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

(11) **EP 3 780 286 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.02.2021 Bulletin 2021/07

(21) Application number: **20189751.9**

(22) Date of filing: **06.08.2020**

(51) Int Cl.:
H01R 13/52 *(2006.01)* ***H01R 13/74*** *(2006.01)*
H01R 27/02 *(2006.01)* *H01R 13/424* *(2006.01)*

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

(30) Priority: **16.08.2019 JP 2019149315**

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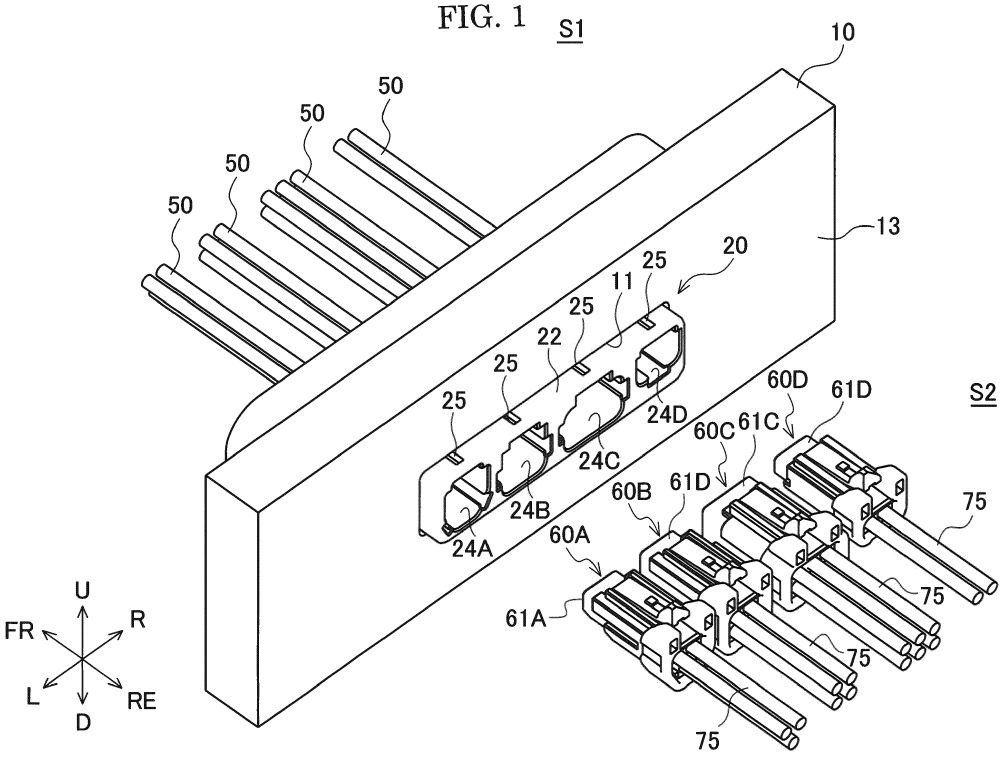
(54) ELECTRIC CONNECTOR

(57) An electric connector is provided with a housing attached to an attachment hole of a panel of a casing. The housing includes a housing main body inserted into the attachment hole of the panel and a flange part extending outward from an outer circumferential face of the housing main body. The housing main body has a plurality of fitting ports into which a plurality of cable connectors is fitted, on an outside of the casing. The flange part has a fixed part fixed to the panel. A first water-proof seal is installed to each of the fitting ports, and seals between a circumferential wall of each of the fitting ports and each of the cable connectors. A second water-proof seal is installed around an outer circumferential face of the housing main body, and seals between the housing main body and the panel.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to an electric connector.

BACKGROUND

[0002] As an electric connector fixed to a panel of a casing, an electric connector having a plurality of fitting ports to and from which cable connectors are connected and disconnected is known (for example, refer to patent literature 1 (JP 2014-107046)). The electric connector disclosed in patent literature 1 includes a housing having a cylindrical housing main body in which fitting ports are formed side by side and a pair of fixed parts protruding from the side face of the housing main body. A panel of the casing has an attachment hole into which a case part is insertable. In a state where the case part is inserted into the attachment hole from an inside of the casing and the case part is protruded from the outer face of the panel, the electric connector is fastened to the inner face of the panel via the pair of fixed parts using screws.

SUMMARY OF THE INVENTION

[0003] By the way, such an electric connector is sometimes attached to a portion where a high water-proof performance is required. Although the above described electric connector does not require to be prepared individually for each cable connector and allows space saving, there is a problem in which infiltration of moisture into the inside of the casing is not sufficiently prevented.

[0004] The present invention is made in the above described view and it is therefore an object of the present invention to provide an electric connector of preventing infiltration of moisture into the inside of the casing and achieving space saving.

[0005] To achieve the object, an electric connector of one aspect of the present invention is an electric connector provided with a housing attached to an attachment hole of a panel of a casing, wherein the housing includes a housing main body inserted into the attachment hole of the panel and a flange part extending outward from an outer circumferential face of the housing main body, the housing main body has a plurality of fitting ports into which a plurality of cable connectors is fitted, on an outside of the casing, and the flange part has a fixed part fixed to the panel, wherein a first water-proof seal is installed to each of the fitting ports, the first water-proof seal seals between a circumferential wall of each of the fitting ports and each of the cable connectors, a second water-proof seal is installed around an outer circumferential face of the housing main body, and the second water-proof seal seals between the housing main body and the panel.

EFFECT OF THE INVENTION

[0006] An electric connector of one aspect of the present invention is fixed to the panel via the flange part in a state where the housing main body is inserted into the attachment hole of the panel and the housing main body is protruded from the panel. Because the plurality of fitting ports is formed in the housing main body on the outside of the casing, it is not required to prepare the connectors for each of the cable connectors, and therefore it becomes possible to decrease a number of installation work and to achieve space saving. Furthermore, the first water-proof seals prevent infiltration of moisture into the inside of the casing through the gaps between the circumferential walls of the fitting ports and the cable connectors. The second water-proof seal prevents filtration of moisture into the inside of the casing through the gap between the housing main body and the panel. Accordingly, it becomes possible to achieve space saving and to attach the electric connector to the panel which requires a high water-proof performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a perspective view showing a receptacle connector and a cable connector in the present embodiment;

FIG. 2 is a disassembled perspective view showing the cable connector in the present embodiment;

FIG. 3 is a disassembled perspective view showing the receptacle connector in the present embodiment;

FIG. 4A is a plan view showing the receptacle connector in the present embodiment;

FIG. 4B is a sectional view taken along the line A-A in FIG. 4A;

FIG. 5A is a perspective view showing a male type terminal in the present embodiment;

FIG. 5B is a perspective view showing the male type terminal in the present embodiment;

FIG. 6 is a partially enlarged view showing a terminal storage space and its periphery in the present embodiment;

FIG. 7 is a view showing an attachment state of the receptacle connector in the present embodiment;

FIG. 8A is a front view showing the receptacle connector attached to a panel in the present embodiment;

FIG. 8B is a sectional view taken along the line B-B in FIG. 8A;

FIG. 9A is a transition diagram of a connection operation of the cable connector in the present embodiment;

FIG. 9B is a transition diagram of the connection operation of the cable connector in the present embodiment;

FIG. 10 is a sectional view showing a water-proof configuration of the receptacle connector in the present embodiment;

FIG. 11 is a perspective view showing another using example of the receptacle connector in the present example;

FIG. 12A is a perspective view showing the receptacle connector in a modified example;

FIG. 12B is a perspective view showing the receptacle connector in the modified example; and

FIG. 13 is a front view showing the receptacle connector in another modified example.

DETAILED DESCRIPTION

[0008] Hereinafter, with reference to the attached drawings, the present embodiment will be described. FIG. 1 is a perspective view showing a receptacle connector and a cable connector in the present embodiment. In the following description, a cable connector side of a panel is defined as a casing outside and an opposite side of the panel is defined as a casing inside. "FR", "RE", "U", "D", "L" and "R", marked in each figure respectively show a front direction, a rear direction, an upper direction, a lower direction, a left direction and a right direction. Hereinafter, an example in which the receptacle connector in the present embodiment is applied to an electric power assist bicycle will be described.

[0009] As shown in FIG. 1, the receptacle connector (an electric connector) 20 is a composite connector attached to a panel 10 of a casing, and a plurality of cable connectors 60A to 60D (a counter connector) extending from an external unit, such as a lamp and a meter of the electric power assist bicycle, is connected to the receptacle connector 20. The panel 10 of the casing has a rectangular attachment hole 11 long in the left-and-right direction. Through the attachment hole 11, a rectangular cylindrical case part (a housing main body) 22 of the receptacle connector 20 is partially protruded from the outer face 13 of the panel 10. The protruded portion of the case part 22 has fitting ports 24A to 24D through which the cable connectors 60A to 60B are fitted into the fitting ports 24A to 24D.

[0010] To the receptacle connector 20, a plurality of cables 50 extending from an electric unit set in the casing inside S1 is connected. By fitting the cable connectors 60A to 60D into the fitting ports 24A to 24D of the receptacle connector 20, the electric unit set in the casing inside S1 is electrically connected to the various external units set in the casing outside S2. In order to prevent misconnection between the connectors, the cable connectors 60A to 60D are formed to have different housing shapes. The fitting ports 24A to 24D of the receptacle connector 20 are formed to have shapes corresponding to the housing shapes of the cable connectors 60A to 60D.

[0011] As described above, by concentrating the cable connectors 60A to 60D extending from the external units in the same portion, the receptacle connector 20 makes it possible to achieve space saving and improve workability of the connection work, compared with a case where the receptacle connectors are provided for each external unit. Because the fitting ports 24A to 24D of the receptacle connector 20 have different opening shapes for each type of the cable connectors 60A to 60D, it becomes possible to prevent misconnection of the connectors. In the present embodiment, the receptacle connector 20 is connected to the electric unit via the cables 50, but the receptacle connector 20 may be connected to a circuit board via a L-shaped terminal or the like.

[0012] Additionally, because various electric components are stored in the casing inside S1, a high water-proof performance is required for the attachment portion of the receptacle connector 20 to the panel 10 of the casing. Then, the receptacle connector 20 of the present embodiment includes first water-proof seals 40A to 40D which prevent infiltration of moisture into the casing inside S along the inner faces of the fitting ports 24A to 24D and a second water-proof seal 45 which prevents infiltration of moisture into the casing inside S1 along the outer face of the case part 22 (refer to FIG. 3). Furthermore, the cable connectors 60A to 60D include third water-proof seals which prevent infiltration of moisture into the casing inside S1 along the outer faces of the cables 75 (FIG. 2 shows only the third water-proof seal 70B).

[0013] Hereinafter, configurations of the cable connector and the receptacle connector will be described in detail. FIG. 2 is a disassembled perspective view showing the cable connector in the present embodiment. FIG. 3 is a disassembled perspective view showing the receptacle connector in the present embodiment. FIG. 4A is a plan view showing the receptacle connector in the present embodiment, and FIG. 4B is a sectional view taken along the line A-A in FIG. 4A. FIG. 5A and FIG. 5B are perspective views showing a male type terminal in the present embodiment. FIG. 6 is an enlarged view partially showing a terminal storage space and its periphery in the present embodiment. FIG. 7 is a view showing an attachment state of the receptacle connector in the present embodiment. FIG. 8A is a front view showing the receptacle connector attached to the panel in the present

embodiment, and FIG. 8B is a sectional view taken along the line B-B in FIG. 8A.

