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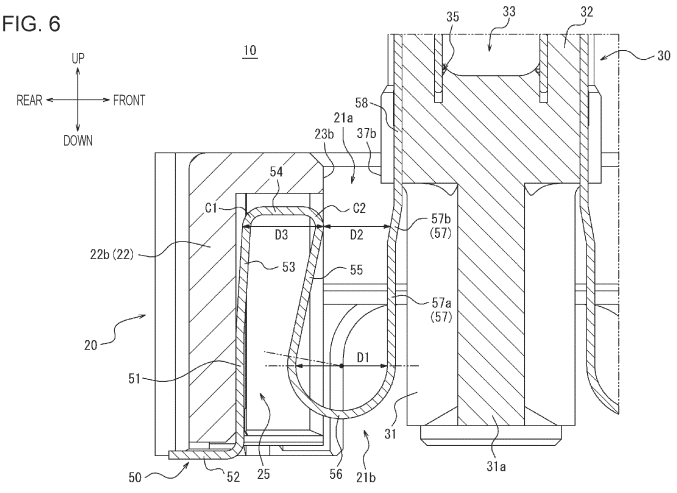
(54) CONNECTOR AND ELECTRONIC DEVICE

(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 first elastic portion 54, a second elastic portion 56, and an extending portion 57. The first and second elastic portions 54 and 56 are located between a first retained portion 51 and a second retained portion 58, and are both elastically deformable. The extending portion 57 extends from the second elastic portion 56 to the second retained portion 58. The second elastic portion 56 is located on a mating side relative to the first elastic portion 54, and has a curved shape. **In** a width direction from one of the first and second insulators 20 and 30 to the other, a maximum dimension D1 of the second elastic portion 56 is larger than a distance D2 between the first elastic portion 54 and the extending portion 57.

FIG. 6



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to Japanese Patent Application No. 2022-096897, filed on June 15, 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 movable connector that includes such a movable insulator and that achieves a reduction in displacement load of a spring portion to improve the ease of insertion and removal of the movable connector.

CITATION LIST

PATENT LITERATURE

[0004] Patent Literature 1: Japanese Patent No. 6415609

SUMMARY

[0005] In an embodiment of the present disclosure, a connector includes a first insulator, a second insulator, and multiple contacts. The first insulator is formed in 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 first retained portion, a second retained portion, a first elastic portion, a second elastic portion, and an extending portion. The first retained portion is attached to the first insulator. The second retained portion is attached to the second insulator. The first elastic portion and the second elastic portion are located between the first retained portion and the second retained portion, and are both elastically deformable. The extending portion extends from the second elastic portion to the second retained portion. The second elastic portion is located, relative to the first elastic portion, on a mating side where the connection object is mated with the second insulator. The second elastic portion is formed in a curved shape. In a width direction from one of the first insulator and the second insulator to the other one of the first insulator and the second insulator, a maximum dimension of the second elastic portion is larger than a distance between the first elastic portion and the extending portion.

[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 a top perspective view of a contact alone 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. 11 is a side view of a contact alone illustrating a first alternative embodiment of the contact.

FIG. 12 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a second alternative embodiment of the contacts.

FIG. 13 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a third alternative embodiment of the contacts.

DESCRIPTION OF EMBODIMENTS

[0008] For example, in a case where a connector is used in an environment where vibration occurs in a mating direction in which the connector and a connection object are mated with each other, the connection object may slide on contacting portions of contacts included in the connector, causing wear of the contacts. This reduces the reliability of contact. In view of this issue, the movable connector disclosed in Patent Literature 1 is configured such that spring portions of contacts are displaced more easily than contacting portions thereof.

Such a configuration reduces sliding on the contacting portions.

[0009] Boards are not always mounted parallel due to, for example, tolerances. For the movable connector disclosed in Patent Literature 1, movement of the movable insulator in the mating direction orthogonal to a board, for example, the Z direction, is primarily highlighted. In the movable connector disclosed in Patent Literature 1, however, sufficient consideration has not been given to the mobility of the connector in a case where the movable insulator moves in an oblique direction inclined from the Z direction and the ease of mating between the connector and a connection object in a case where the connection object is mated at an angle with the connector.

[0010] The present disclosure, which has been made in view of the above issue, provides a connector and an electronic device that exhibit improved mobility of the connector in any direction, including a mating direction and an oblique direction inclined from the mating direction.

[0011] In an embodiment of the present disclosure, a connector and an electronic device exhibit improved mobility of the connector in any direction, including a mating direction and an oblique direction inclined from the mating direction.

[0012] 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 FIG. 10, 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.

[0013] 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.

[0014] In an embodiment, for example, the connector 10 will be hereinafter described as a plug connector. For example, the connection object 60 will be hereinafter described as a receptacle connector. In the connector 10 described as a plug connector, a portion of each of the contacts 50 that is in contact with a respective one of the contacts 90 is not 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 receptacle connector, a portion of each of the contacts 90 that is in contact with a respective one of the contacts 50 is 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 receptacle connector, and the connection object 60 may serve as a plug connector.

[0015] 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).

[0016] 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.

[0017] 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.

[0018] 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 "width direction" 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.

[0019] 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 90 is elastically deformed in contact with the corresponding contact 50. 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 90 is not elastically deformed by an external force.

[0020] 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 can move 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 can move in oblique directions between the respective directions within the predetermined range.

[0021] 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 a top perspective view of the contact 50 alone in FIG. 4.

[0022] 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 contacts 50 are press-fitted from above onto the second insulator 30. The second insulator 30 with the contacts 50 is disposed from below into the first insulator 20 with the fittings 40. At this time, the contacts 50 are press-fitted from below into the first insulator 20.

[0023] The configurations of components of the connector 10 in the unmated state will be primarily described below. The configuration of the first insulator 20 will be primarily described with reference primarily to FIG. 4.

[0024] 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.

[0025] The first insulator 20 includes first restricting portions 23a defined by inner surfaces of the lateral walls 22a. The first insulator 20 includes second restricting portions 23b defined by inner surfaces of the longitudinal walls 22b. 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 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, the wall portion 31a has a rectangular shape in cross-sectional view. The width of the wall portion 31a in the front-rear direction is uniform 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. A portion of the mating protrusion 32 that is located above a lower portion of the mating protrusion 32 has a width slightly larger than that of the base 31 in the left-right direction, and protrudes on 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 recessed from inner surfaces of the mating depression 33 in the front-rear direction, outer surfaces of the mating protrusion 32 in the front-rear direction, and the upper surface of the mating protrusion 32. The multiple contact attachment grooves 35 extend substantially across the mating protrusion 32 in the up-down direction. Each of the multiple contacts 50 is attached to a respective one of the multiple contact attachment grooves 35. The multiple 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 are recessed from the outer surfaces of the mating protrusion 32 in the front-rear direction and extend from the bottom of the mating protrusion 32 to the top thereof. A lower end of the mating protrusion 32 at which lower ends of the contact attachment grooves 35 are located is continuous with the wall portion 31a. Lower ends of the contact attachment grooves 35 recessed from the inner surfaces of the mating depression 33 in the front-rear direction are located in the thickness of the mating protrusion 32.

[0033] As illustrated in FIG. 4, the second insulator 30 includes retaining protrusions 36 located one each on opposite sides 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 the lower portion, which is stepped inward in the left-right direction, of the mating protrusion 32. The inward-stepped lower portion is reduced in dimension in the left-right direction. 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 the lower portion of the mating protrusion 32 in the front-rear direction. An outer surface defined by each of the second restricted portions 37b is formed between one contact attachment groove 35 and another contact attachment groove 35 in the left-right 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.

[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 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] As illustrated in FIGs. 6 and 7, each of the contacts 50 includes a first retained 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 retained portion 51 to define an L-shape. The first retained 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 first extending portion 53 extending obliquely upward from an upper end of the first retained portion 51 and slightly inclined toward the second insulator 30.

[0041] The contact 50 includes a first elastic portion 54 that is bent from an upper end of the first extending portion 53 and that is elastically deformable. The first elastic portion 54 is formed in an inverted U-shape such that the first elastic portion 54 is bent from the upper end of the first extending portion 53 and is further bent toward the mating side. The first elastic portion 54 is bent at an angle of approximately 90° from the upper end of the first extending portion 53 and extends horizontally and linearly toward the second insulator 30. An end part of the first elastic 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. The end part of the first elastic portion 54 adjacent to the second insulator 30 is bent toward the mating side at an angle less than 90° from a part of the first elastic portion 54 that extends horizontally and linearly toward the second insulator 30.

[0042] The contact 50 includes a coupling portion 55 sloping obliquely and linearly from the end part of the first elastic portion 54 adjacent to the second insulator 30 toward the mating side and toward the first insulator 20. The contact 50 includes a second elastic portion 56 that is gently curved from a lower end of the coupling portion 55 toward the removal side opposite to the mating side and that is elastically deformable. The second elastic portion 56 is coupled to the first elastic portion 54 by the coupling

portion 55.

[0043] The contact 50 includes a second extending portion 57 extending from the second elastic portion 56 to a second retained portion 58, which will be described later, toward the removal side. The second extending portion 57 includes a base part 57a and a third elastic part 57b. The base part 57a extends linearly and parallel to the up-down direction. The third elastic part 57b extends linearly and obliquely upward from an upper end of the base part 57a and is slightly inclined toward the second insulator 30.

[0044] As illustrated in FIG. 5, the contact 50 includes the second retained portion 58 extending upward from an upper end of the third elastic part 57b of the second extending portion 57. **In** the contact 50, the second retained portion 58 extends from the upper end of the third elastic part 57b of the second extending portion 57 to an end of the contact 50. The second retained portion 58, which extends linearly upward from the upper end of the third elastic part 57b of the second extending portion 57, is curved to define an inverted U-shaped upper end part and extends linearly downward. The second retained portion 58 is supported by the second insulator 30.

[0045] The contact 50 includes a first contact part 59a and a second contact part 59b. The first contact part 59a is located on an outer surface of the second retained portion 58 in the front-rear direction. The second contact part 59b is located on an inner surface of the second retained portion 58 in the front-rear direction.

[0046] As illustrated in FIG. 6, the first retained portion 51 of each contact 50 engages the contact attachment groove 25 located in the longitudinal wall 22b of the first insulator 20. The first retained portion 51 is attached to the first insulator 20. As illustrated in FIG. 5, the second retained portion 58 of each contact 50 engages the contact attachment groove 35 located in the mating protrusion 32 of the second insulator 30. The second retained portion 58 is attached to the second insulator 30. The first elastic portion 54 and the second elastic portion 56, which are both elastically deformable, are located between the first retained portion 51 and the second retained portion 58.

[0047] Once the multiple contacts 50 are attached to the first insulator 20 and the second insulator 30, the second contact part 59b of each of the contacts 50 is located in the mating depression 33 of the second insulator 30. The second contact part 59b of each contact 50 is disposed along the inner surface of the mating depression 33 in the front-rear direction, and faces a space inside the mating depression 33. The first contact part 59a of each contact 50 is disposed along the outer surface of the mating protrusion 32 of the second insulator 30, and faces a space outside the mating protrusion 32.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] At this time, the second restricted portions 37b of the second insulator 30 are located 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.

[0052] 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.

[0053] 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 a respective one of the retaining protrusions 36 of the second insulator 30 in the up-down direction.

