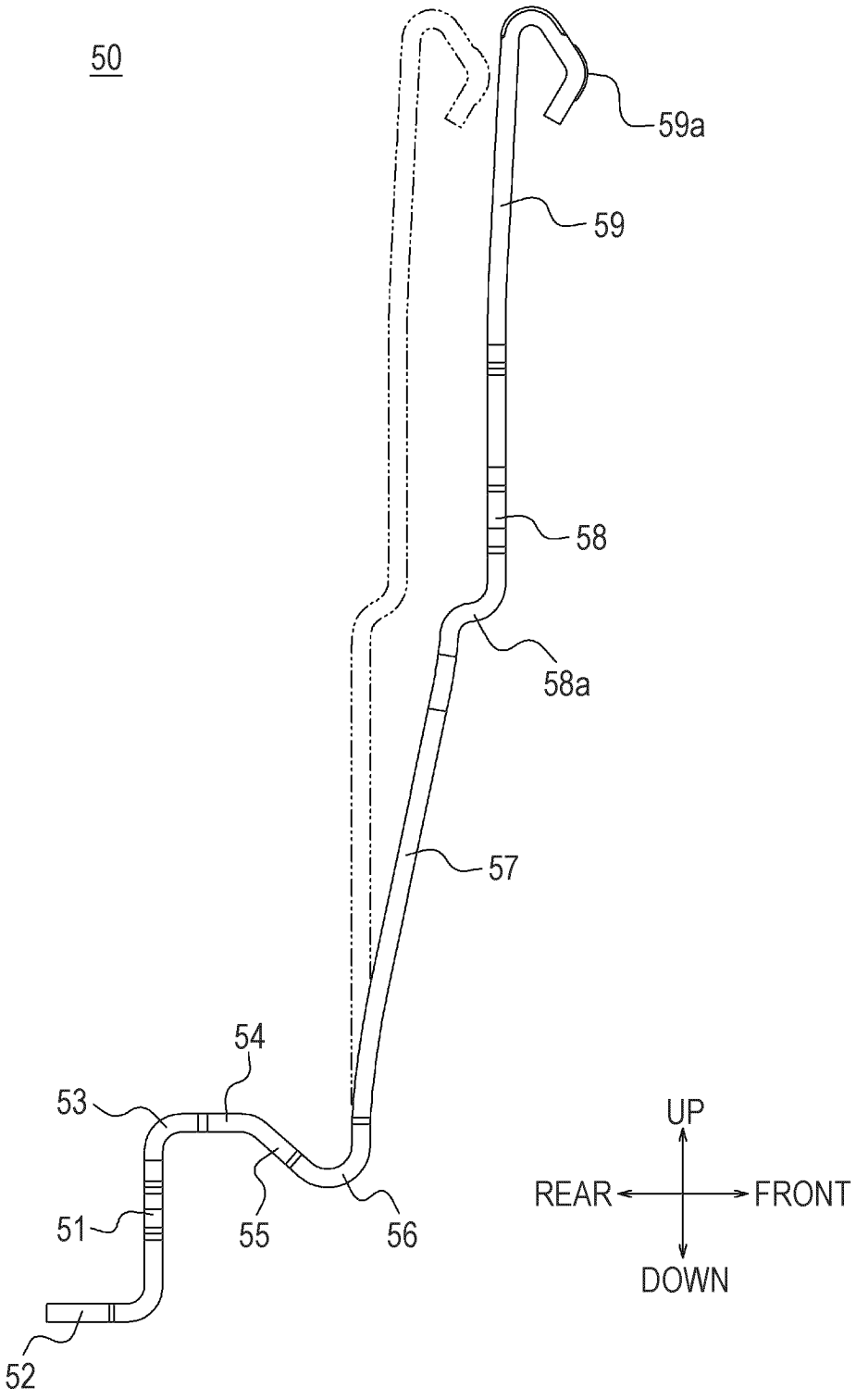


FIG. 12A

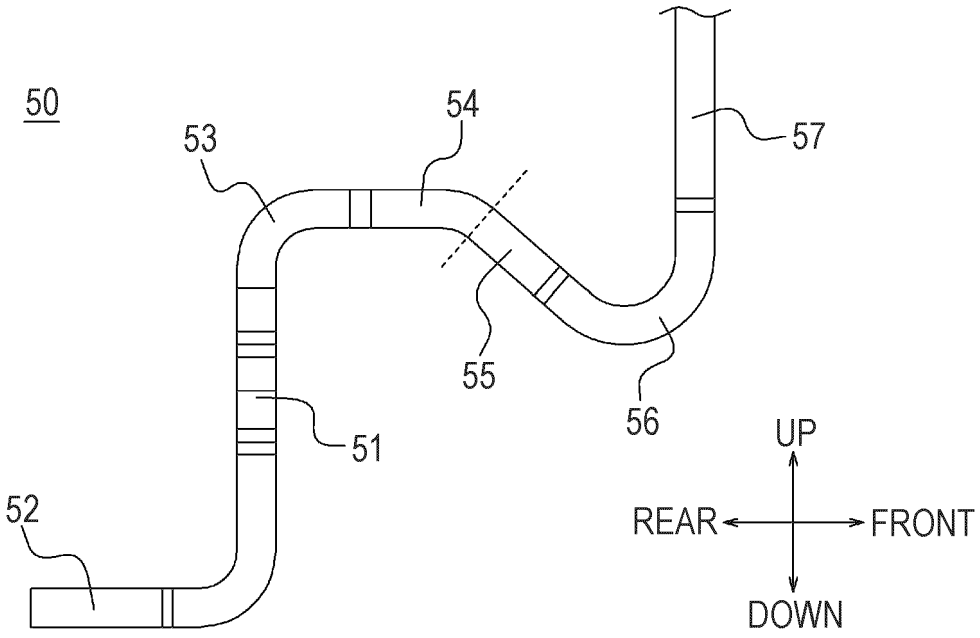