[0014] As shown in FIG. 2, the cable connector 60B is a signal cable connector, and includes an approximately rectangular cylindrical housing 61B extending in the front-and-rear direction. In the front end portion of the housing 61B, a plurality of terminal insertion ports (not shown) is formed, and in the rear end portion of the housing 61B, a rectangular opening 62 is formed. Inside the housing 61B, a female type terminal 76 connected to each cable 75 is stored through the opening 62. The female type terminals 76 are stored in the front end portion of the inside of the housing 61B. The front end face of each female type terminal 76 is exposed to an outside through the terminal insertion port of the housing 61B.

[0015] To the opening 62 of the housing 61B, the third water-proof seal 70B which seals between the housing 61B and the cables 75 is installed. The third water-proof seal 70B is made of elastic material, such as silicone rubber, formed into an approximately parallelepiped shape, and formed with a plurality of installation holes 71 along the front-and-rear direction into which the cables 75 are insertable tightly. The outer circumferential face of the third water-proof seal 70B comes into contact with the inner circumferential face of the housing 61B. Around the outer circumferential face of the third water-proof seal 70B, a plurality of annular projections 72 each having a mountain-like sectional shape is formed. By installing the third water-proof seal 70B to the opening 62 of the housing 61B, the plurality of annular projections 72 is slightly crushed to bring the third water-proof seal 70B into pressure-contact with the housing 61B.

[0016] On the upper face of the housing 61B, a lock mechanism 63 is provided, and the lock mechanism 63 keeps the fitting state of the housing 61B of the cable connector 60B into the fitting port 24B of the receptacle connector 20 (refer to FIG. 3). The lock mechanism 63 has an arm part 64 extending rearward from the front side end portion of the housing 61B as a fixed end portion, a lock part 65 formed in a middle of the arm part 64 in its extending direction, and an operation part 66 provided in the free end portion of the arm part 64. When the housing 61B is fitted into the fitting port 24B, the lock part 65 is engaged with a lock hole 25 (refer to FIG. 1) described later, and the fitting state is kept. When the operation part 66 is pushed under the fitting state, the arm part 64 is pushed downward to disengage the lock part 65 from the lock hole 25 and then to release the fitting state.

[0017] On the upper face of the housing 61B, a pair of left and right protection parts 67 to protect the lock mechanism 63 is provided. The pair of left and right protection parts 67 prevents the arm part 64 from being deformed when an operator's hand or an article touches the operation part 66, and also prevents the lock mechanism 63 from being inoperable by inserting of the cable 75 and the like between the lock mechanism 63 and the housing 61B. Here, although the four-wire cable connector 60B has been described as an example, a three-wire, a six-wire and a two-wire cable connectors 60A, 60B and 60C have the same basic configuration as the above example. Then, the descriptions of the three-wire, six-wire and two-wire cable connectors 60A, 60B and 60C are omitted.

[0018] As shown in FIG. 3, FIG. 4A and FIG. 4B, the receptacle connector 20 includes a resin housing 21 attached to the panel 10 (refer to FIG. 1) of the casing. The housing 21 has the case part 22 inserted into the attachment hole 11 of the panel 10 and a flange part 23 extending outwardly in the radial direction from the front end side outer circumferential face of the case part 22. The case part 22 is formed into an approximately rectangular cylindrical shape extending in the front-and-rear direction and having a wide width in the left-and-right direction. In the upper wall of the case part 22, a plurality of the lock holes 25 communicating with the fitting ports 24A to 24D is formed. With the lock holes 25, the lock parts 65 (refer to FIG. 3) of the cable connectors 60A to 60D are engaged.

[0019] In the rear end portion of the case part 22, the fitting ports 24A to 24D having different opening shapes are formed side by side in the left-and-right direction. The fitting ports 24A to 24D extend from the rear end of the case part 22 to the center portion of the case part 22 in the front-and-rear direction. The fitting ports 24A to 24D are formed to have different opening shapes corresponding to the number of poles (the number of connection line of the cable 50). For example, the fitting ports 24A to 24D are formed to have the opening shapes corresponding to the number of poles "three-wire", "four-wire", "six-wire" and "two-wire" respectively. The cable connectors 60A to 60D (refer to FIG. 1) are formed to have housing shapes corresponding to the opening shapes of the fitting ports 24A to 24D respectively.

[0020] On the back faces of the fitting ports 24A to 24D, the first water-proof seals 40A to 40D are installed. The first water-proof seals 40A to 40D seal between the circumferential walls 28 of the fitting ports 24A to 24D and the cable connectors 60A to 60D (refer to FIG. 1). The first water-proof seals 40A to 40D are made of elastic material, such as silicon rubber, and formed into annular shapes corresponding to the opening shapes of the fitting ports 24A to 24D, respectively. The first water-proof seals 40A to 40D each has a plurality of engagement pieces 41. By pushing the first water-proof seals 40A to 40D on the inner bottom face of the case part 22, the engagement pieces 41 are inserted into the engagement holes 27 formed in the circumferential wall 28 of the case part 22, and the first water-proof seals 40A to 40D installed to the insides of the fitting ports 24A to 24D are prevented from being removed.

[0021] Around the outer circumferential face of the case part 22, the second water-proof seal 45 is installed. The second water-proof seal 45 seals between the housing 21 and the panel 10. The second water-proof seal 45 is formed into an annular shape. The second water-proof seal 45 is pushed in the front end portion of the case part 22 such that the front end portion of the second water-

proof seal 45 is fitted into an annular groove 33 of the flange part 23. Thereby, the second water-proof seal 45 is positioned to the casing inside S1 (refer to FIG. 1) in a state where the receptacle connector 20 is attached to the panel 10. In the casing inside S1, a gear or the like is stored in addition to the electric unit, and the gear is applied with grease as lubricant. Thereby, the second water-proof seal 45 is made of elastic material having excellent oil resistant property.

[0022] Around the outer circumferential face of the second water-proof seal 45, a plurality of annular projections 46 having a mountain-like sectional shape is formed. Around the inner circumferential face of the second water-proof seal 45, a plurality of annular projections 47 having a mountain-like sectional shape is formed. The annular projection 46 on the outer circumferential side has a protruding height higher than the annular projection 47 on the inner circumferential side, and the annular projection 46 on the outer circumferential side has a larger crushed amount. By installing the second water-proof seal 45 around the outer circumferential face of the case part 22, the annular projection 47 on the inner circumferential side is crushed to bring the second water-proof seal 45 into pressure-contact with the case part 22. Furthermore, by inserting the second water-proof seal 45 into the storage recess 15 (refer to FIG. 7) of the panel 10, the annular projection 46 on the outer circumferential side is crushed to bring the second water-proof seal 45 into pressure-contact with the storage recess 15 of the panel 10.

[0023] In both the left and right end portions of the flange part 23, a pair of fixed parts 31 is formed so as to fix the receptacle connector 20 to the panel 10. The fixed part 31 has an insertion hole 32 for screwing. The outer circumferential face of the flange part 23 is formed asymmetrically in the upper-and-lower direction so as to prevent the receptacle connector 20 from being installed upside down. In the flange part 23, the annular groove 33 is formed so as to surround the case part 22. The annular groove 33 has the substantially same groove width as the thickness of the front end portion of the second water-proof seal 45. By inserting the front end portion of the second water-proof seal 45 into the annular groove 33, a seal performance between the flange part 23 and the second water-proof seal 45 is improved.

[0024] In the front end portion of the case part 22, a plurality of terminal storage spaces 34 in which the male type terminals 51 connected to the cables 50 are stored is formed. The terminal storage space 34 is formed for each of the fitting ports 24A to 24D by the number of the connection wire of the corresponding cable 50. The terminal storage spaces 34 extend from the front end of the case part 22 to the fitting ports 24A to 24D. The terminal storage spaces 34 are communicated with the fitting ports 24A to 24D. When the male type terminals 51 are stored in the corresponding terminal storage spaces 34 from the front end side of the case part 22, the pin-like contacts 55 of the male type terminals 51 are protruded from the back faces of the fitting ports 24A to 24D.

[0025] As shown in FIG. 5A and FIG. 5B, the male type terminal 51 is made of electric conductive material, such as copper alloy, and formed by a cylindrical outer layer caulking part 52, a cylindrical core wire caulking part 53, a box-shaped middle part 54 and the pin-like contact 55 which are connected in the order from the base end side to the tip end side. The outer layer of the cable 50 is caulked by the outer layer caulking part 52, the core wire protruding from the outer layer of the cable 50 is caulked by the core wire caulking part 53, and then the male type terminal 51 is connected to the cable 50 (refer to FIG. 4B). The middle part 54 is a portion stored in the terminal storage space 34 (refer to FIG. 4B) of the case part 22, and on one side face of the middle part 54, a lance hole 56 engaged with a lance 35 described later is formed.

[0026] As shown in FIG. 6, on the inner wall of the terminal storage space 34 of the case part 22, the lance 35 with which the male type terminal 51 is engaged is provided. The lance 35 is inclined so as to be separated from the inner wall of the terminal storage space 34 in the insertion direction I1 of the male type terminal 51. When the male type terminal 51 is inserted into the terminal storage space 34, the lance 35 is pushed in, and then the male type terminal 51 is inserted to a predetermined position. When the male type terminal 51 is positioned to the predetermined position, the lance 35 is elastically returned and then the tip end portion of the lance 35 is inserted in the lance hole 56 (refer to FIG. 5A) of the male type terminal 51. Then, the male type terminal 51 is fixed to the terminal storage space 34, and the cable 50 is prevented from being removed from the receptacle connector 20.

[0027] Because the male type terminal 51 is installed to the receptacle connector 20 via the lance 35, the prevention of the removal of the male type terminal 51 by the lance 35 can be released by using a specific tool. Thereby, even if the male type terminal 51 is incorrectly inserted into the terminal storage space 34 of the receptacle connector 20, the prevention of the removal of the male type terminal 51 by the lance 35 can be released by using the specific tool, and it becomes possible to remove the male type terminal 51 from the receptacle connector 20 easily. In the above manner, because the male type terminal 51 connected to the cable 50 is directly installed to the receptacle connector 20, it becomes possible to make the connector configuration of the receptacle connector 20 simple and decrease the cost.

[0028] As shown in FIG. 7, FIG. 8A and FIG. 8B, the receptacle connector 20 is fixed to the panel 10 with a pair of bolts 39. The panel 10 has an annular protruded part 14. The annular protruded part 14 is protruded from the inner face 12 of the panel 10 to the casing inside S1 so as to surround the attachment hole 11. Inside the annular protruded part 14, the storage recess 15 in which the receptacle connector 20 is stored is formed. The storage recess 15 is formed to be front and rear two steps by a front step recess 16 in which the flange part 23 of

the housing 21 is storable and a rear step recess 17 in which the second water-proof seal 45 installed to the case part 22 of the housing 21 is storable.

[0029] In the front step recess 16 of the storage recess 15, the positioned flange part 23 of the housing 21 is stored. In detail, the inner circumferential face of the front step recess 16 is formed asymmetrically in the upper-and-lower direction corresponding to the upper-and-lower asymmetric outer circumferential face of the flange part 23. Thereby, the flange part 23 is prevented from being stored in the front step recess 16 upside down, and it becomes possible to attach the receptacle connector 20 to the panel 10 in the correct orientation. On the bottom face of the front step recess 16, a pair of screw holes 18 is formed at a position corresponding to the pair of insertion holes 32 of the flange part 23 in a state where the flange part 23 is stored to the front step recess 16.

[0030] In the rear step recess 17 of the storage recess 15, the second water-proof seal 45 installed to the case part 22 is tightly stored. On the bottom face of the rear step recess 17, the attachment hole 11 into which the case part 22 exposed from the second water-proof seal 45 is inserted is formed. When the receptacle connector 20 is attached to the panel 10, the case part 22 is inserted into the attachment hole 11, the second water-proof seal 45 is stored in the rear step recess 17 and the flange part 23 is stored in the front step recess 16. Then, the pair of bolts 39 is screwed to the pair of screw holes 18 through the pair of insertion holes 32 of the flange part 23, and then the receptacle connector 20 is attached to the panel 10.