[0054] As illustrated in FIG. 6, a first corner C1 of the first elastic portion 54 adjacent to the first insulator 20 is bent at an angle of approximately 90° from the upper end of the first extending portion 53. The first corner C1 is formed in a shape like an arc of a sector having a central angle of approximately 90°. A second corner C2 of the first elastic portion 54 adjacent to the second insulator 30 is bent at an acute angle less than 90°. The second corner C2 is formed in a shape like an arc of a sector having an obtuse central angle greater than 90°.

[0055] The first elastic portion 54 extends linearly in the width direction from one of the first insulator 20 and the second insulator 30 to the other one of them. More specifically, a part of the first elastic portion 54 that is located between the first corner C1 and the second corner C2 is formed as a straight line extending in the

front-rear direction.

[0056] The second elastic portion 56 is formed in an arcuate shape such that the second elastic portion 56 is gently rounded and bent from the lower end of the coupling portion 55, which slopes obliquely and linearly downward and outward in the front-rear direction, and such that an end of the second elastic portion 56 faces upward. The second elastic portion 56 is formed in the shape of an arc of a sector having a central angle of 180° or more. For example, the second elastic portion 56 is formed in a shape like an arc of a substantially semicircle. The second elastic portion 56 is formed such that an arc forming the second elastic portion 56 coincides with a chord joining opposite ends of the arc or is located on the mating side relative to the chord. The second elastic portion 56 is formed such that the arc faces toward the mating side.

[0057] The arcuate shape of the second elastic portion 56 may be formed by bending the contact 50 multiple times with a stamping die. In consideration of errors in manufacturing, the arcuate shape of the second elastic portion 56 includes a shape having a partly varying radius of curvature. For example, the arcuate shape of the second elastic portion 56 may be formed by bending three parts of the second elastic portion 56 in three separate operations such that the three parts have slightly different radii of curvature.

[0058] The second elastic portion 56 is located on the mating side, where the connection object 60 is mated with the second insulator 30, relative to the first elastic portion 54, and is formed in a curved shape. As used herein, the "curved shape" includes a shape along a curve and excludes a shape along a straight line, or a line having a radius of curvature of zero. Of multiple elements of the contact 50 that are located between the first retained portion 51 and the second retained portion 58, the second elastic portion 56 is located furthest on the mating side, or lowest. In the contact 50, the first elastic portion 54 located on the removal side extends in a straight line in the front-rear direction, whereas the second elastic portion 56 located on the mating side extends in a curved line in the front-rear direction.

[0059] In the width direction from one of the first insulator 20 and the second insulator 30 to the other one of them, a maximum dimension D1 of the second elastic portion 56 is larger than a distance D2 between the first elastic portion 54 and the second extending portion 57. The maximum dimension D1 of the second elastic portion 56 is equal to the length of a straight line joining a first point located closest to the first insulator 20 on the arc forming the second elastic portion 56 and a second point located closest to the second insulator 30 on the arc forming the second elastic portion 56. The distance D2 corresponds to a distance between a part of the second corner C2 of the first elastic portion 54 that is located closest to the second insulator 30 and a part of the second extending portion 57 that is located at the same position as that of the part of the second corner C2 in the up-down direction.

[0060] In the width direction from one of the first insulator 20 and the second insulator 30 to the other one of them, the maximum dimension D1 of the second elastic portion 56 is larger than a maximum dimension D3 of the first elastic portion 54. In the width direction, the second elastic portion 56 is located closer to the second insulator 30 than the first elastic portion 54. The maximum dimension D3 of the first elastic portion 54 is the same as a maximum dimension of the first elastic portion 54 in the front-rear direction as viewed from above.

[0061] Since the coupling portion 55 slopes obliquely and linearly downward and outward in the front-rear direction, the width of a space surrounded by the coupling portion 55, the second elastic portion 56, and the second extending portion 57 in the front-rear direction gradually increases to the maximum dimension D1 in a direction from the removal side to the mating side. The width of the space in the front-rear direction monotonically increases to the maximum dimension D1 in the direction from the removal side to the mating side.

[0062] In each of the contacts 50, the mounting portion 52, the first retained portion 51, the first extending portion 53, the first elastic portion 54, the coupling portion 55, and part of the second elastic portion 56 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.

[0063] In each of the contacts 50, the remaining part of the second elastic portion 56 and the second extending portion 57 are located between the first insulator 20 and the second insulator 30. The first insulator 20 and the second insulator 30 are 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.

[0064] 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.

[0065] The first retained portion 51 of the contact 50 has a large width in the left-right direction so that the first retained portion 51 can engage the contact attachment groove 25 of the first insulator 20. The second retained portion 58 of the contact 50 has a large width in the left-right direction so that the second retained portion 58 can engage the contact attachment groove 35 of the second insulator 30. In the contact 50, a portion located between the second retained portion 58 and a combination of the mounting portion 52 and the first retained portion 51 has a smaller width in the left-right direction than the first retained portion 51 and the second retained portion 58. The width of this portion in the left-right direction is uniform.

[0066] 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.

[0067] The structure of the connection object 60 will be described with reference primarily to FIGs. 8 and 9.

[0068] 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.

[0069] 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 below into the insulator 70 and press-fitting the contacts 90 from below into the insulator 70.

[0070] 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 guides 73 extending along upper edges of opposite ends of the mating depression 71 in the left-right direction such that the guides 73 are across the mating depression 71 from each other in the left-right direction. The guides 73 are defined by sloping faces that slope obliquely downward and inward from the upper edges of the opposite ends of the mating depression 71 in the left-right direction.

[0071] 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 recessed from inner surfaces of the insulator 70 and linearly extending substantially across the insulator 70 in the up-down direction. 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.

[0072] 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 at each of the opposite ends of the insulator 70 in the left-right direction. The fitting 80 includes an L-shaped mounting portion 81 located at a lower end of the fitting 80 and extending outward in the left-right direction. The fitting 80 includes an engaging portion 82 formed continuously with the mounting portion 81 and being to engage the insulator 70. The engaging portion 82 is connected at its lower edge to the mounting portion 81.

[0073] Each of the contacts 90 is formed by shaping a sheet of, for example, a copper alloy containing 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 only by stamping. The method of forming the contact 90 is not limited to this example. The method may include, after stamping, bending a workpiece in a thickness direction of the workpiece. The contact 90 is plated with nickel, serving as an undercoat layer, and is then plated with, for example, gold or tin.

[0074] The multiple contacts 90 are arrayed in the left-right direction. Each of the contacts 90 includes a mounting portion 91 extending linearly outward in the front-rear direction. The contact 90 includes an engaging portion 92 formed continuously with the mounting portion 91. The contact 90 includes a bifurcated elastic contact piece 93 extending upward from the engaging portion 92. The contact 90 includes a first contact part 94a located in an outer part of the elastic contact piece 93 in the front-rear direction. The contact 90 includes a second contact part 94b located in an inner part of the elastic contact piece 93 in the front-rear direction.

[0075] 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 at the opposite ends of the insulator 70 in the left-right direction.

[0076] 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 engaging portion 92 of the contact 90 engages the contact attachment groove 75 of the insulator 70. At this time, the elastic contact piece 93 of the contact 90 is disposed in the contact attachment groove 75 and is elastically deformable in the front-rear direction. The first contact part 94a and the second contact part 94b of the elastic contact piece 93 are exposed from the contact attachment groove 75 and are located in the mating depression 71.

[0077] 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.

[0078] 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.

[0079] 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 move relative to the first insulator 20 fixed to the circuit board CB1.

[0080] 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.

[0081] 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.

[0082] 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.

[0083] 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 will contact the guides 73 of the connection object 60.

[0084] 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.

[0085] 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 first contact part 59a of the contact 50 contacts the first contact part 94a of the contact 90. The second contact part 59b of the contact 50 contacts the second contact part 94b of the contact 90. At this time, the elastic contact piece 93 of the contact 90 is slightly elastically deformed such that a bifurcated portion of the elastic contact piece 93 increases in width in the front-rear direction, and is elastically displaced in the front-rear direction inside the contact attachment groove 75.

[0086] 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.

[0087] In such a state, each of the elastic contact pieces 93 of the contacts 90 pinches the respective one of the contacts 50 of the connector 10 on the opposite sides in the front-rear direction with an elastic force acting in the front-rear direction. Thus, pressing forces applied to the contacts 50 in the above-described manner cause 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.

[0088] 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.

[0089] 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.

[0090] In an embodiment, the connector 10 exhibits improved mobility in any direction, including the mating direction and an oblique direction inclined from the mating direction. In the connector 10, the second elastic portion 56 is located on the mating side relative to the first elastic portion 54 and is formed in a curved shape. In addition, the maximum dimension D1 of the second elastic portion 56 is larger than the distance D2 between the first elastic portion 54 and the second extending portion 57 in the width direction. The second elastic portion 56 is formed in a curved shape having a small radius of curvature.

[0091] An increase in radius of curvature in the second elastic portion 56 causes stress resulting from elastic deformation of the contact 50 associated with movement of the second insulator 30 to be distributed in the second elastic portion 56. Thus, the contact 50 can respond to movement of the second insulator 30 in an oblique direction. If the connection object 60 is obliquely inserted into or removed from the connector 10, or if the second insulator 30 moves in an oblique direction, the second elastic portion 56 of the contact 50 can be flexibly and elastically deformed. The contact 50 can respond to movement of the second insulator 30 in the mating direction and an oblique direction. This leads to improved mobility of the connector 10 in the mating and oblique directions. Similarly, this leads to improved ease of mating the connection object 60 with the connector 10 in the mating and oblique directions.

[0092] The contact 50 further includes the coupling portion 55 coupling the first elastic portion 54 and the second elastic portion 56, resulting in a longer distance between the first elastic portion 54 and the second elastic portion 56. This can reduce an effect of elastic deformation of one of the first elastic portion 54 and the second elastic portion 56 that may be exerted on the other one of them.

[0093] The coupling portion 55 slopes obliquely and linearly from the end part of the first elastic portion 54 adjacent to the second insulator 30 toward the mating side and toward the first insulator 20. This further increases an area in which stress resulting from elastic deformation of the contact 50 associated with movement of the second insulator 30 can be distributed in the second elastic portion 56. The coupling portion 55 has a linear shape with no bend. Such a shape makes it difficult for stress to be concentrated in portions other than the second elastic portion 56 in the contact 50. Thus, the above-described mobility of the connector 10 and the above-described ease of mating are further improved. The mobility of the connector 10 and the ease of mating in the mating and oblique directions are further improved. For example, the mobility in the up-down direction is also improved.

[0094] The first insulator 20 is not located between a portion of one contact 50 that includes the remaining part of the second elastic portion 56 and the second extending portion 57 and such a portion of another contact 50 adjacent to the one contact 50 in the left-right direction. 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 second elastic portion 56 of 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. **In** addition, the mobility of the connector 10 associated with elastic deformation of the contacts 50 is further improved.

[0095] The first elastic portion 54, which extends linearly in the width direction, can contribute to a reduction in size of the connector 10 in the mating direction, or a low profile of the connector 10, as compared with a case where the first elastic portion 54 has, for example, a shape significantly curved upward.

[0096] Since the second elastic portion 56 is located closer to the second insulator 30 than the first elastic portion 54 in the width direction, the second elastic portion 56 having a curved shape, for example, an arcuate shape, is at a location that is closer to the second insulator 30 and in which stress is likely to be concentrated. This facilitates distribution of stress concentrated in the second elastic portion 56 of the contact 50.