FIG. 12B

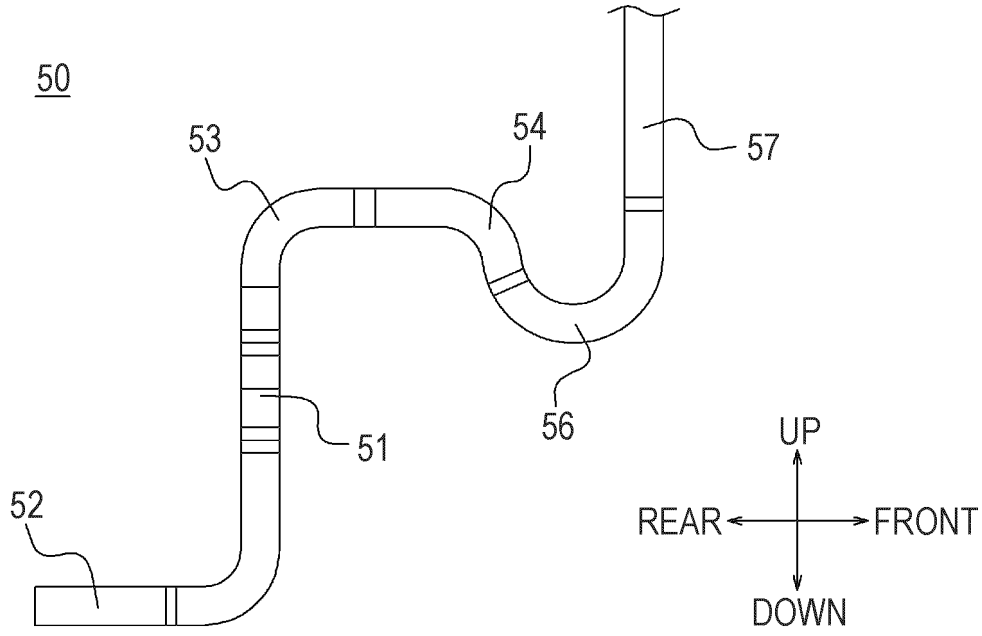
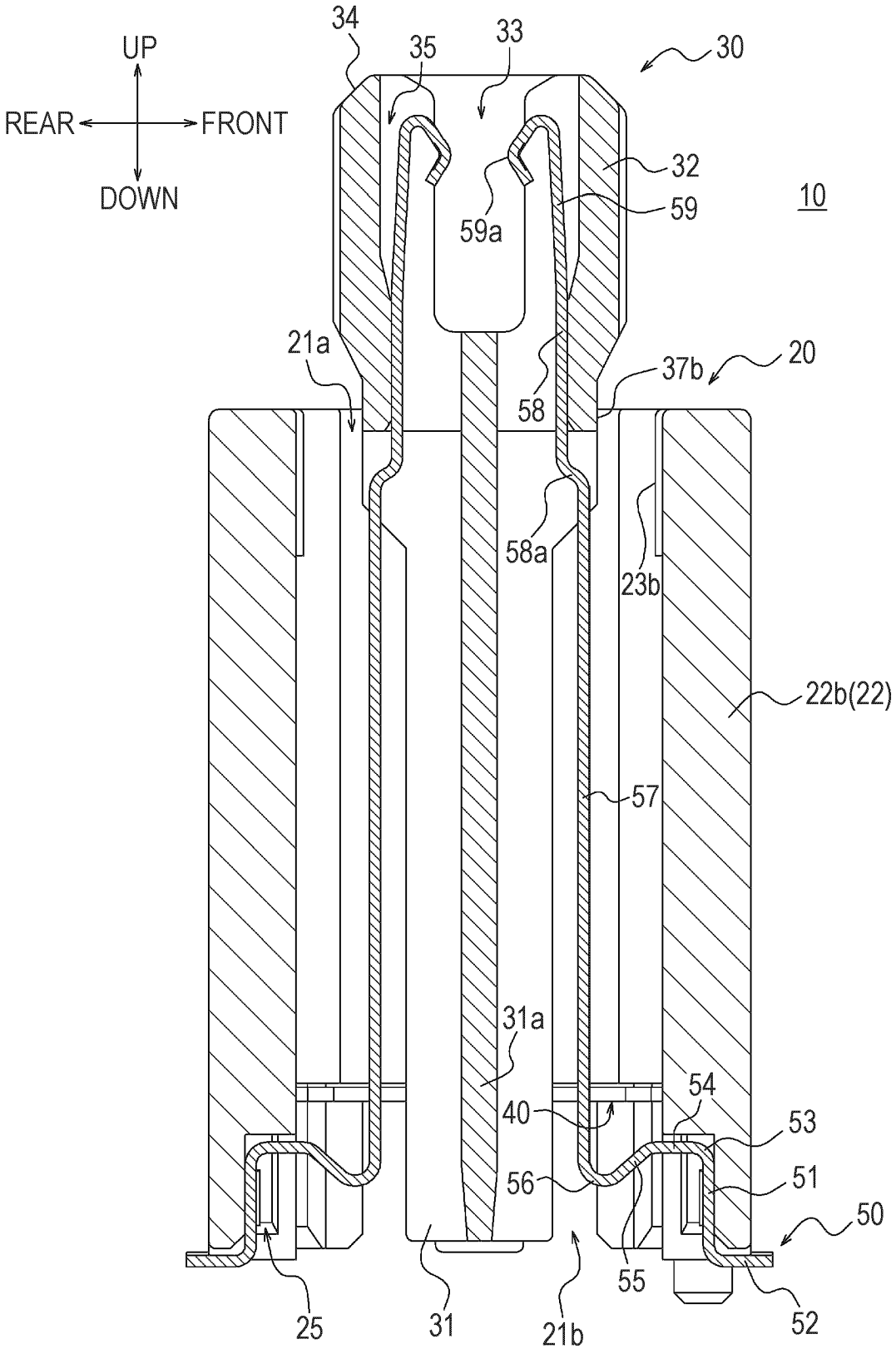