[0031] Next, with reference to FIG. 9A. FIG. 9B and FIG. 10, an installation operation of the cable connector to the receptacle connector and a water-proof configuration of the receptacle connector will be described. FIG. 9A and FIG. 9B are transition diagrams showing the installation operation of the cable connector of the present embodiment. FIG. 10 is a sectional view showing the water-proof configuration of the receptacle connector of the present embodiment. Here, the four-wire cable connector will be described as an example, and the three-wire, six-wire and two-wire cable connectors have the same configuration as the above example.

[0032] As shown in FIG. 9A, the receptacle connector 20 is attached to the panel 10 with the case part 22 protruding from the outer face 13 of the panel 10. On the back face of the fitting port 24B of the case part 22, the first water-proof seal 40B is installed. Around the outer circumferential face of the case part 22, the second water-proof seal 45 is installed. The annular projection 46 on the outer circumferential side of the second water-proof seal 45 is crushed by the inner circumferential face of the storage recess 15, and the annular projection 47 (refer to FIG. 3) on the inner circumferential side of the second water-proof seal 45 is crushed by the outer circumferential face of the case part 22. The second water-proof seal 45 seals between the storage recess 15 of the panel 10 and the case part 22.

[0033] In the cable connector 60B, the third water-proof seal 70B is installed to the opening 62 in the rear end portion of the housing 61B. Into the installation hole 71 (refer to FIG. 2) of the third water-proof seal 70B, the cable 75 is tightly inserted. The annular projection 72 on the outer circumferential side of the third water-proof seal 70B is crushed by the inner circumferential face of the housing 61B. The third water-proof seal 70B seals the rear end portion of the housing 61B of the cable connector 60B. Then, the cable connector 60B is placed to face the opening of the fitting port 24B of the receptacle connector 20, and then the cable connector 60B is pushed in the fitting port 24B in the insertion direction 12.

[0034] As shown in FIG. 9B, when the housing 61B is inserted into the fitting port 24B, the arm part 64 of the lock mechanism 63 on the upper face of the housing 61B is pushed downward, and the housing 61B is displaced in the insertion direction 12. When the housing 61B comes into contact with the back face of the fitting port 24B, the arm part 64 is elastically returned, the lock part 65 is inserted into the lock hole 25 of the case part 22, and the fitting state of the housing 61B into the fitting port 24B is kept. At this time, the front end portion of the housing 61B enters the inside of the first water-proof seal 40B, and the first water-proof seal 40B seals between the circumferential wall 28 of the fitting port 24B and the housing 61B.

[0035] As shown in FIG. 10, a slight gap is formed between the panel 10 and the receptacle connector 20, and a slight gap is formed between the receptacle connector 20 and the cable connector 60B. Then, in the portion where the receptacle connector 20 is attached, a moisture infiltration path from the casing outside S2 to the casing inside S1 exists. For example, the moisture infiltration path contains a first infiltration path L1 along which moisture infiltrated from the lock hole 25 or the others of the case part 22 flows to the casing inside S1, a second infiltration path L2 along which moisture infiltrated through the gap between the case part 22 and the panel 10 flows to the casing inside S1, and a third infiltration path L3 along which moisture flows to the casing inside S1 through the cable 75 of the cable connector 60B.

[0036] However, on a middle of the first infiltration path L1, the first water-proof seal 40B is disposed. The first water-proof seal 40B seals between the circumferential wall 28 of the fitting port 24B and the housing 61B. On a middle of the second infiltration path L2, the second water-proof seal 45 is disposed. The second water-proof seal 45 seals between the case part 22 and the storage recess 15 of the panel 10. On a middle of the third infiltration path L3, the third water-proof seal 70B is disposed. The third water-proof seal 70B seals between the housing 61B and the cable 75. In the above configuration, all of the first to third infiltration paths L1 to L3 from the casing outside S2 to the casing inside S1 are blocked to improve a water-proof performance of the casing inside S1.

[0037] Furthermore, the case part 22 of the receptacle connector 20 is partially protruded from the outer face 13

of the panel 10, and separates the operation part 66 of the cable connector 60B from the outer face 13 of the panel 10. By separating the operation part 66 from the outer face 13 of the panel 10, it becomes possible to operate the operation part 66 easily by the operator's finger and to improve the operation performance of the operation part 66. Additionally, on the upper face of the case part 22, the plurality of lock holes 25 is formed for each of the fitting ports 24A to 24D (refer to FIG. 1). Thereby, the operation parts 66 can be operated from the same upper side for the cable connectors 60A to 60D fitted into the fitting ports 24A to 24D, and the operation performance of the operation part 66 by the operator can be further improved.

[0038] With reference to FIG. 11, another using example of the receptacle connector in the present embodiment will be described. FIG. 11 is a perspective view showing the another using example of the receptacle connector in the present embodiment.

[0039] The above described embodiment describes an example where the cable connectors 60A to 60D having different numbers of pole are installed to all of the fitting ports 24A to 24D of the receptacle connector 20, but the using example of the receptacle connector is not limited to the above example. The receptacle connector 20 of the present embodiment can be variously applied depending on requirement of the user. For example, as shown by the other using example in FIG. 11, only three of the fitting ports 24A, 24B and 24D among the four fitting ports 24A to 24D (refer to FIG. 1) may be used, and the three-wire cable connector 60A and the four-wire cable connector 60B may be used as the two-wire cable connector.

[0040] In this case, into the unused fitting port 24C of the receptacle connector 20, a cable connector shaped cap 80 is fitted. The cap 80 has the same outer shape as the housing 61C (refer to FIG. 1) of the cable connector 60C only except that an inner space is not formed. In place of the housing 61C of the cable connector 60C, the cap 80 is fitted into the unused fitting port 24C, and therefore, the first water-proof seal 40C (refer to FIG. 3) seals between the fitting port 24C and the cap 80. Thereby, it becomes possible to prevent infiltration of moisture through the unused fitting port 24C into the casing inside S1.

[0041] In the three-wire cable connector 60A, the cables 75 are inserted into the two installation holes 71 among the three installation holes 71 of the third water-proof seal 70A while a water-proof rod 81 is inserted into the remaining one installation hole 71 tightly. In the four-wire cable connector 60B, the cables 75 are inserted into the two installation holes 71 among the four installation holes 71 while the water-proof rods 81 are inserted into the remaining two installation holes 71 tightly. By the third water-proof seals 70A and 70B into which the water-proof rods 81 are inserted, it becomes possible to use the three-wire cable connector 60A and the four-wire cable connector 60B as a two-wire cable connector.

[0042] As described above, according to the present embodiment, because the plurality of fitting ports 24A to 24D is formed on the casing outside S2 of the case part 22, it is not required to prepare the connectors for each of the cable connectors 60A to 60D, and therefore it becomes possible to decrease a number of installation work and to achieve space saving. Additionally, the first water-proof seals 40A to 40D prevent infiltration of moisture into the casing inside S1 through the gaps between the circumferential walls 28 of the fitting ports 24A to 24D and the cable connectors 60A to 60D. The second water-proof seal 45 prevents filtration of moisture into the casing inside S1 through the gap between the case part 22 and the panel 10. Furthermore, the third water-proof seals 70A to 70D prevent infiltration of the moisture into the casing inside S1 through the cables 75 of the cable connectors 60A to 60D. Accordingly, it becomes possible to achieve space saving and to attach the receptacle connector 20 to the panel 10 which requires a high water-proof performance.

[0043] The present embodiment describes the receptacle connector 20 having the case part 22 in which the fitting ports 24A to 24D are formed side by side in a row and attached to the panel 10 from the casing inside S1, but is not limited the above configuration. As shown by a modified example in FIG. 12A and FIG. 12B, the receptacle connector 95 may have the case part 96 in which the fitting ports 98A to 98D are formed side by side in upper and lower two rows, and may be attached to the panel 90 from the casing outside S2. Into the fitting ports 98A to 98D of the case part 96, the first water-proof seals 101A to 101D are installed. Around the outer circumferential face of the case part 96, the second water-proof seal 102 is installed.

[0044] The flange part 97 is provided in the rear end portion of the case part 96, and the annular protruded part 92 is formed on the outer face 94 of the panel 90 so as to surround the attachment hole 91. On the face of the annular protruded part 92, the pair of screw holes 93 is formed. A pair of bolts 100 is screwed to the pair of screw holes 93 through the pair of insertion holes 99 of the flange part 97, and then the receptacle connector 95 is attached to the panel 90. When the receptacle connector 95 is attached to the panel 90, the cable connectors 103A to 103D are installed to the fitting ports 98A to 98D of the receptacle connector 95.

[0045] The present embodiment describes the signal cable connector as a plurality of cable connector, but the plurality of cable connector may include a signal cable connector and a power cable connector. For example, as shown by a modified example in FIG. 13, the case part 106 of the receptacle connector 105 may have a plurality of approximately rectangular fitting ports 107A to 107D for a plurality of the signal cable connectors and an approximately circular fitting port 108 for the power cable connector. Thereby, it becomes possible to integrate the receptacle connector for the signal cable connector and the receptacle connector for the power cable

connector together and to decrease the cost by decreasing the number of members and the number of work process.

[0046] The present embodiment describes an example where the receptacle connector is used for the electric power assist bicycle, but the receptacle connector may be used for a vehicle such as an electric power scooter and an electric power wheelchair, an apparatus requiring a water-proof performance and the like.

[0047] In the present embodiment, the fitting ports of the receptacle connector are formed to have different opening shapes, but the fitting ports of the receptacle connector may be formed to have the same opening shape.

[0048] In the present embodiment, the second water-proof seal is made of elastic material having oil resistant property, but in a case where the receptacle connector is attached to an apparatus which does not use lubricant, such as grease, the second water-proof seal may be made of elastic material, such as silicon rubber.

[0049] In the present embodiment, the outer circumferential face of the flange part is formed asymmetrically in the upper-and-lower direction, but the outer circumferential face of the flange part may be formed rotationally asymmetrically. For example, the outer circumferential face of the flange part may be formed asymmetrically in the left-and-right direction.

[0050] In the present embodiment, the case part is protruded from the outer face of the panel, but the case part may not be protruded from the outer face of the panel. The case part may be formed to expose the plurality of fitting ports from the outer face of the panel so as to be connected to the cable connectors.

[0051] In the present embodiment, the flange part extends outwardly in the radial direction from all the outer circumferential face of the case part, but the flange part may extend outwardly in the radial direction from at least a part of the outer circumferential face of the case part.

[0052] As described above, the electric connector (the receptacle connector) of the present embodiment is an electric connector provided with a housing (21) attached to an attachment hole (11) of a panel (10) of a casing, wherein the housing includes a housing main body (the case part 22) inserted into the attachment hole of the panel and a flange part (23) extending outward from an outer circumferential face of the housing main body, the housing main body has a plurality of fitting ports (24A to 24D) into which a plurality of cable connectors (60A to 60D) is fitted, on an outside (S2) of the casing, and the flange part has a fixed part (31) fixed to the panel, wherein a first water-proof seal (40A to 40D) is installed to each of the fitting ports, the first water-proof seal seals between a circumferential wall (28) of each of the fitting ports and each of the cable connectors, a second water-proof seal (45) is installed around an outer circumferential face of the housing main body, and the second water-proof seal seals between the housing main body and the panel. According to the configuration, the electric connector is fixed to the panel via the flange part in a state where the housing main body is inserted into the attachment hole of the panel and the housing main body is protruded from the panel. Because the plurality of fitting ports is formed in the housing main body on the outside of the casing, it is not required to prepare the connectors for each of the cable connectors, and therefore it becomes possible to decrease a number of installation work and to achieve space saving. Additionally, the first water-proof seals prevent infiltration of moisture into the casing inside through the gaps between the circumferential walls of the fitting ports and the cable connectors. The second water-proof seal prevents filtration of moisture into the casing inside through the gap between the housing main body and the panel. Accordingly, it becomes possible to achieve space saving and to attach the electric connector to the panel which requires a high water-proof performance.