[0097] The second elastic portion 56 is formed in the shape of an arc of a sector having a central angle of 180° or more. This further increases the area in which stress resulting from elastic deformation of the contact 50 associated with movement of the second insulator 30 can be distributed in the second elastic portion 56. Therefore, the above-described mobility of the connector 10 and the above-described ease of mating are further improved.

[0098] 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.

[0099] 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.

[0100] 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.

[0101] 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.

[0102] 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.

[0103] 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.

[0104] 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.

[0105] 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.

[0106] 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.

[0107] In the above-described embodiment, the contact 50 further includes the coupling portion 55 coupling the first elastic portion 54 and the second elastic portion 56. The configuration is not limited to this example. In the contact 50, the first elastic portion 54 and the second elastic portion 56 may be connected directly to each other.

[0108] In the above-described embodiment, the first elastic portion 54 extends linearly in the width direction. The configuration is not limited to this example. The first elastic portion 54 may be formed in a curved shape in the width direction. For example, the first elastic portion 54 may be formed in an arcuate shape such that the first elastic portion 54 is gently rounded and bent from the upper end of the first extending portion 53 and such that an end of the first elastic portion 54 faces downward. The first elastic portion 54 may be formed in the shape of an arc of a sector having a central angle of 180° or more. For example, the first elastic portion 54 may be formed in a shape like an arc of a substantially semicircle. The first elastic portion 54 may be formed such that an arc forming the first elastic portion 54 coincides with a chord joining opposite ends of the arc or is located on the removal side relative to the chord. The first elastic portion 54 may be formed such that the arc faces toward the removal side.

[0109] In the contact 50, the first elastic portion 54 formed such that the arc faces toward the removal side and the second elastic portion 56 formed such that the arc faces toward the mating side may be connected directly to each other without the coupling portion 55 located therebetween. In the contact 50, the first elastic portion 54 and the second elastic portion 56 may be formed such that the overall shape of these portions resembles a horizontally reversed S-shape.

[0110] FIG. 11 is a side view of a contact 50 alone illustrating a first alternative embodiment of the contact 50.

[0111] In the above-described embodiment, the coupling portion 55 slopes obliquely and linearly from the end part of the first elastic portion 54 adjacent to the second insulator 30 toward the mating side and toward the first insulator 20. The configuration is not limited to this example. As illustrated in FIG. 11, the coupling portion 55 may extend linearly from the end part of the first elastic portion 54 adjacent to the second insulator 30 toward the mating side. The coupling portion 55 may extend linearly and vertically downward from the end part of the first elastic portion 54 adjacent to the second insulator 30. In this case, the second elastic portion 56 may be formed in the shape of an arc of a sector having a central angle greater than 180° and be connected to the lower end of the coupling portion 55 such that the maximum dimension D1 is larger than the distance D2 in the width direction.

[0112] The coupling portion 55 may be formed in any shape and be located between the first elastic portion 54 and the second elastic portion 56 as long as the maximum dimension D1 is larger than the distance D2 in the width direction. For example, at least one part of the coupling portion 55 may be formed in a curved line. In the above-described embodiment, the coupling portion 55 slopes obliquely and linearly downward and outward in the front-rear direction, so that the width of the space surrounded by the coupling portion 55, the second elastic portion 56, and the second extending portion 57 in the front-rear direction gradually increases to the maximum dimension D1 in the direction from the removal side to the

mating side. The configuration is not limited to this example. The width of the space in the front-rear direction does not necessarily need to monotonically increase to the maximum dimension D1 in the direction from the removal side to the mating side.

[0113] In the above-described embodiment, the first insulator 20 is located between the first elastic portion 54 and the coupling portion 55 of one contact 50 and these portions of another contact 50 adjacent to the one contact 50. The configuration is not limited to this example. The first insulator 20 does not necessarily need to be located between the first elastic portion 54 and the coupling portion 55 of one contact 50 and these portions of another contact 50 adjacent to the one contact 50. The first elastic portion 54 and the coupling portion 55 may be exposed from the contact attachment groove 25 of the first insulator 20 and be located between the first insulator 20 and the second insulator 30.

[0114] Such a configuration of the connector 10 can further reduce a likelihood that the contact 50 made of metal may contact the first insulator 20 made of resin when the first elastic portion 54 and the second elastic portion 56 of the contact 50 elastically deform in response to movement of the second insulator 30. This further reduces breakage of the first insulator 20. As a result, the connector 10 can achieve a more stable floating operation, leading to further improved reliability of the connector 10 as a product. In addition, the mobility of the connector 10 associated with elastic deformation of the contacts 50 is further improved.

[0115] Additionally, if the contact 50 touches the first insulator 20 while elastically deforming in response to movement of the second insulator 30, a portion of the contact 50 that is located between the second retained portion 58 and a touching part of the contact 50 in contact with the first insulator 20 can elastically deform. In the configuration in which the first insulator 20 is not located between the first elastic portion 54 and the coupling portion 55 of one contact 50 and these portions of another contact 50 adjacent to the one contact 50, therefore, if the contact 50 touches the first insulator 20, a touching part of the contact 50 will be located closer to the first insulator 20. This reduces a decrease in length of a spring caused by such a touching part.

[0116] In the above-described embodiment, the second elastic portion 56 is formed in an arc of a sector having a central angle of 180° or more. The configuration is not limited to this example. The second elastic portion 56 may be formed in any curved shape different from an arc. For example, the second elastic portion 56 may be formed in a curved shape corresponding to the periphery of an ellipse. In the above-described embodiment, the second elastic portion 56 is formed in the shape of an arc facing toward the mating side. The configuration is not limited to this example. The second elastic portion 56 may be formed in the shape of an arc facing toward the removal side.

[0117] The second elastic portion 56 formed in a curved shape corresponding to the periphery of an ellipse makes it easy for stress resulting from elastic deformation of the contact 50 associated with movement of the second insulator 30 to be distributed in the second elastic portion 56. The second elastic portion 56 formed in a curved shape corresponding to an arc of a sector makes it easier for stress resulting from elastic deformation of the contact 50 associated with movement of the second insulator 30 to be distributed in the second elastic portion 56 than in a case where the curved shape corresponds to the periphery of an ellipse.

[0118] 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.

[0119] In the above-described embodiment, the first elastic portion 54 of each contact 50 is bent at an angle of approximately 90° from the upper end of the first extending portion 53 and extends horizontally and linearly toward the second insulator 30. The configuration is not limited to this example. The first elastic portion 54 may be bent at an angle of approximately 90° from the upper end of the first extending portion 53 and extend obliquely toward the second insulator 30.

[0120] In the above-described embodiment, the second extending portion 57 of each contact 50 includes the base part 57a extending linearly and parallel to the up-down direction. The configuration is not limited to this example. The base part 57a of the second extending portion 57 may be formed non-parallel to the up-down direction. At least part of the entire second extending portion 57 including the base part 57a and the third elastic part 57b may be formed in a non-linear shape. Conversely, the second extending portion 57 may include no third elastic part 57b, include only the base part 57a, and be formed in a linear shape as a whole such that the base part 57a is parallel to the up-down direction.

[0121] In the above-described embodiment, the first retained portion 51 of each contact 50 has a large width in the left-right direction so that the first retained portion 51 can engage the contact attachment groove 25 of the first insulator 20. The configuration is not limited to this example. The first retained portion 51 does not necessarily need to have a large width in the left-right direction for insert molding, rather than press-fitting.

[0122] In the above-described embodiment, the second retained portion 58 of each contact 50 has a large width in the left-right direction so that the second retained portion 58 can engage the contact attachment groove 35 of the second insulator 30. The configuration is not limited to this example. The second retained portion 58 does not necessarily need to have a large width in the left-right direction for insert molding, rather than press-fitting.

[0123] In the above-described embodiment, the first

extending portion 53 of each contact 50 extends obliquely upward from the upper end of the first retained portion 51. The configuration is not limited to this example. The first extending portion 53 does not necessarily need to extend obliquely upward from the upper end of the first retained portion 51. For example, the first extending portion 53 may extend linearly and vertically upward from the upper end of the first retained portion 51.

[0124] FIG. 12 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a second alternative embodiment of the contacts 50. FIG. 13 is a cross-sectional view, which is equivalent to FIG. 5, illustrating a third alternative embodiment of the contacts 50. In the above-described embodiment, as illustrated in FIGs. 6 and 7, for example, the first corner C1 is bent at an angle of approximately 90°, and the second corner C2 is bent at an angle of approximately 90°. The corners are not limited to such forms.

[0125] The first corner C1 does not necessarily need to be bent at an angle of approximately 90°. The radius of curvature of the first corner C1 may be greater than or equal to 1.0d and less than or equal to 20d, where d denotes the thickness of the first elastic portion 54. The radius of curvature of the first corner C1 may be greater than or equal to 1.3d and less than or equal to 20d, greater than or equal to 1.5d and less than or equal to 20d, or greater than or equal to 1.7d and less than or equal to 20d.

[0126] The second corner C2 does not necessarily need to be bent at an angle of approximately 90°. The radius of curvature of the second corner C2 may be greater than or equal to 1.0d and less than or equal to 20d, where d denotes the thickness of the first elastic portion 54. The radius of curvature of the second corner C2 may be greater than or equal to 1.3d and less than or equal to 20d, greater than or equal to 1.5d and less than or equal to 20d, or greater than or equal to 1.7d and less than or equal to 20d.

[0127] The configuration is not limited to the above example in which the first elastic portion 54 extends horizontally and linearly from the first corner C1 to the second corner C2. The first elastic portion 54 does not necessarily need to extend horizontally. The first elastic portion 54 may include no linear part and be formed in an arcuate shape as a whole. The sum of the radius of curvature of the first corner C1 and that of the second corner C2 may be greater than or equal to 2.0d and less than or equal to 25d, where d denotes the thickness of the first elastic portion 54.

[0128] FIG. 12 illustrates an example in which the first corner C1 and the second corner C2 are symmetrically formed. The radius of curvature of the first corner C1 is the same as that of the second corner C2. FIG. 13 illustrates an example in which the first corner C1 and the second corner C2 are asymmetrically formed. The radius of curvature of the first corner C1 is different from that of the second corner C2. The radius of curvature of the first corner C1 is larger than that of the second corner C2.

[0129] The contact 50 with such a form illustrated in FIG. 12 or 13 is less likely to be broken by stress applied to the contact 50.

[0130] 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.

[0131] The connection object 60 has been described as a receptacle 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.

[0132] 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.

[0133] In such an electronic device, the connector 10 with a floating structure exhibits improved mobility in any direction, including the mating direction and an oblique direction inclined from the mating direction. 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.

[0134] 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.

[0135] The following concepts can be extracted from the present disclosure.

(1) A connector including:

a first insulator formed in 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 first retained portion attached to the first insulator,
a second retained portion attached to the second insulator,
a first elastic portion and a second elastic portion located between the first retained portion and the second retained portion, the first elastic portion and the second elastic portion being both elastically deformable, and
an extending portion extending from the second elastic portion to the second retained portion,

wherein the second elastic portion is located, relative to the first elastic portion, on a mating side where the connection object is mated with the second insulator,
wherein the second elastic portion is formed in a curved shape, and
wherein, in a width direction from one of the first insulator and the second insulator to the other one of the first insulator and the second insulator, a maximum dimension of the second elastic portion is larger than a distance between the first elastic portion and the extending portion.