FIG. 13


UP
REAR
FRONT
DOWN
34
35
33
30
32
59
10
59a
21a
37b
20
58
58a
23b
22b(22)
57
31a
54
40
53
56
51
50
55
25
31
21b
52

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/017340

A. CLASSIFICATION OF SUBJECT MATTER

H01R 12/91(2011.01)i
FI: H01R12/91

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)

H01R12/91

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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.
X	JP 2016-181495 A (IRISO ELECTRONICS CO., LTD.) 13 October 2016 (2016-10-13) paragraphs [0050], [0051], [0096], fig. 11, 15	1-9
A	JP 2022-051035 A (MOLEX LLC) 31 March 2022 (2022-03-31) entire text, all drawings	1-9
A	WO 2019/181462 A1 (KYOCERA CORP.) 26 September 2019 (2019-09-26) entire text, all drawings	1-9
A	WO 2016/042625 A1 (YAMAICHI ELECTRONICS CO., LTD.) 24 March 2016 (2016-03-24) entire text, all drawings	1-9
A	JP 2021-093244 A (IRISO ELECTRONICS CO., LTD.) 17 June 2021 (2021-06-17) entire text, all drawings	1-9
A	JP 2021-026874 A (IRISO ELECTRONICS CO., LTD.) 22 February 2021 (2021-02-22) entire text, all drawings	1-9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 June 2023	**11 July 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/017340

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 5946804 B2 (HIROSE ELECTRIC CO., LTD.) 06 July 2016 (2016-07-06) entire text, all drawings	1-9

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/017340

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2016-181495 A	13 October 2016	US 2016/294089 A1 paragraphs [0085], [0086], [0131], fig. 11, 15 US 2016/294111 A1 EP 3076491 A1 EP 3076490 A1 CN 106058538 A CN 106058569 A	
JP 2022-051035 A	31 March 2022	(Family: none)	
WO 2019/181462 A1	26 September 2019	JP 2019-169347 A	
WO 2016/042625 A1	24 March 2016	DE 112014006961 T5 CN 107078426 A CN 110247215 A	
JP 2021-093244 A	17 June 2021	(Family: none)	
JP 2021-026874 A	22 February 2021	(Family: none)	
JP 5946804 B2	06 July 2016	US 2015/044901 A1 entire text, all drawings US 2016/204536 A1 CN 104347991 A CN 105720401 A	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2022081182 A **[0001]**
- JP 5946804 B **[0004]**