[0053] In the electric connector of the present embodiment, the fitting ports are formed to have different opening shapes. According to the configuration, it becomes possible to prevent the plurality of cable connectors from being incorrectly connected to the plurality of fitting ports.

[0054] In the electric connector of the present embodiment, the housing main body has a terminal storage recess (34) in which a terminal (the male type connector 51) connected to a cable is stored, on an inside (S1) of the casing, and a lance (35) to prevent removing of the terminal is formed on an inner wall of the terminal storage recess. According to the configuration, even if the terminal is incorrectly inserted into the terminal storage space, the prevention of the removal of the terminal by the lance can be released by using a specific tool so that the terminal can be easily removed from the electric connector. Accordingly, because the terminal is directly installed to the electric connector, it becomes possible to make the connector configuration of the electric connector simple and decrease the cost.

[0055] In the electric connector of the present embodiment, an outer circumferential face of the flange part is formed rotationally asymmetrically, and the panel has a storage recess (15) in which the flange part is stored with being positioned. According to the configuration, the flange part is stored in the storage recess of the panel in a predetermined orientation so that it becomes possible to install the electric connecter with a correct orientation.

[0056] In the electric connector of the present embodiment, the housing main body has a plurality of lock holes (25) communicated with the plurality of fitting ports, the cable connectors each has a lock part (65) engaged with each of the lock holes and an operation part (66) to be operated so as to disengage each of the lock parts from each of the lock holes, and the housing main body is protruded from an outer face of the panel so as to separate the operation part of the cable connector from the outer face of the panel. According to the configuration, by separating the operation part of the cable connector from the outer face of the panel, it becomes possible to operate the operation part easily by the operator's fingers

or the like and to improve the operation performance of the operation part.

[0057] In the electric connector of the present embodiment, the fitting ports are aligned side by side in a long side direction of the housing main body, and the lock holes are formed on one end face in a short side direction of the housing main body. According to the configuration, because the operation parts can be operated from the same side for the cable connectors fitted into the respective fitting ports, it becomes possible to heighten the operation performance of the operation part.

[0058] In the electric connector of the present embodiment, a cable connector shaped cap (80) is fitted into an unused fitting port among the fitting ports. According to the configuration, the first water-proof seal seals the gap between the unused fitting port and the cable connector shaped cap so that infiltration of moisture from the unused fitting port to the inner face of the panel can be prevented.

[0059] In the electric connector of the present embodiment, the cable connectors contain a signal cable connector and a power cable connector, and the fitting ports contain a fitting port (107A to 107D) for the signal cable connector and a fitting port (108) for the power cable connector. According to the configuration, it becomes possible to integrate the electric connector for the signal cable connector and the electric connector for the power cable connector together and to decrease the cost by decreasing the number of member and the number of work process.

[0060] Although the present embodiment has been explained, as another embodiment, the above embodiment and the modified examples may be combined as a whole or partially.

[0061] The technique of the present invention is not limited to the above described embodiments, and may be modified, substituted or deformed in various ways without departing from the sprit of the technical idea. Furthermore, if the technical idea can be realized in another way by development of technology and another derived technology, it may be carried out by using the way. Accordingly, the claims cover all embodiments that may be included within the scope of the technical idea.

Claims

1. An electric connector provided with a housing attached to an attachment hole of a panel of a casing, wherein
   the housing includes a housing main body inserted into the attachment hole of the panel and a flange part extending outward from an outer circumferential face of the housing main body,
   the housing main body has a plurality of fitting ports into which a plurality of cable connectors is fitted, on an outside of the casing, and
   the flange part has a fixed part fixed to the panel, wherein
   a first water-proof seal is installed to each of the fitting ports,
   the first water-proof seal seals between a circumferential wall of each of the fitting ports and each of the cable connectors,
   a second water-proof seal is installed around an outer circumferential face of the housing main body, and
   the second water-proof seal seals between the housing main body and the panel.

2. The electric connector according to claim 1, wherein the fitting ports are formed to have different opening shapes.

3. The electric connector according to claim 1, wherein the housing main body has a terminal storage recess in which a terminal connected to a cable is stored, on an inside of the casing, and
   a lance to prevent removing of the terminal is formed on an inner wall of the terminal storage recess.

4. The electric connector according to claim 1, wherein an outer circumferential face of the flange part is formed rotationally asymmetrically, and
   the panel has a storage recess in which the flange part is stored with being positioned.

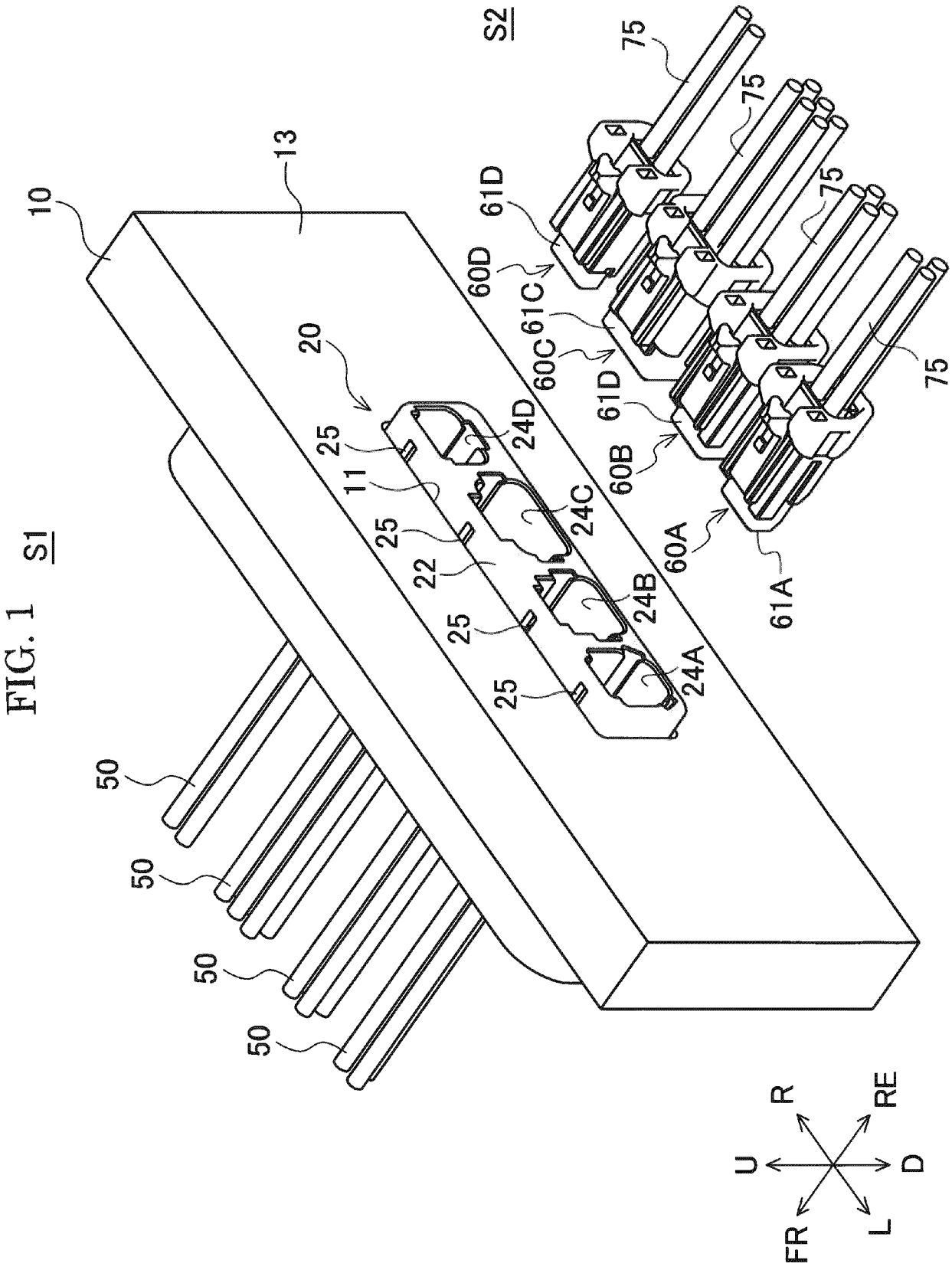
5. The electric connector according to claim 1, wherein the housing main body has a plurality of lock holes communicated with the plurality of fitting ports,
   the cable connectors each has a lock part engaged with each of the lock holes and an operation part to be operated so as to disengage each of the lock parts from each of the lock holes, and
   the housing main body is protruded from an outer face of the panel so as to separate the operation part of the cable connector from the outer face of the panel.

6. The electric connector according to claim 5, wherein the fitting ports are aligned side by side in a long side direction of the housing main body, and
   the lock holes are formed on one end face in a short side direction of the housing main body.

7. The electric connector according to claim 1, wherein a cable connector shaped cap is fitted into an unused fitting port among the fitting ports.

8. The electric connector according to claim 1, wherein the cable connectors contain a signal cable connector and a power cable connector, and
   the fitting ports contain a fitting port for the signal cable connector and a fitting port for the power cable connector.

FIG. 1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S2
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FIG. 2