(2) The connector according to (1), wherein the second elastic portion is formed in a curved shape corresponding to the periphery of an ellipse.
(3) The connector according to (1), wherein the second elastic portion is formed in a curved shape corresponding to an arc of a sector.
(4) The connector according to any one of (1) to (3), wherein the multiple contacts each further include a coupling portion coupling the first elastic portion and the second elastic portion.
(5) The connector according to (4), wherein the coupling portion slopes obliquely and linearly from an end part of the first elastic portion adjacent to the second insulator toward the mating side and toward the first insulator.
(6) The connector according to any one of (1) to (5), wherein the first elastic portion extends linearly in the width direction.
(7) The connector according to any one of (1) to (6), wherein the maximum dimension of the second elastic portion is larger than a maximum dimension of the first elastic portion in the width direction.
(8) The connector according to any one of (1) to (7), wherein the second elastic portion is located closer to the second insulator than the first elastic portion in the width direction.
(9) The connector according to (3), wherein the sector has a central angle of 180° or more and the arc forming the second elastic portion faces toward the mating side.
(10) An electronic device including the connector according to any one of (1) to (9).

REFERENCE SIGNS

[0136]

10	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 retained portion
52	mounting portion
53	first extending portion
54	first elastic portion
55	coupling portion
56	second elastic portion
57	second extending portion (extending portion)
57a	base part
57b	third elastic part
58	second retained portion
59a	first contact part
59b	second 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	engaging portion
93	elastic contact piece
94a	first contact part
94b	second contact part
C1	first corner
C2	second corner
CB1	circuit board
CB2	circuit board
D1	maximum dimension
D2	distance

Claims

1. A connector comprising:

a first insulator formed in 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 first retained portion attached to the first insulator,
a second retained portion attached to the second insulator,
a first elastic portion and a second elastic portion located between the first retained portion and the second retained portion, the first elastic portion and the second elastic portion being both elastically deformable, and
an extending portion extending from the second elastic portion to the second retained portion,

wherein the second elastic portion is located, relative to the first elastic portion, on a mating side where the connection object is mated with the second insulator,
wherein the second elastic portion is formed in a curved shape, and
wherein, in a width direction from one of the first insulator and the second insulator to an other one of the first insulator and the second insulator, a maximum dimension of the second elastic portion is larger than a distance between the first elastic portion and the extending portion.

2. The connector according to claim 1, wherein the second elastic portion is formed in a curved shape corresponding to a periphery of an ellipse.

3. The connector according to claim 1, wherein the second elastic portion is formed in a curved shape corresponding to an arc of a sector.

4. The connector according to any one of claims 1 to 3, wherein the multiple contacts each further comprise a coupling portion coupling the first elastic portion and the second elastic portion.

5. The connector according to claim 4, wherein the coupling portion slopes obliquely and linearly from an end part of the first elastic portion adjacent to the second insulator toward the mating side and toward the first insulator.

6. The connector according to any one of claim 1 to 3, wherein the first elastic portion extends linearly in the width direction.

7. The connector according to any one of claims 1 to 3, wherein the maximum dimension of the second elastic portion is larger than a maximum dimension of the first elastic portion in the width direction.

8. The connector according to any one of claims 1 to 3, wherein the second elastic portion is located closer to the second insulator than the first elastic portion in the width direction.

9. The connector according to claim 3, wherein the sector has a central angle of 180° or more and the arc forming the second elastic portion faces toward the mating side.