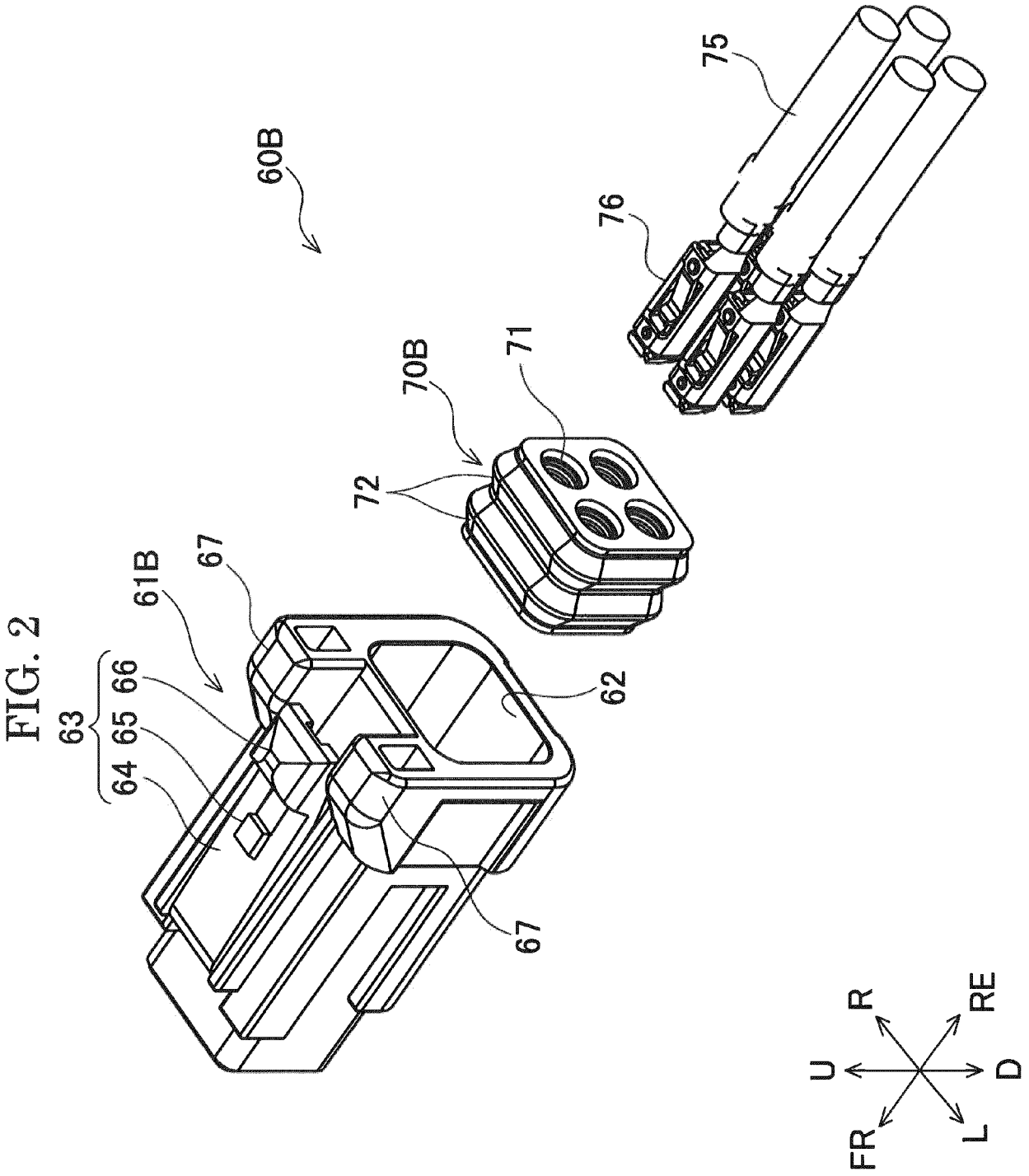

FIG. 3

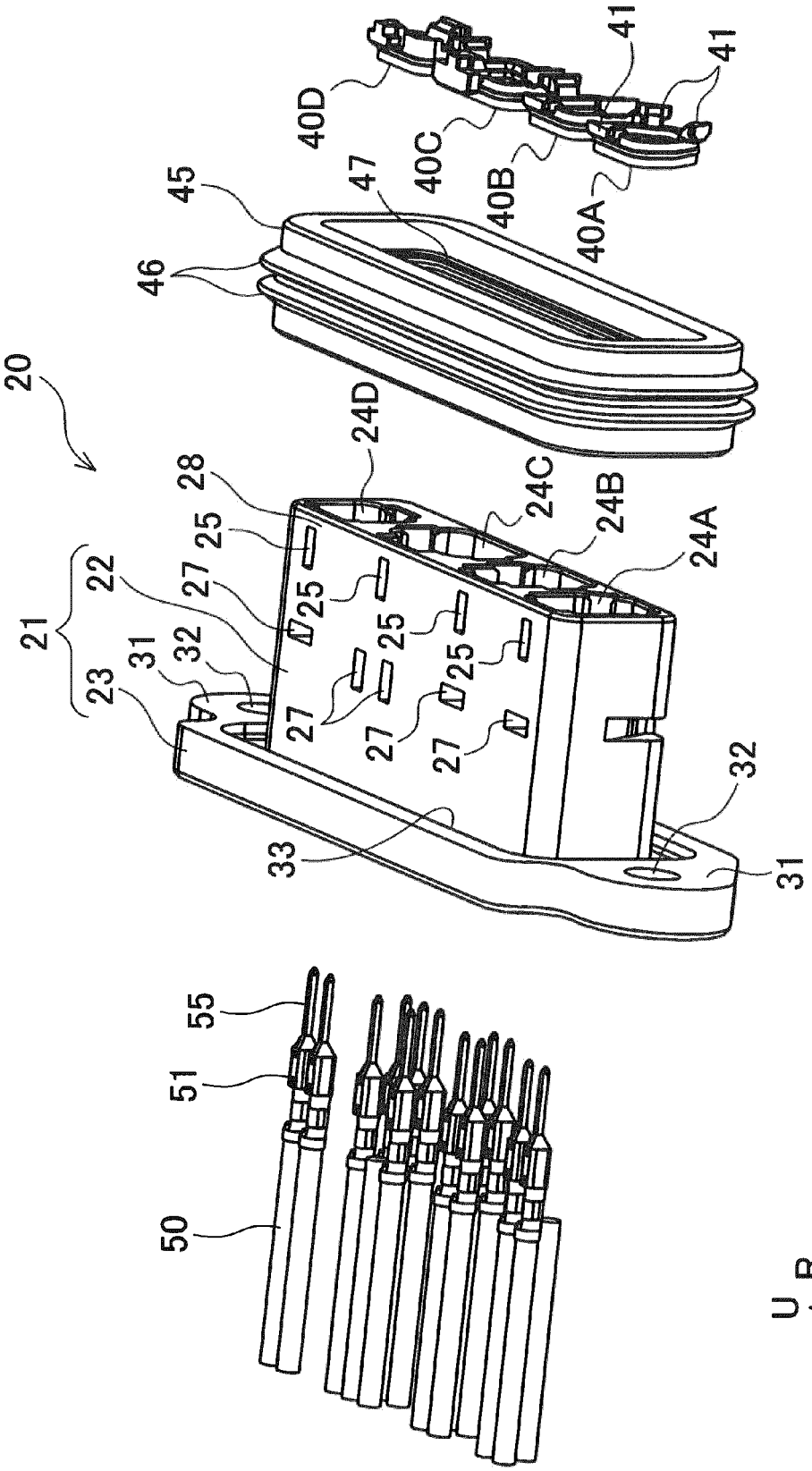
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FIG. 4A

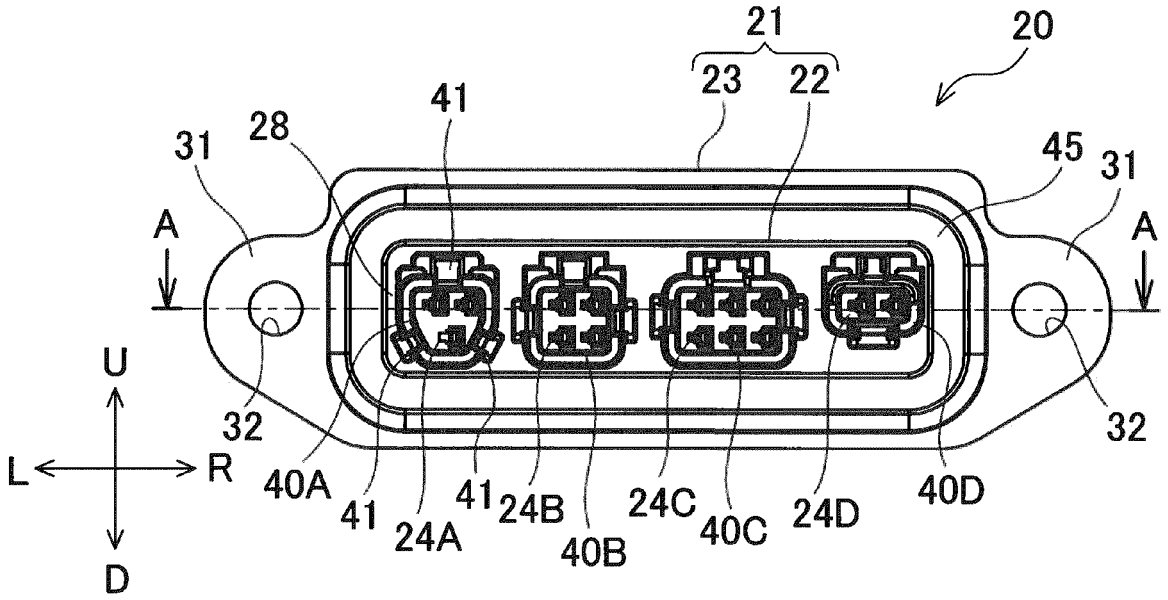
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FIG. 4B

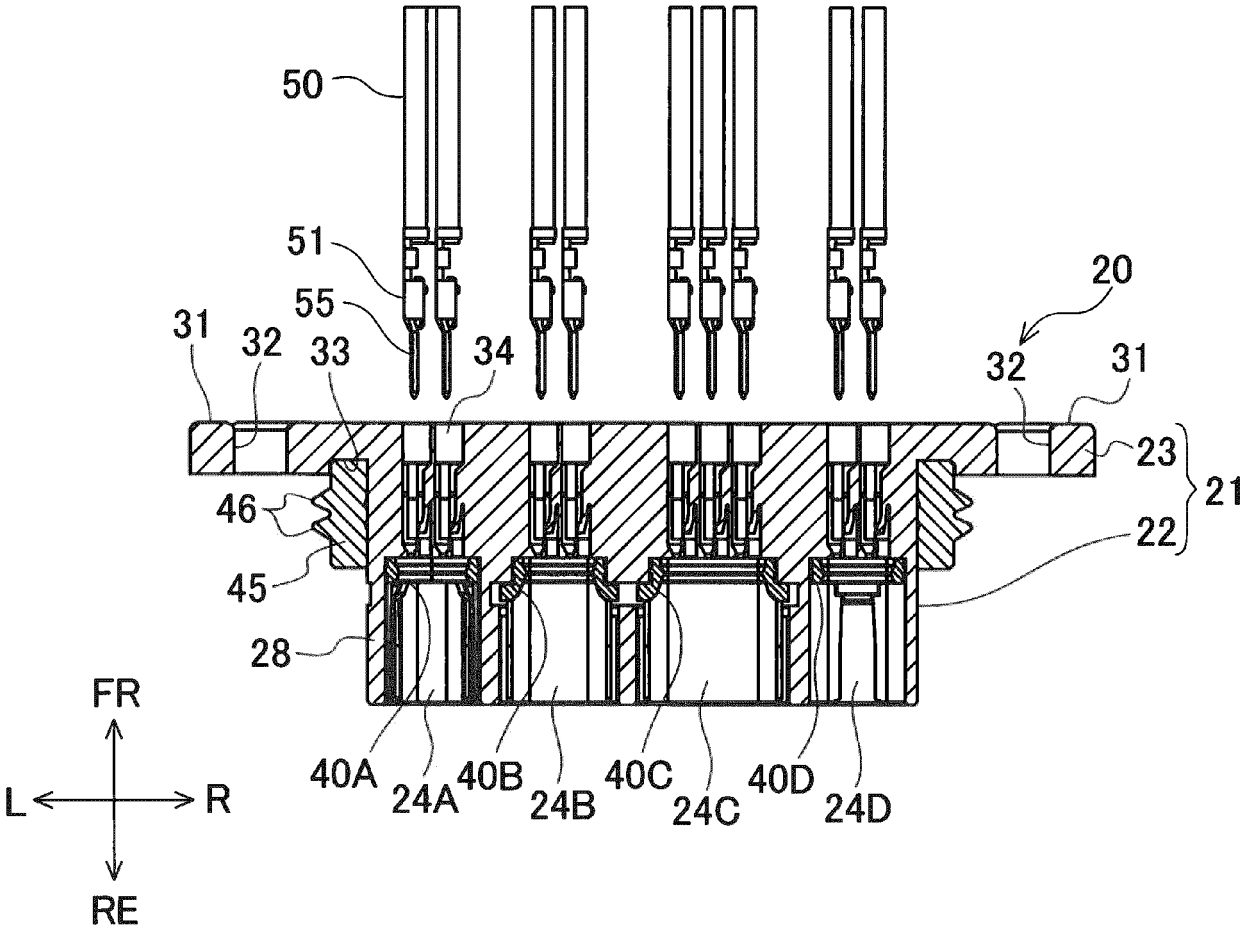
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FIG. 5A