10. An electronic device comprising the connector according to any one of claims 1 to 3.

FIG. 1

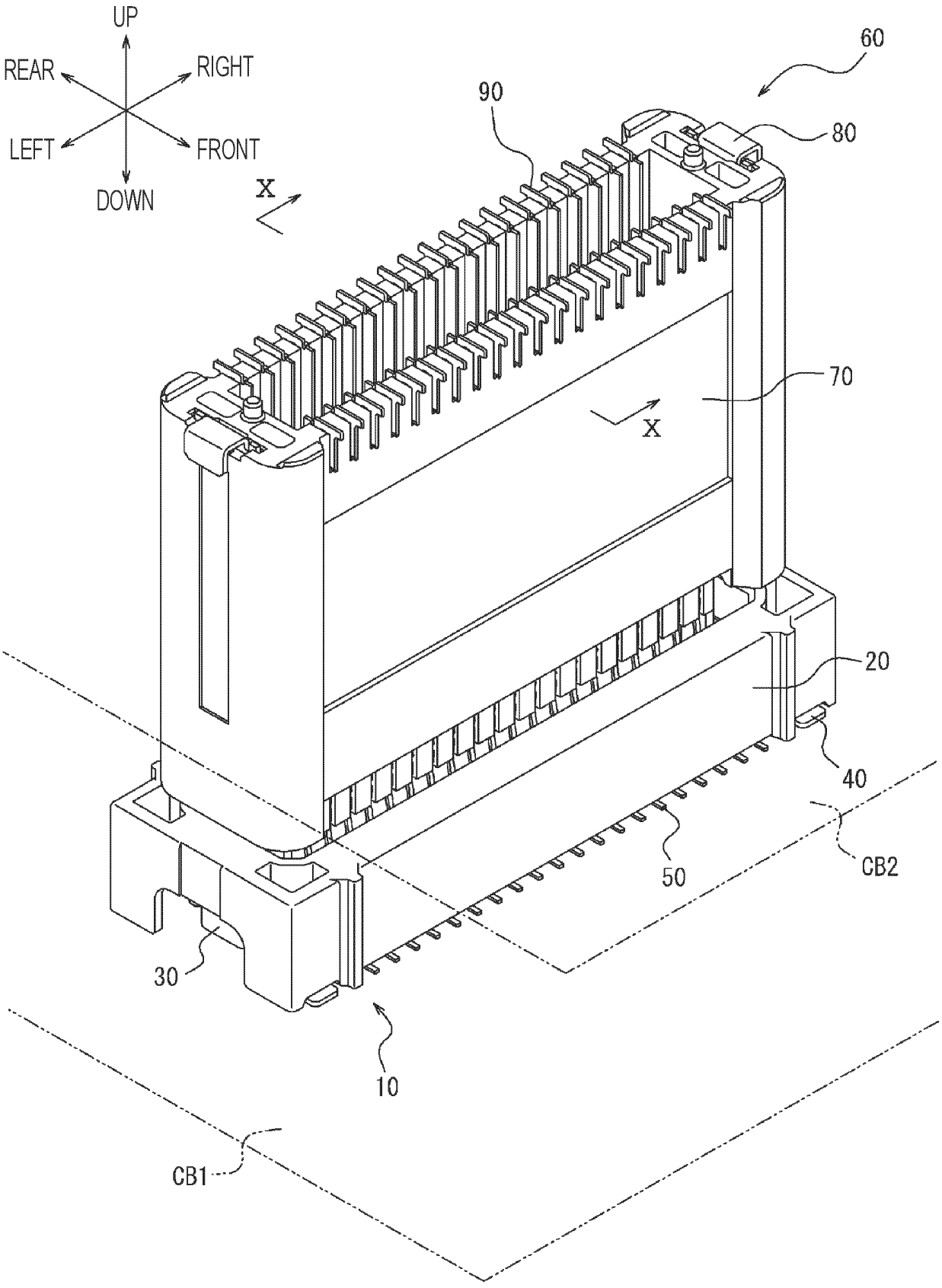

UP
REAR
RIGHT
LEFT
FRONT
DOWN
X
X
60
90
80
70
20
40
50
CB2
30
10
CB1

FIG. 2

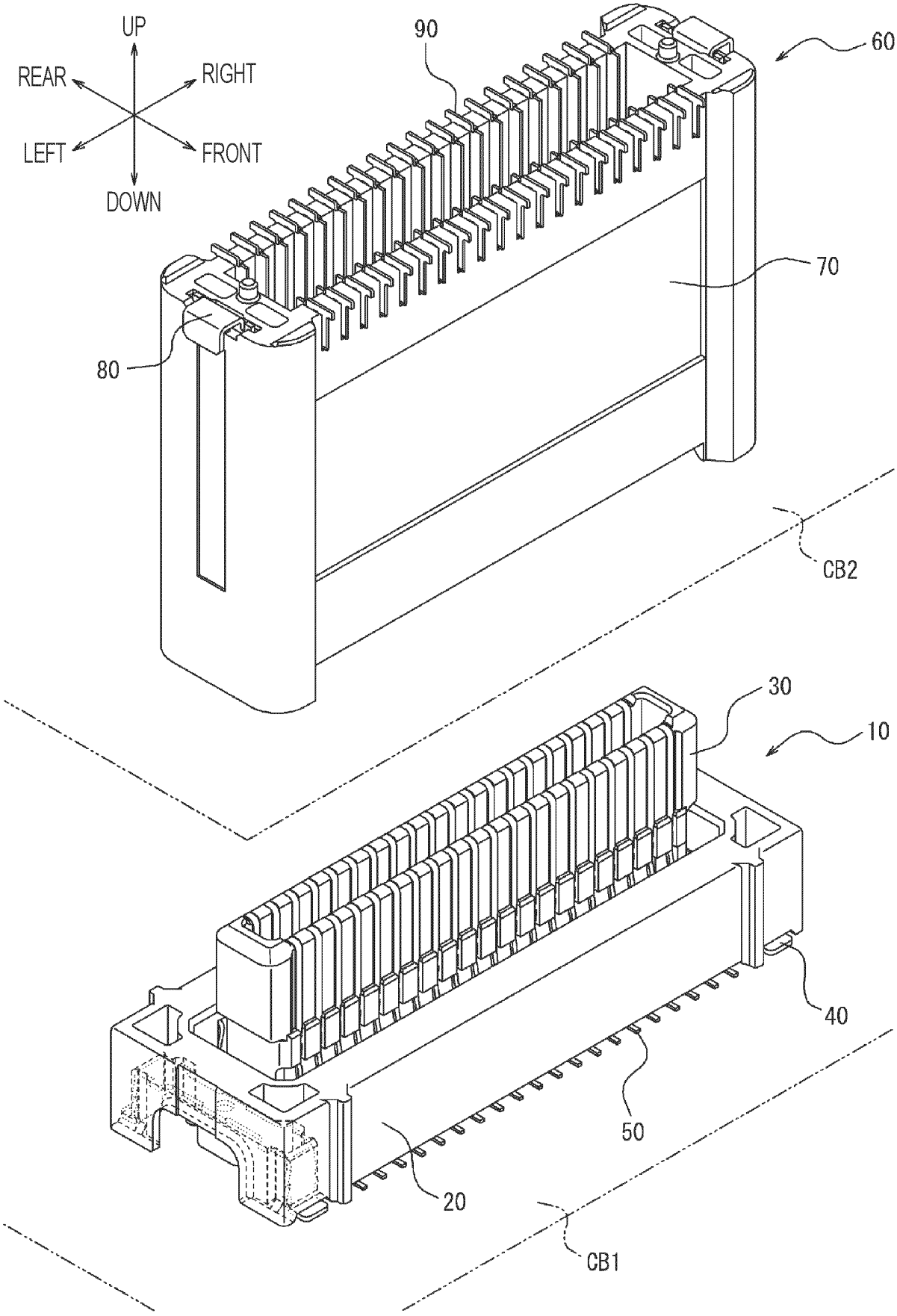


FIG. 3

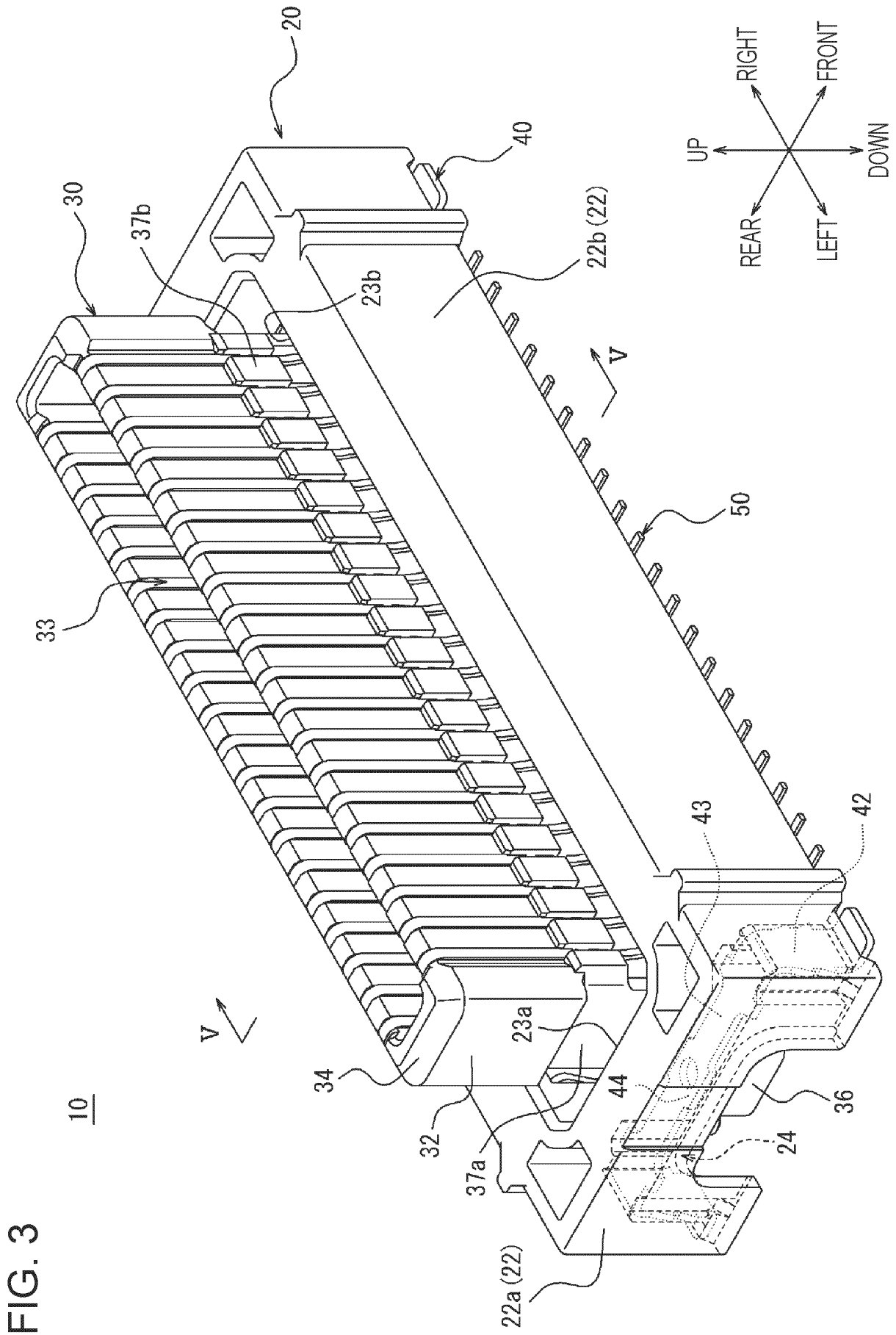
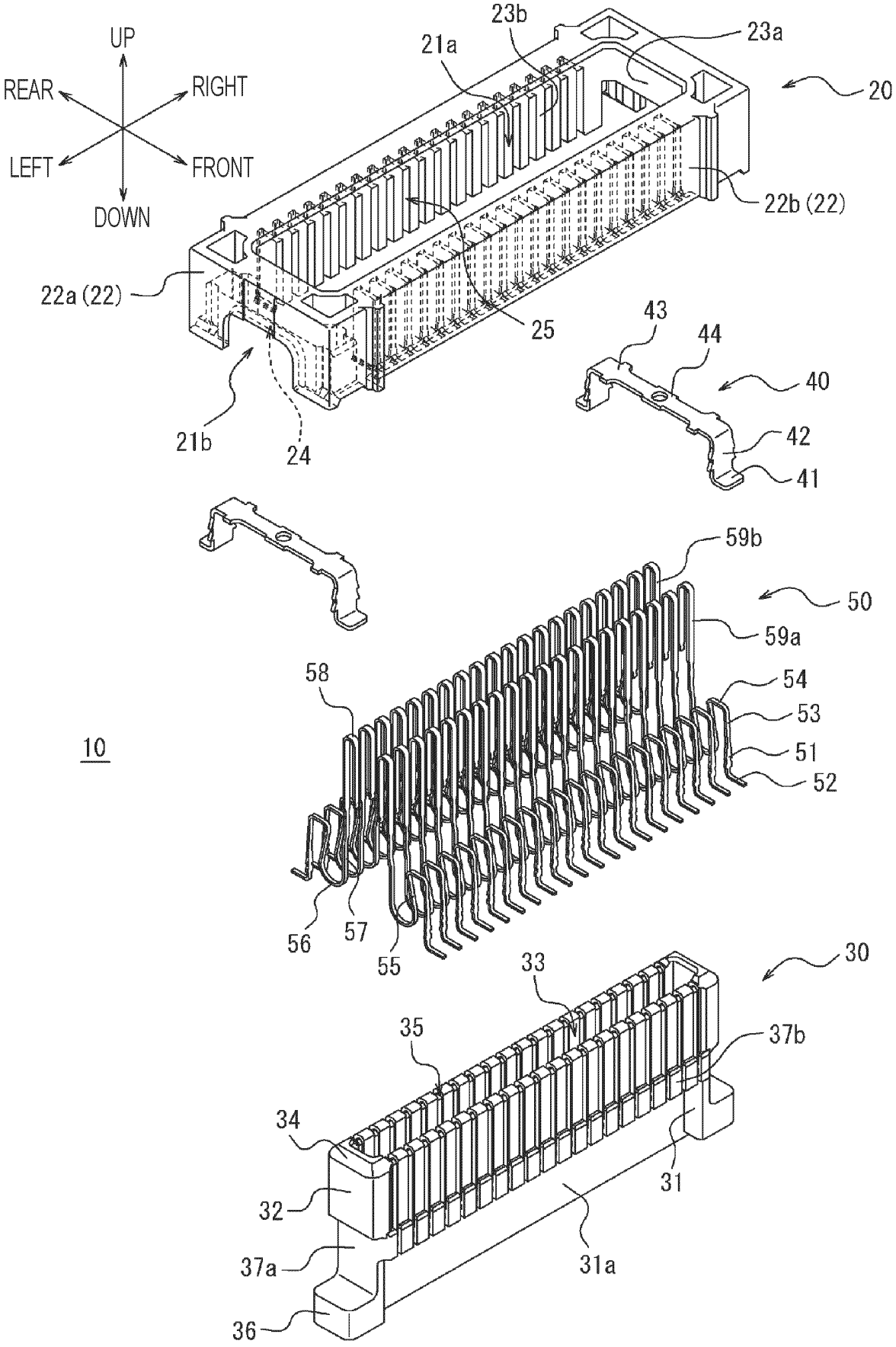
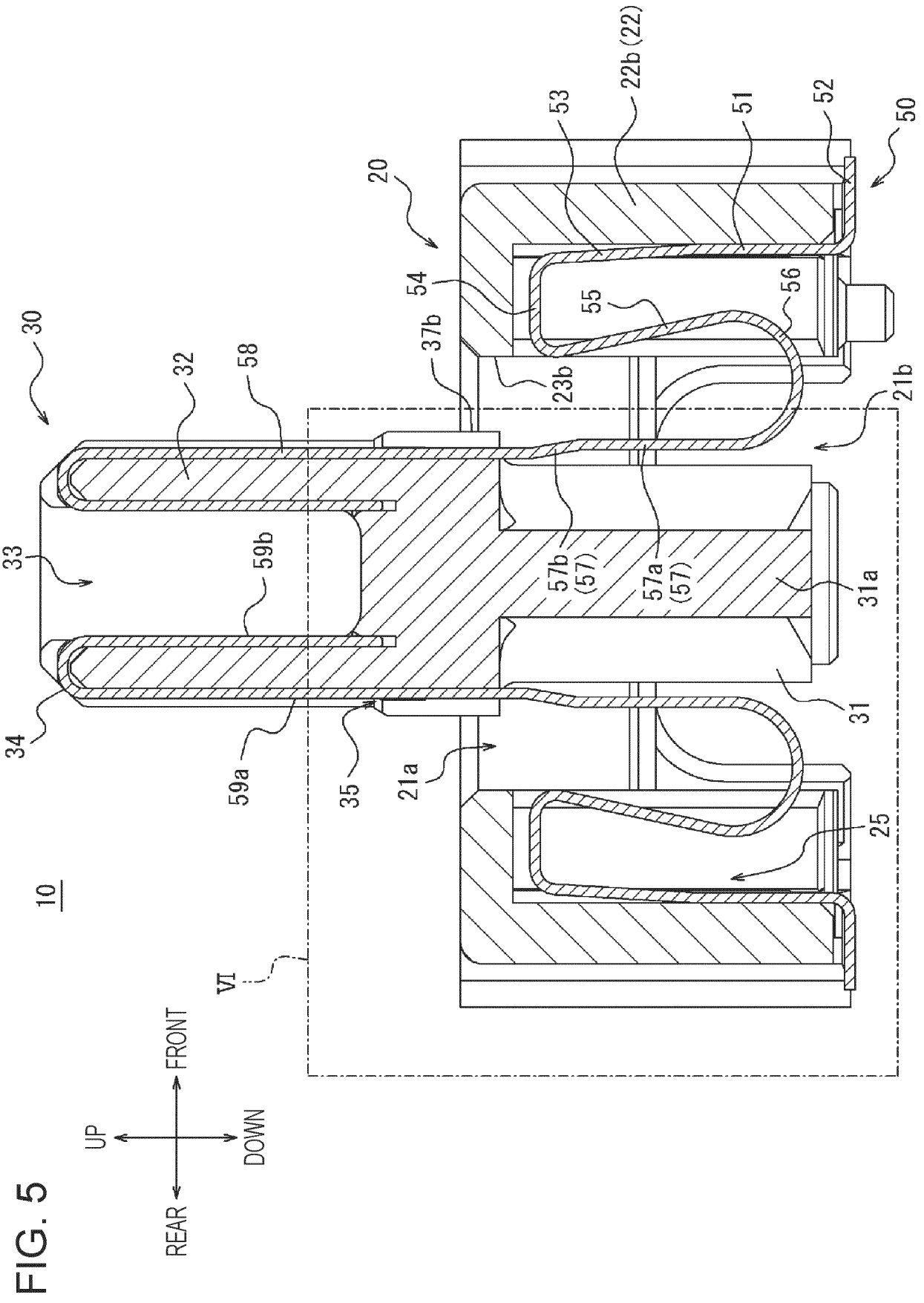

20
40
30
37b
23b
22b (22)
UP
RIGHT
FRONT
DOWN
REAR
LEFT
V
V
50
33
43
42
23a
34
44
36
32
24
37a
22a (22)
10

FIG. 4


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


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

FIG. 5

FIG. 6

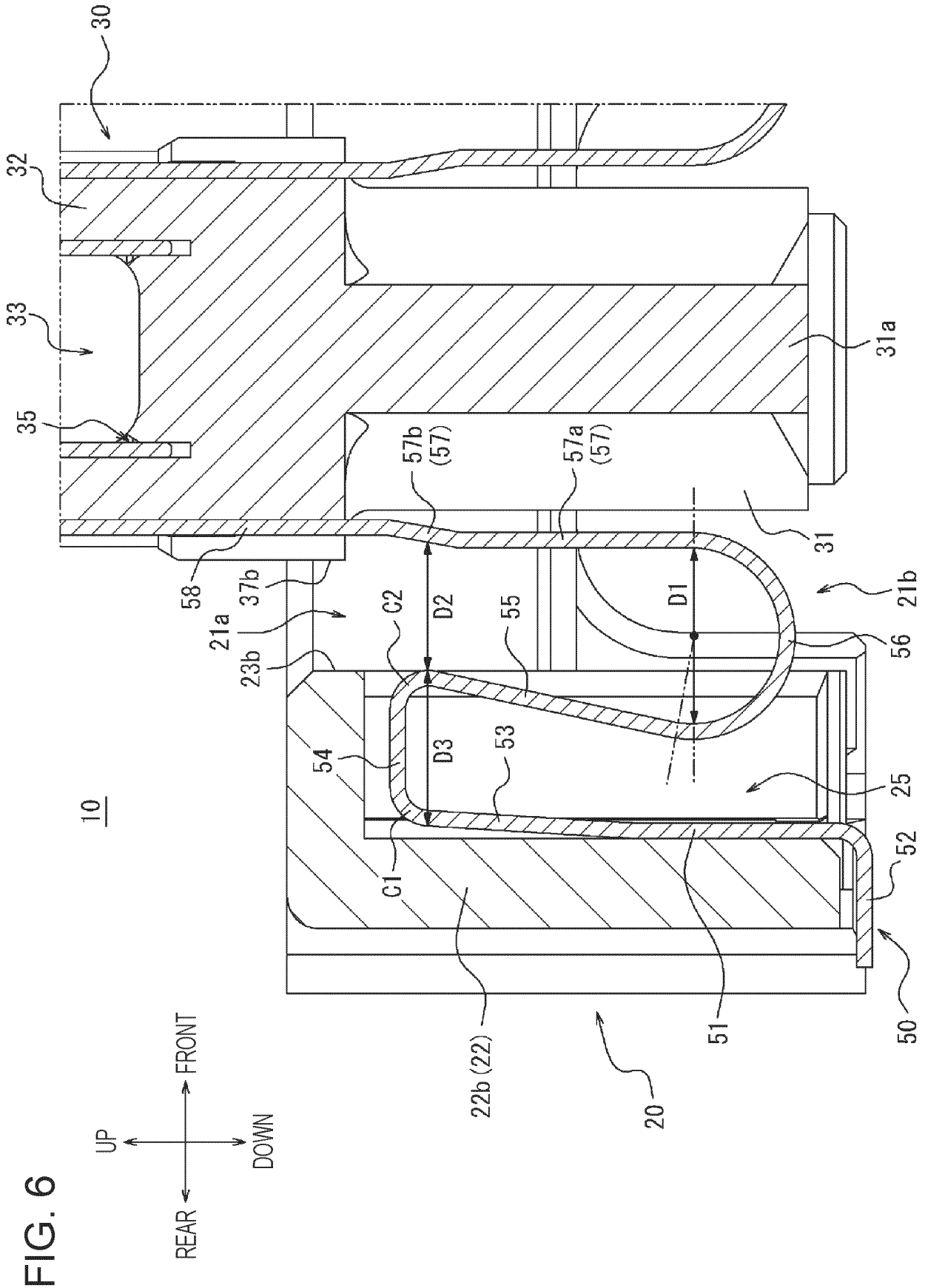
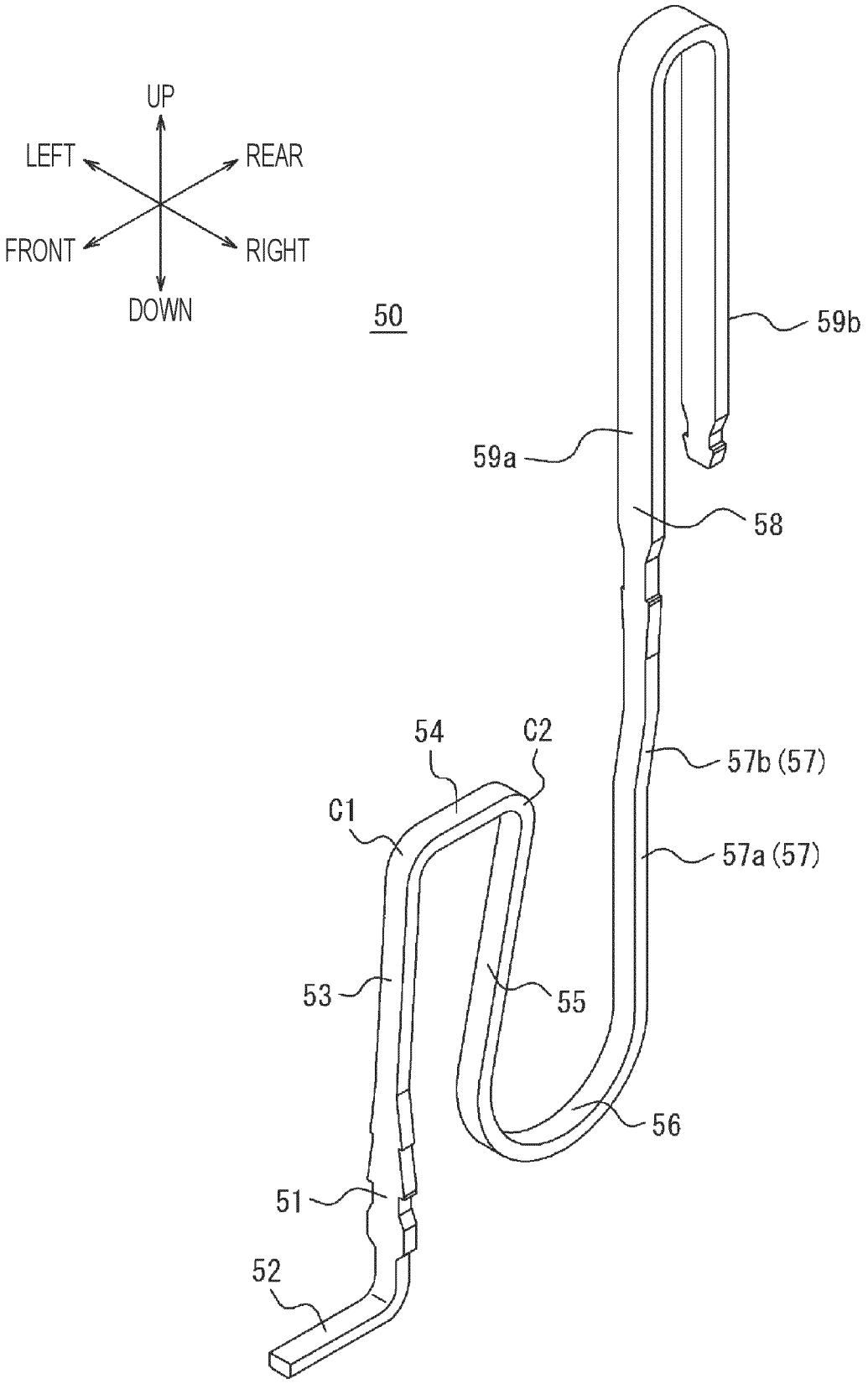

30
32
33
35
31a
57b (57)
57a (57)
31
58
37b
21a
23b
C2
D2
55
D1
21b
56
54
D3
53
25
C1
52
50
22b (22)
20
51
10
FRONT
UP
DOWN
REAR