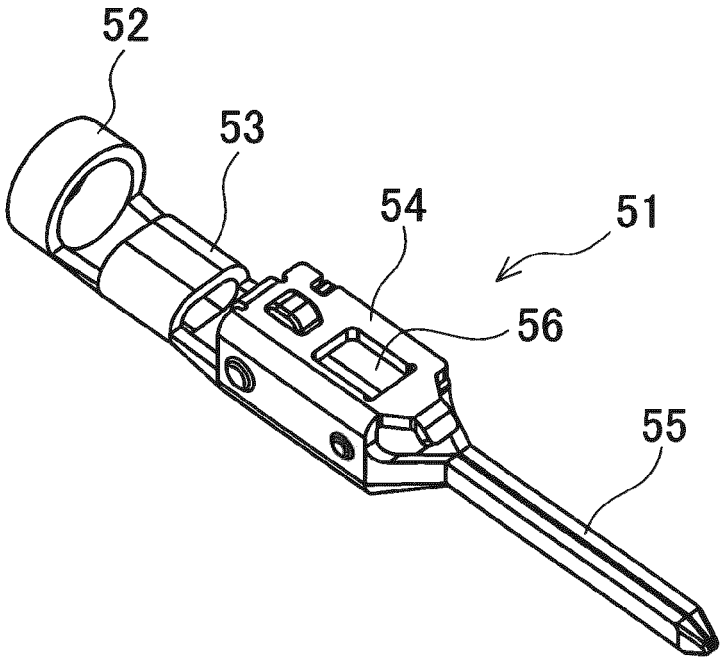

FIG. 5B

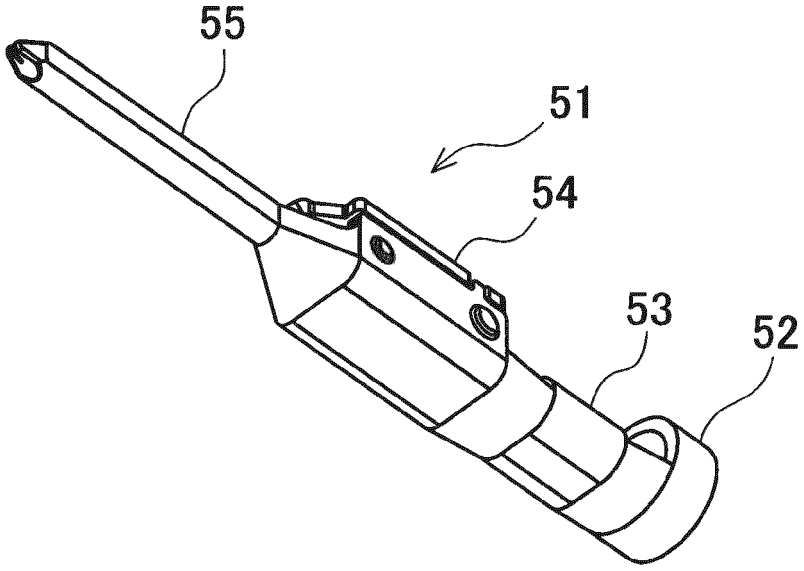

FIG. 6

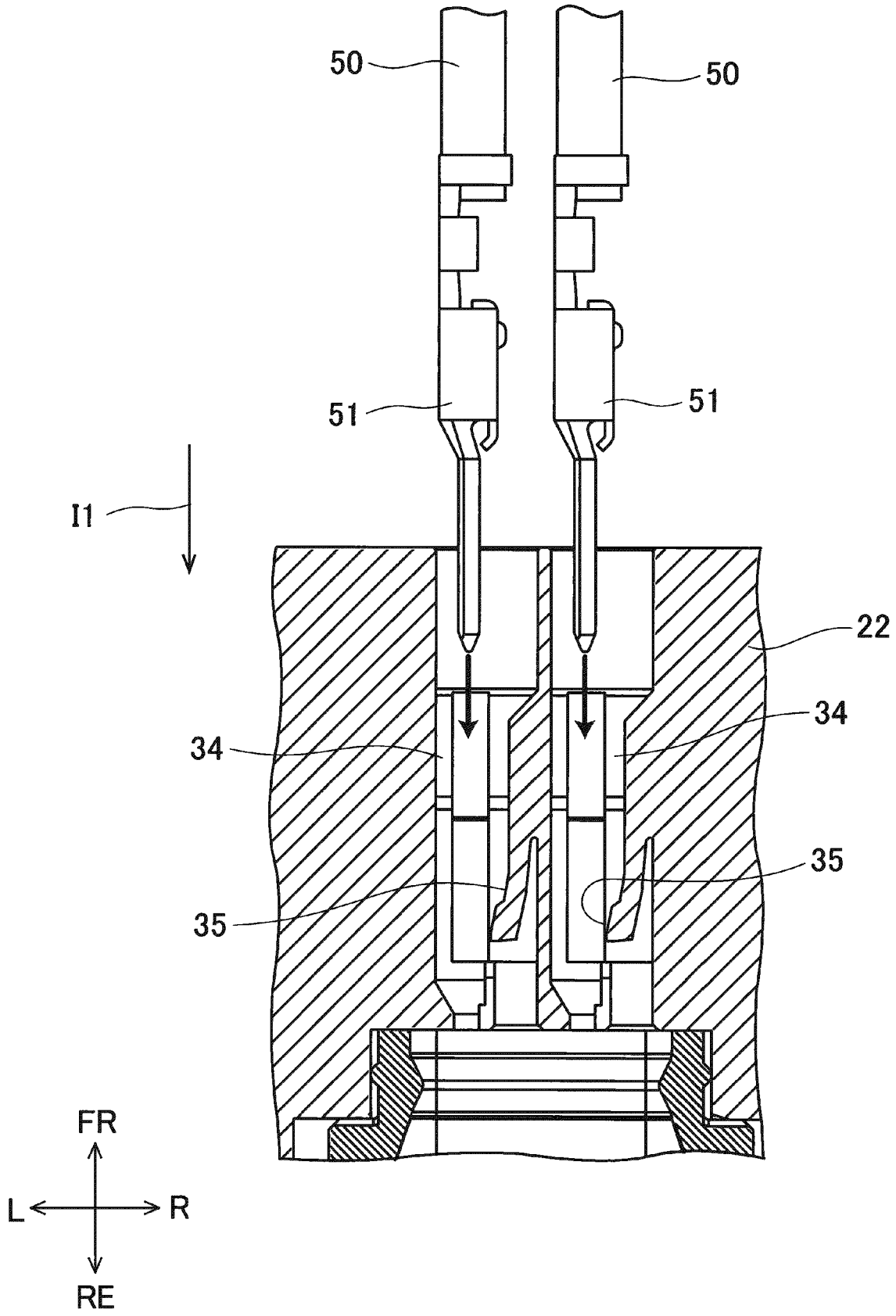

FIG. 7

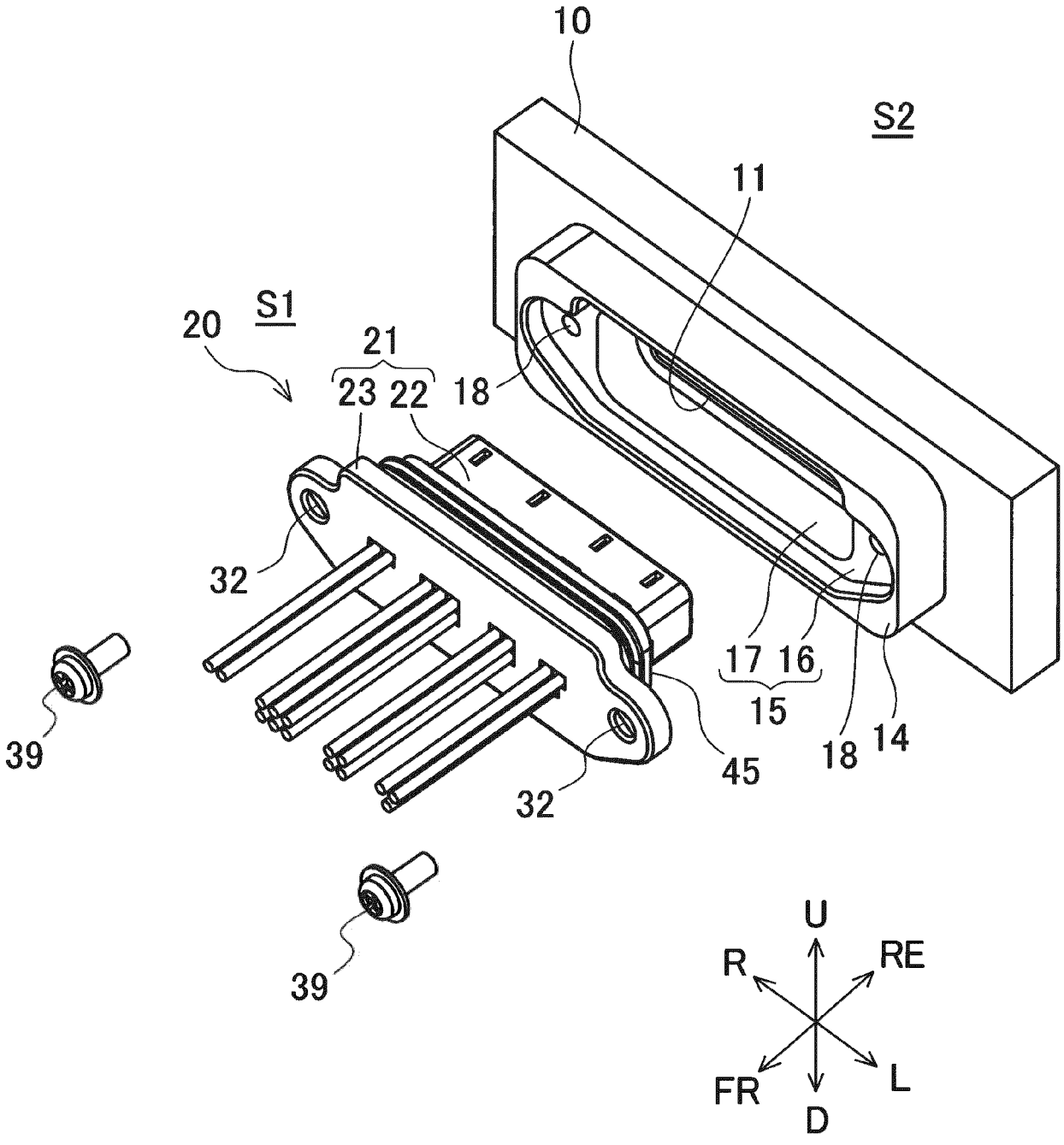

FIG. 8A

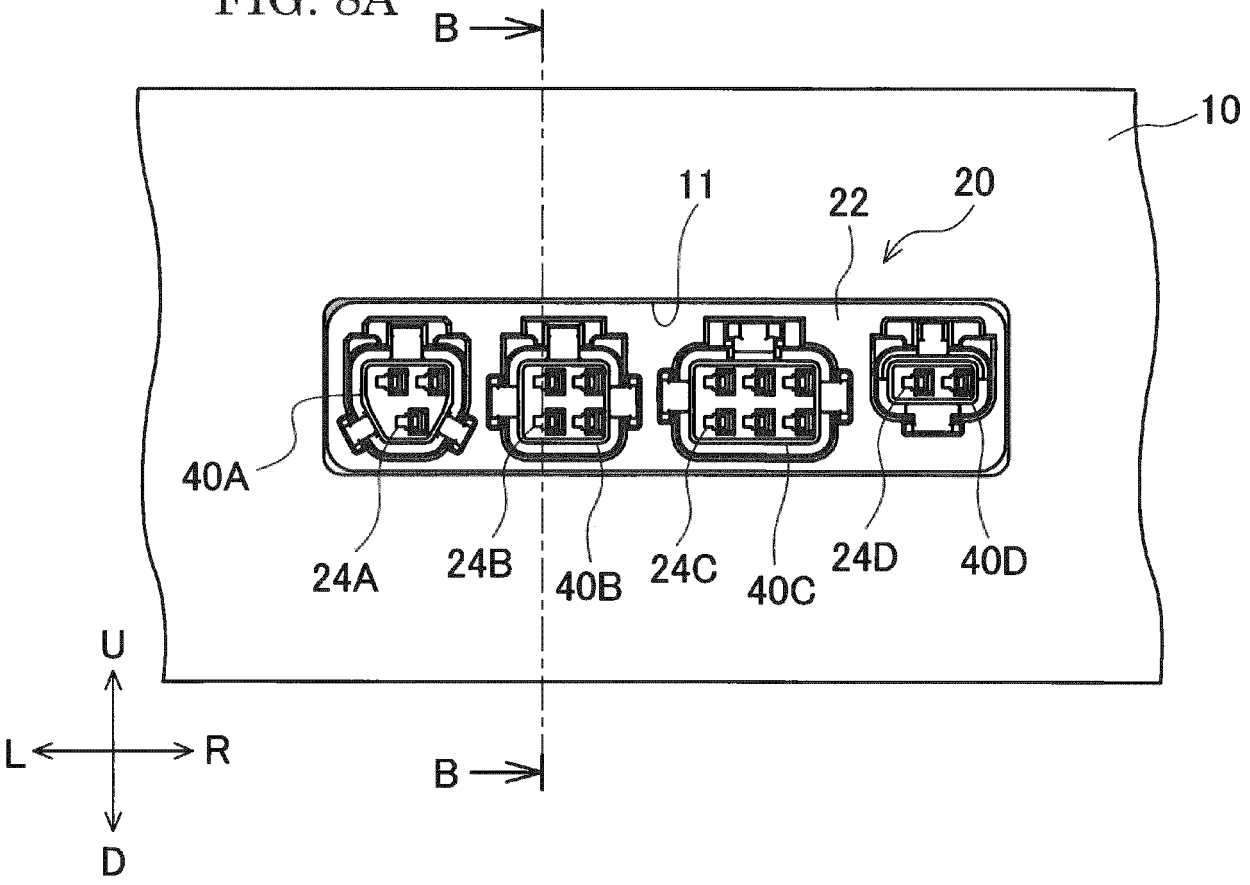
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FIG. 8B

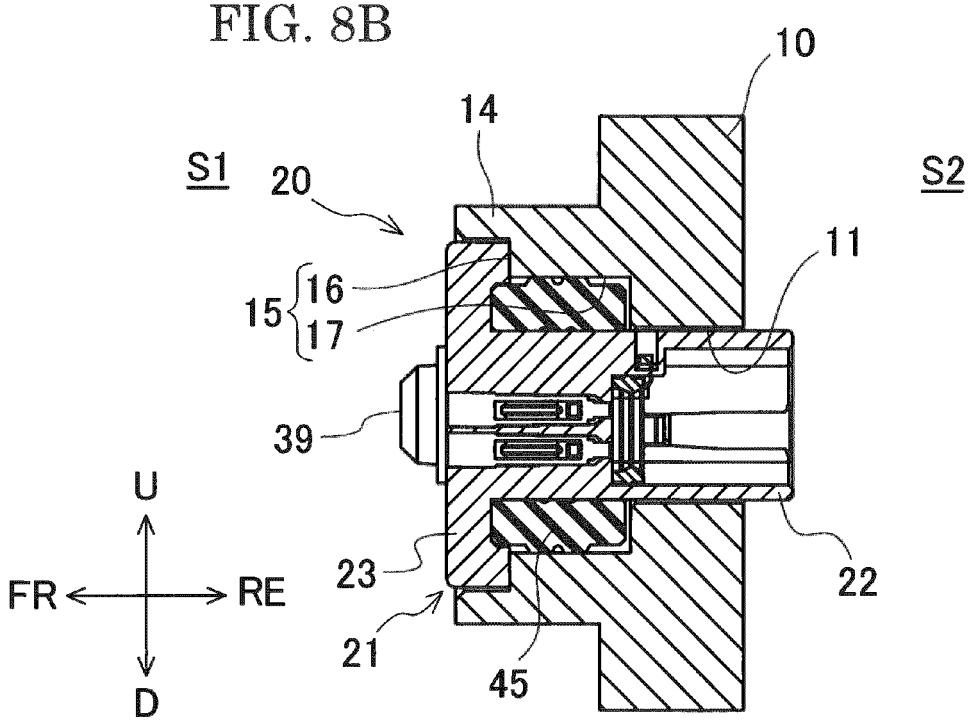
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FIG. 9A

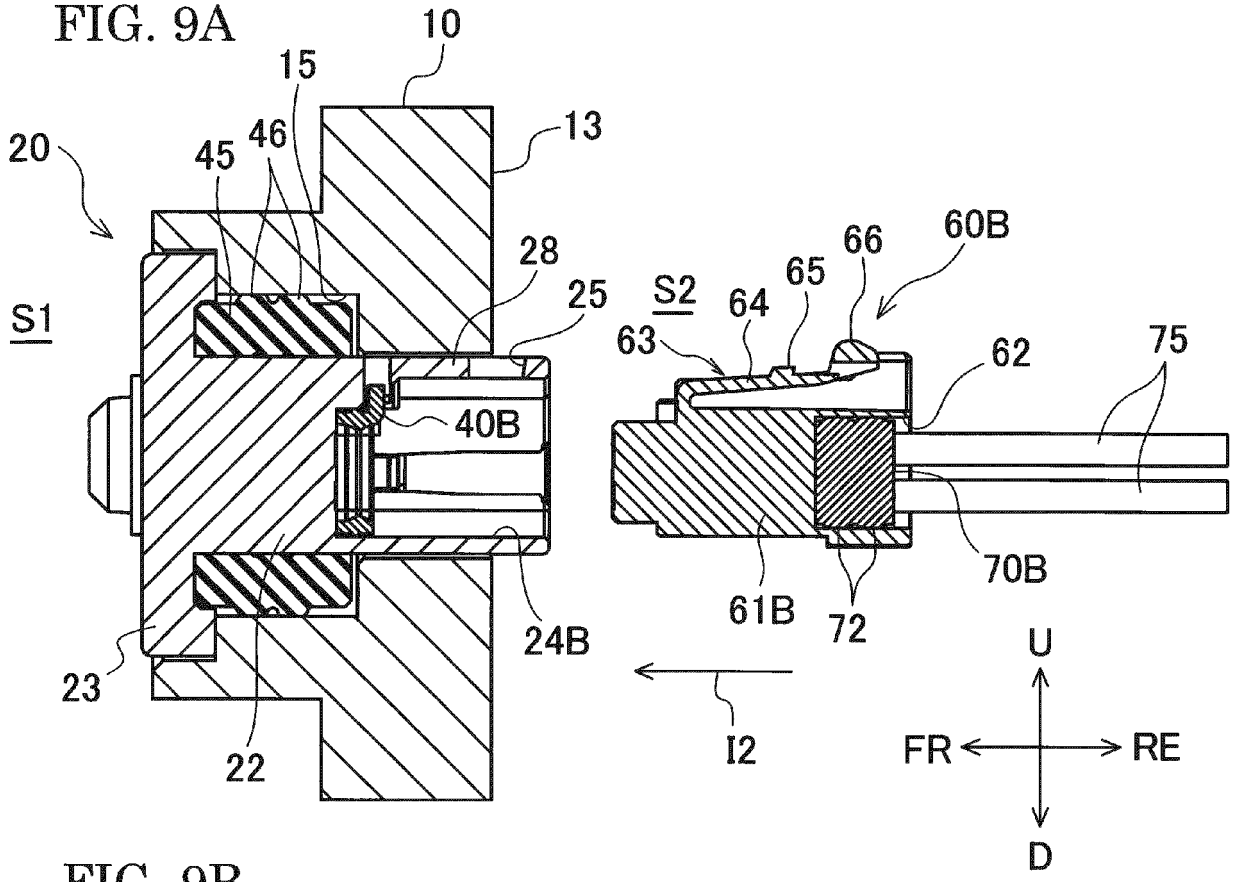
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FIG. 9B

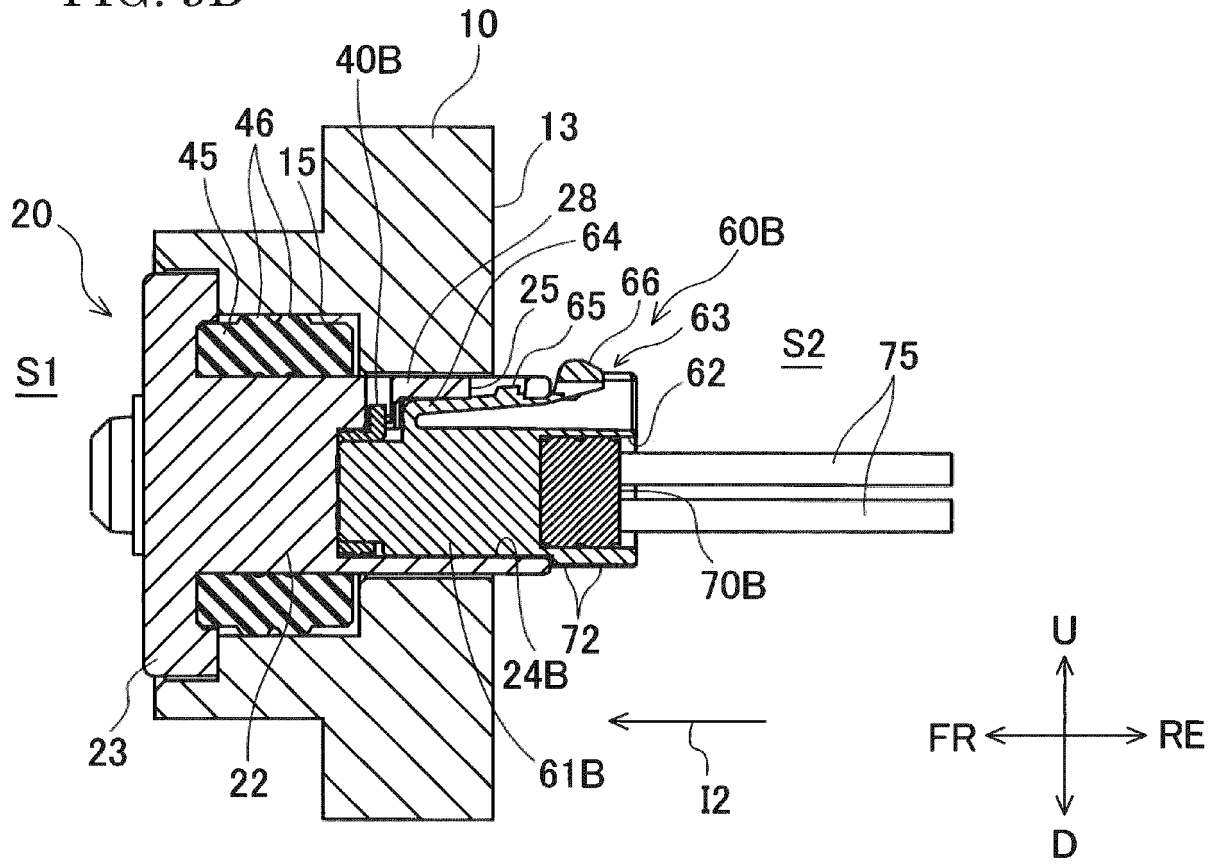
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FIG. 10