FIG. 7


UP
LEFT
REAR
FRONT
RIGHT
DOWN
50
59b
59a
58
54
C2
57b (57)
C1
57a (57)
53
55
56
51
52

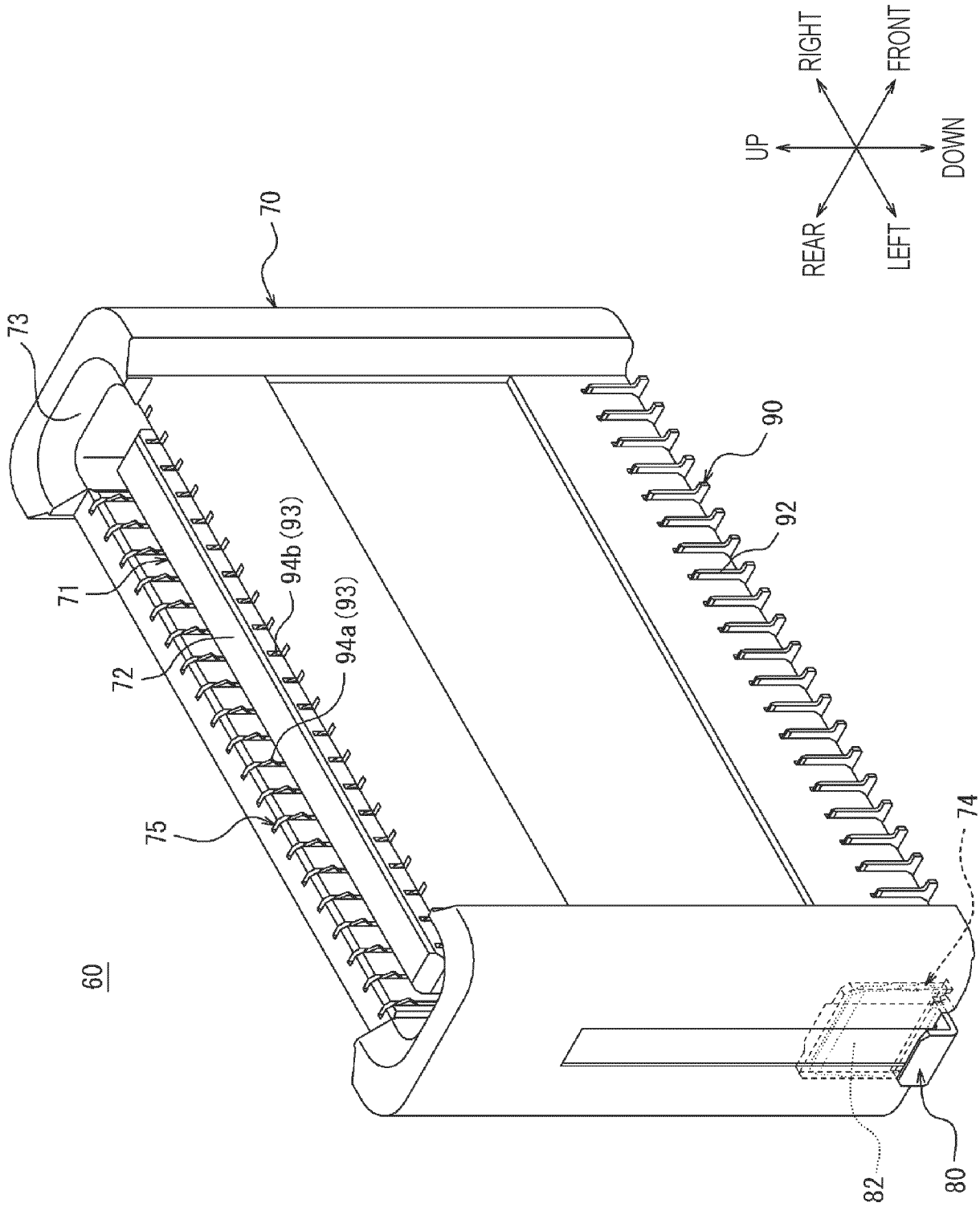
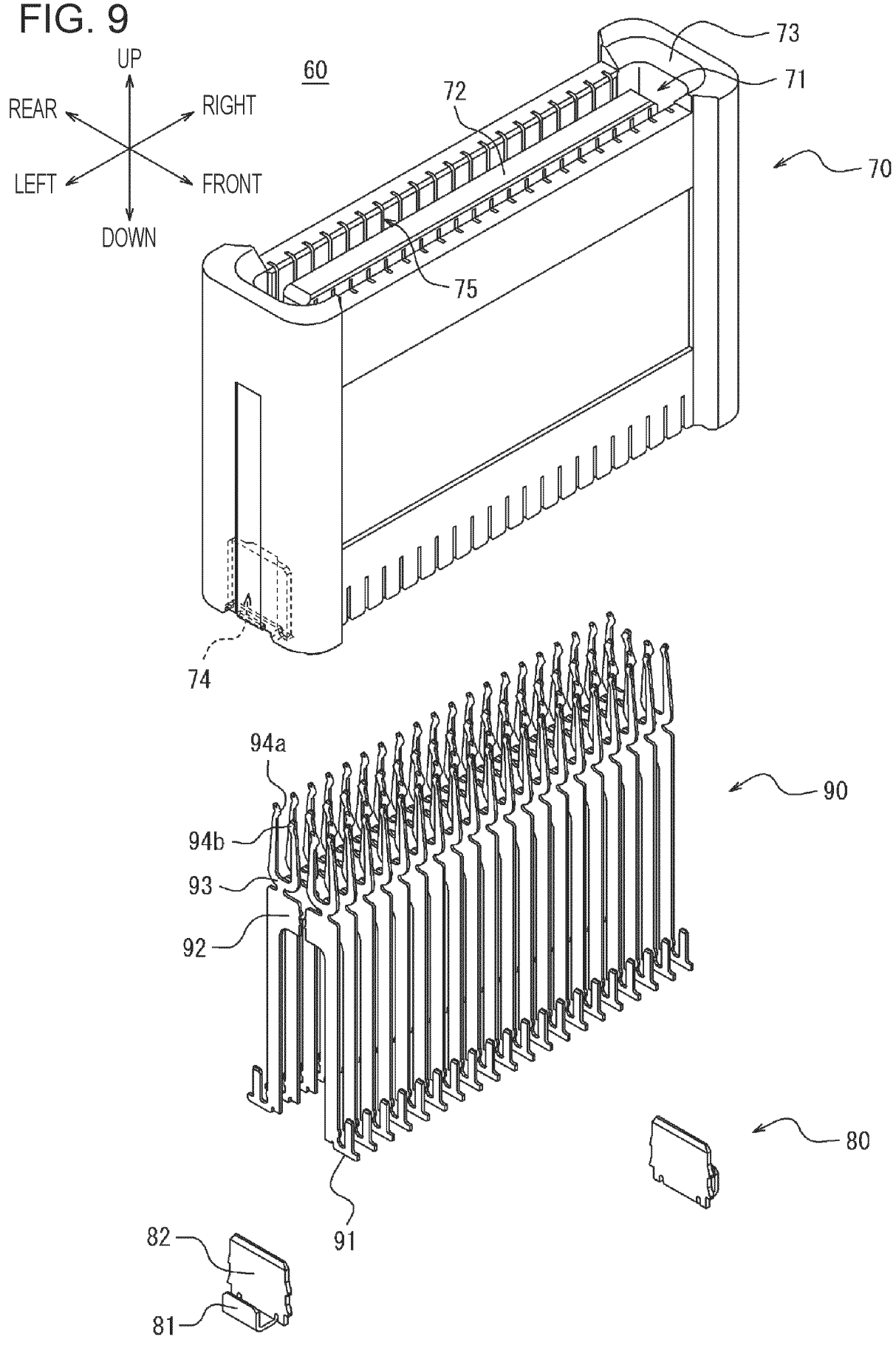

UP
RIGHT
FRONT
DOWN
REAR
LEFT
70
73
71
72
75
60
94b (93)
94a (93)
90
92
74
82
80

FIG. 8

FIG. 9


UP
REAR
RIGHT
LEFT
FRONT
DOWN
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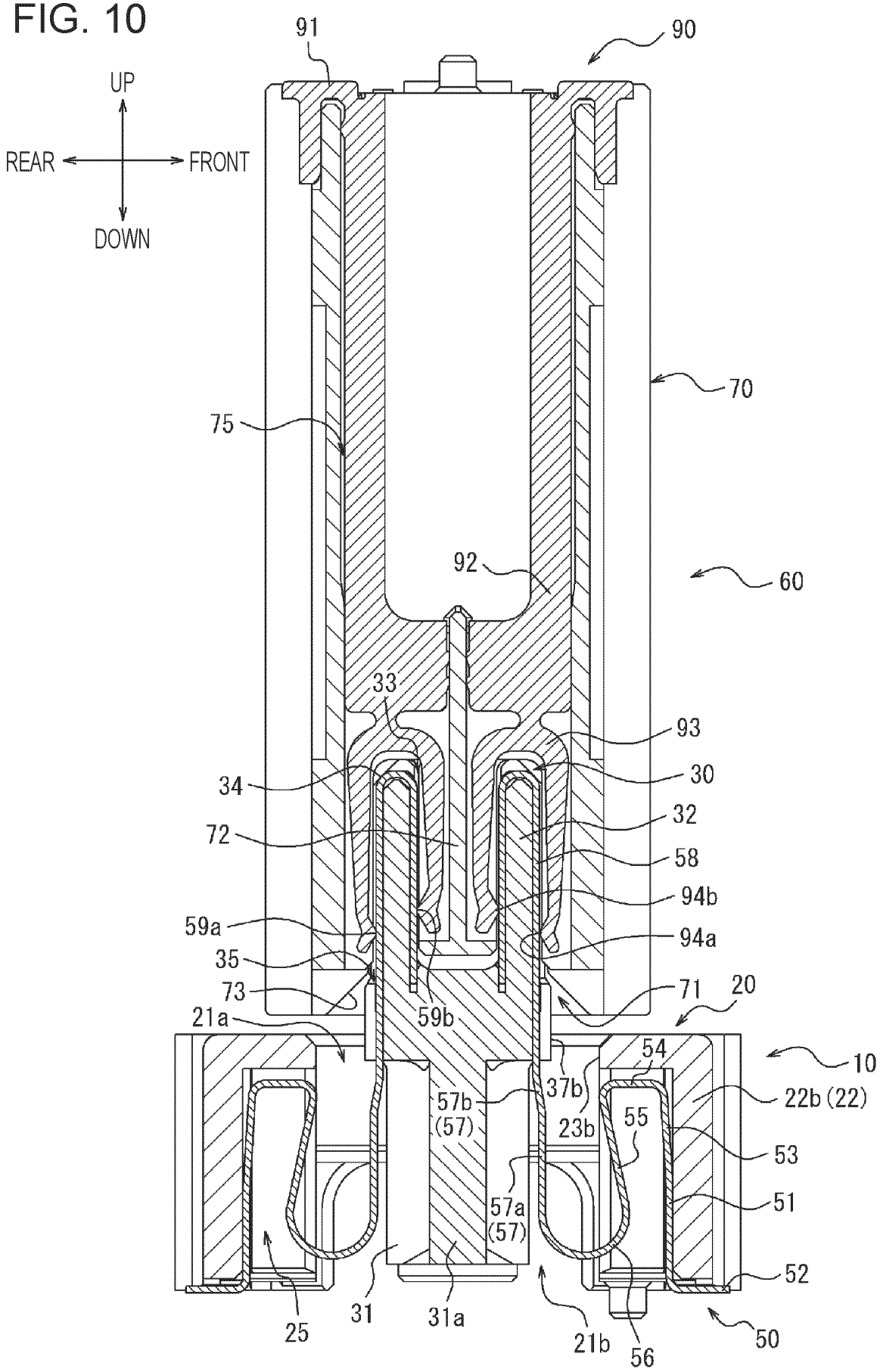
71
72
70
75
74
94a
90
94b
93
92
80
91
82
81

FIG. 10


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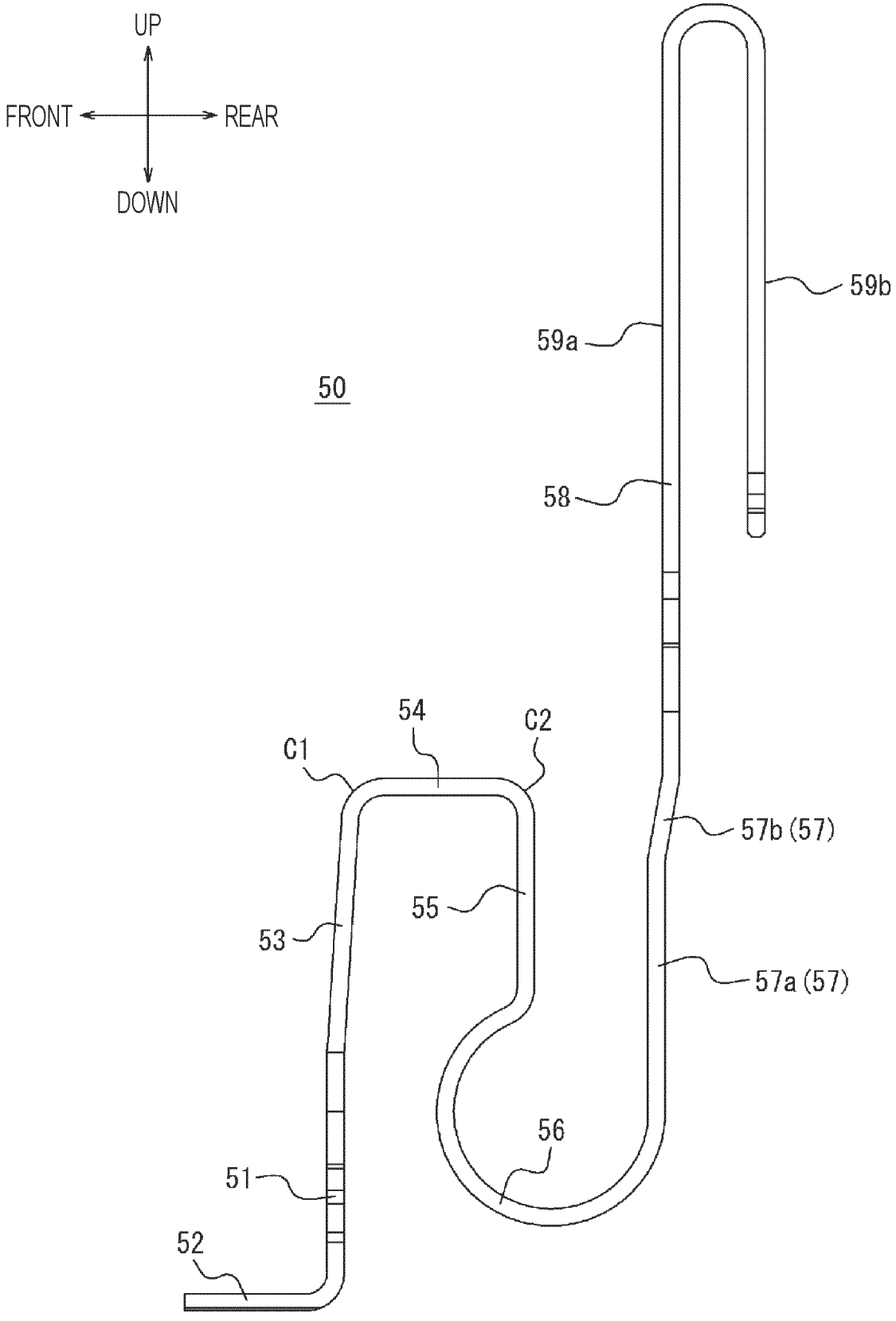
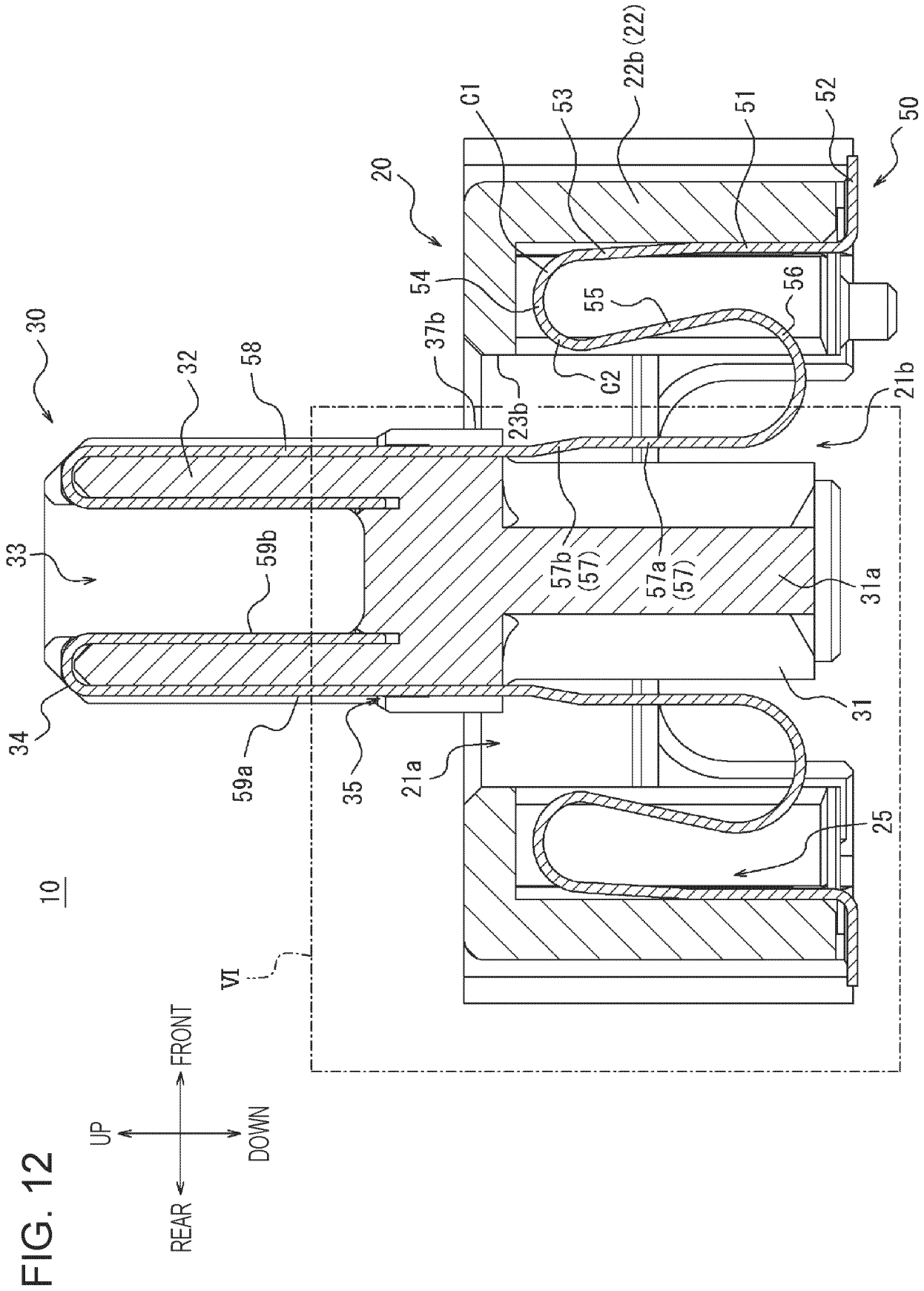
93
34
30
72
32
58
94b
59a
94a
35
73
59b
71
20
21a
54
10
37b
57b
(57)
23b
55
22b (22)
53
51
57a
(57)
52
25
31
31a
21b
56
50

FIG. 11


UP
FRONT
REAR
DOWN
50
59b
59a
58
54
C2
C1
57b (57)
55
53
57a (57)
56
51
52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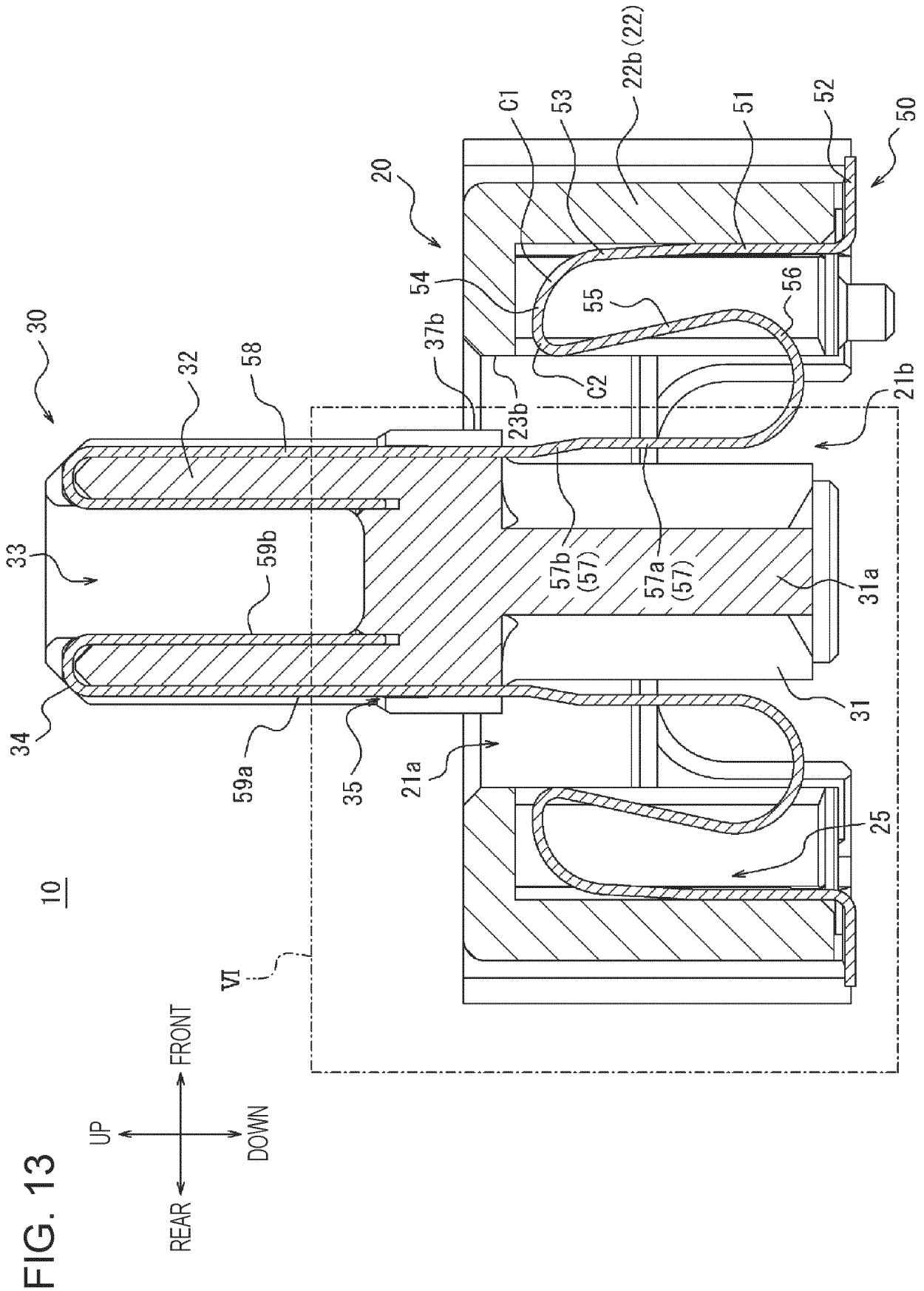
55
56
58
59a
59b
21a
21b
22b (22)
23b
25
31
31a
37b
57a (57)
57b (57)
C1
C2
VI
UP
DOWN
FRONT
REAR

FIG. 12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59a
59b
C1
C2
21a
21b
22b (22)
23b
25
31
31a
37b
57a (57)
57b (57)
VI
UP
DOWN
FRONT
REAR

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/020892

A. CLASSIFICATION OF SUBJECT MATTER

H01R 12/91(2011.01)i; ***H01R 13/631***(2006.01)i
FI: H01R12/91; H01R13/631

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; H01R13/631

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.
A	WO 2019/181462 A1 (KYOCERA CORP) 26 September 2019 (2019-09-26) entire text, all drawings	1-10
A	JP 2019-021389 A (IRISO ELECTRONICS CO LTD) 07 February 2019 (2019-02-07) entire text, all drawings	1-10
A	JP 2020-024878 A (JAPAN AVIATION ELECTRONICS IND LTD) 13 February 2020 (2020-02-13) entire text, all drawings	1-10
A	JP 2018-037151 A (HIROSE ELECTRIC CO LTD) 08 March 2018 (2018-03-08) entire text, all drawings	1-10
A	WO 2021/020152 A1 (KYOCERA CORP) 04 February 2021 (2021-02-04) entire text, all drawings	1-10
A	CN 106299878 A (KUNSHAN FAMFULL ELECTRONICS CO., LTD.) 04 January 2017 (2017-01-04) entire text, all drawings	1-10

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

* Special categories of cited documents:
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"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
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"&" 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 July 2023	**08 August 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.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/020892

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6415609 B2 (IRISO ELECTRONICS CO LTD) 31 October 2018 (2018-10-31) entire text, all drawings	1-10

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/020892

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2019/181462 A1	26 September 2019	JP 2019-169347 A	
JP 2019-021389 A	07 February 2019	US 2019/020134 A1 entire text, all drawings JP 2019-067779 A	
JP 2020-024878 A	13 February 2020	US 2020/052440 A1 entire text, all drawings	
JP 2018-037151 A	08 March 2018	TW 201807902 A entire text, all drawings KR 10-2018-0025188 A CN 107799948 A	
WO 2021/020152 A1	04 February 2021	US 2022/239026 A1 entire text, all drawings EP 4007077 A1 JP 6687790 B1 KR 10-2022-0024967 A CN 114041245 A	
CN 106299878 A	04 January 2017	(Family: none)	
JP 6415609 B2	31 October 2018	US 2018/198234 A1 entire text, all drawings EP 3349309 A1 CN 108306131 A	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2022096897 A **[0001]**
- JP 6415609 B **[0004]**