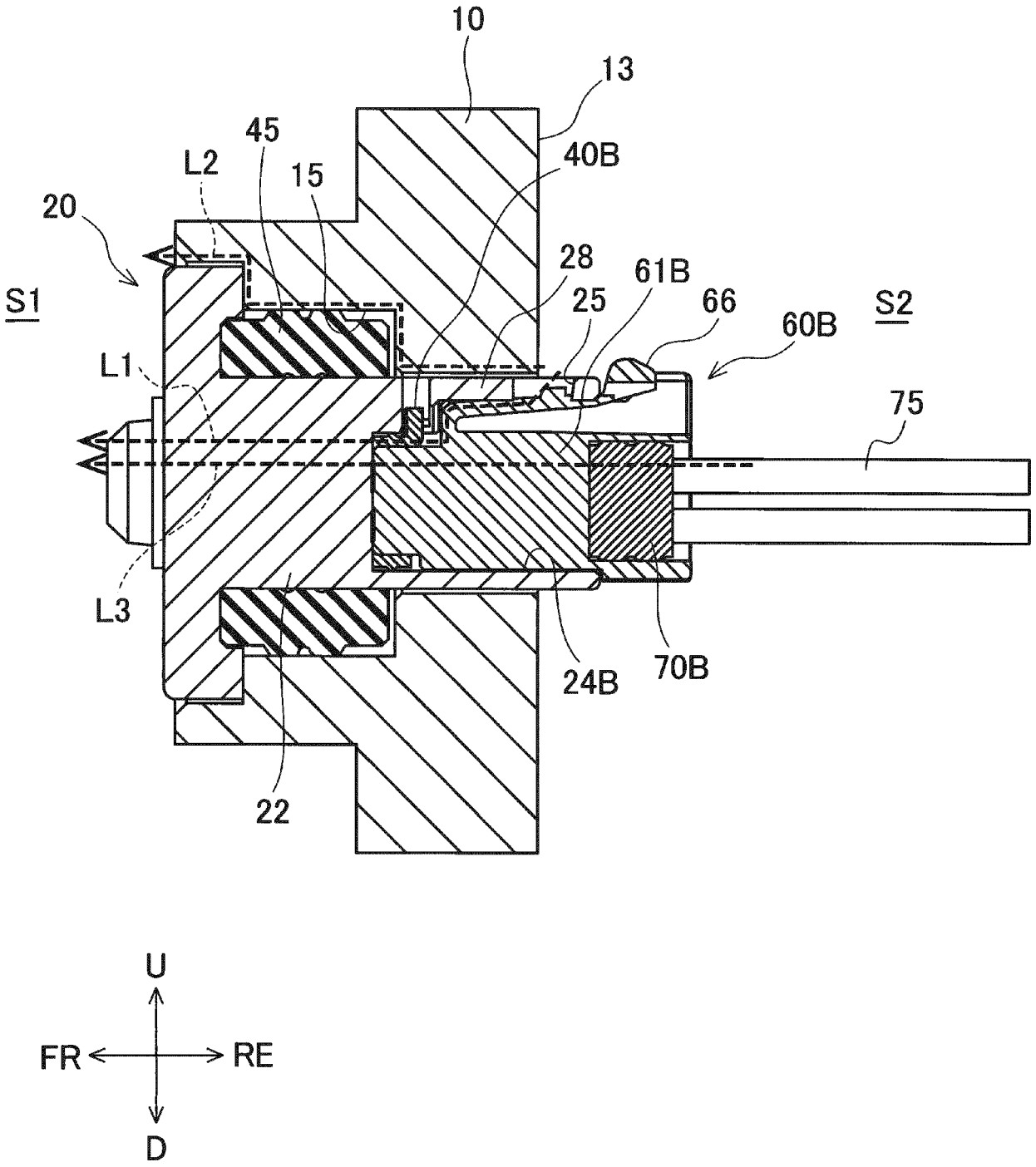
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FIG. 11

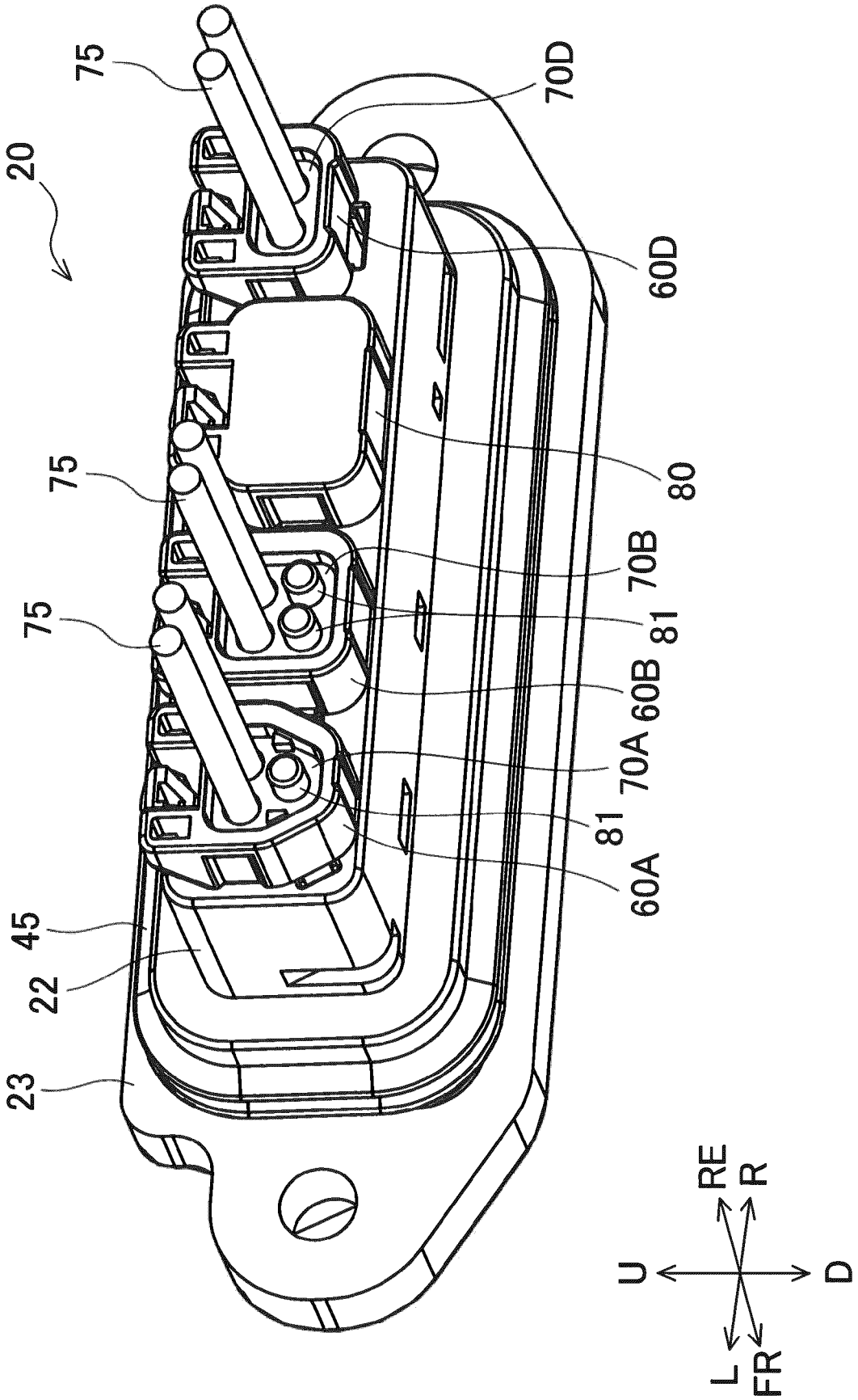


FIG. 12A

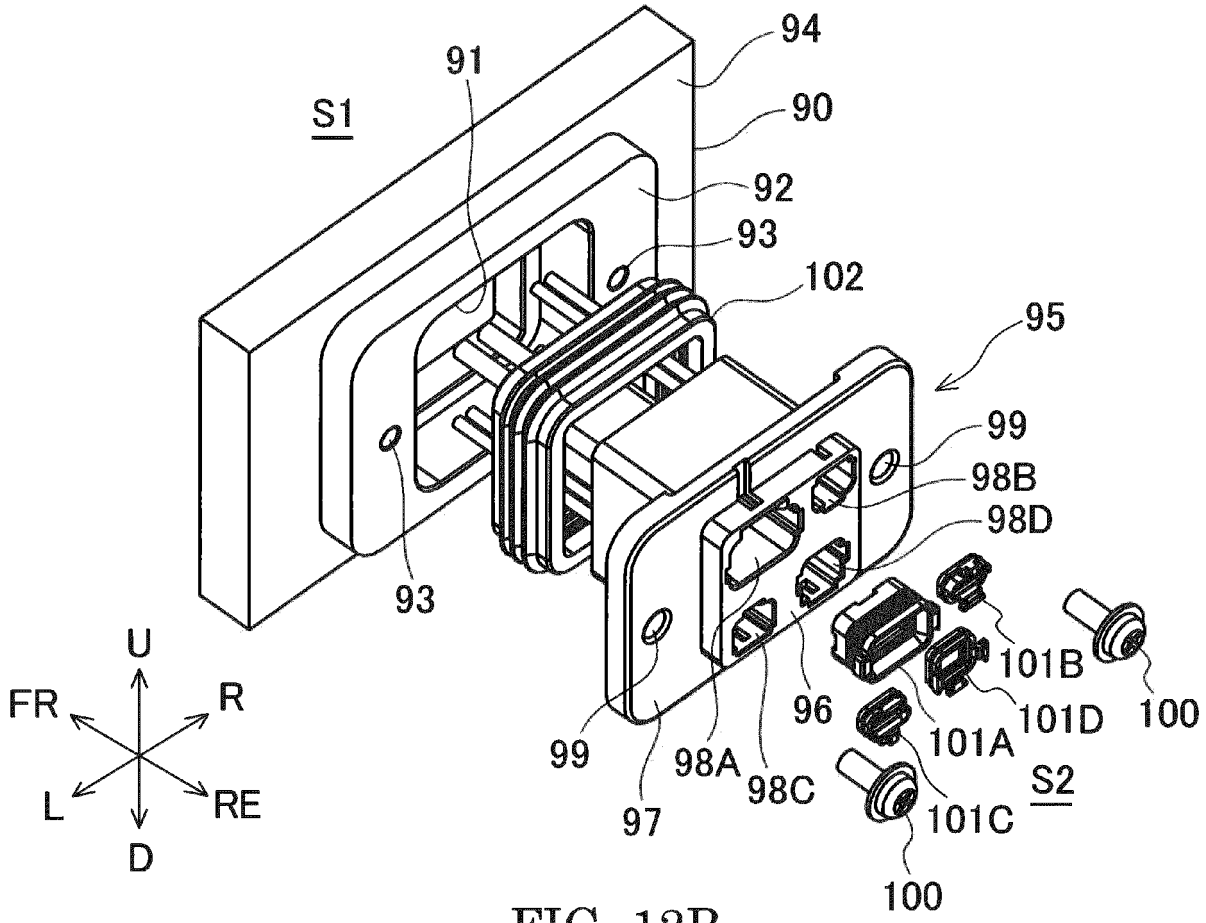


FIG. 12B

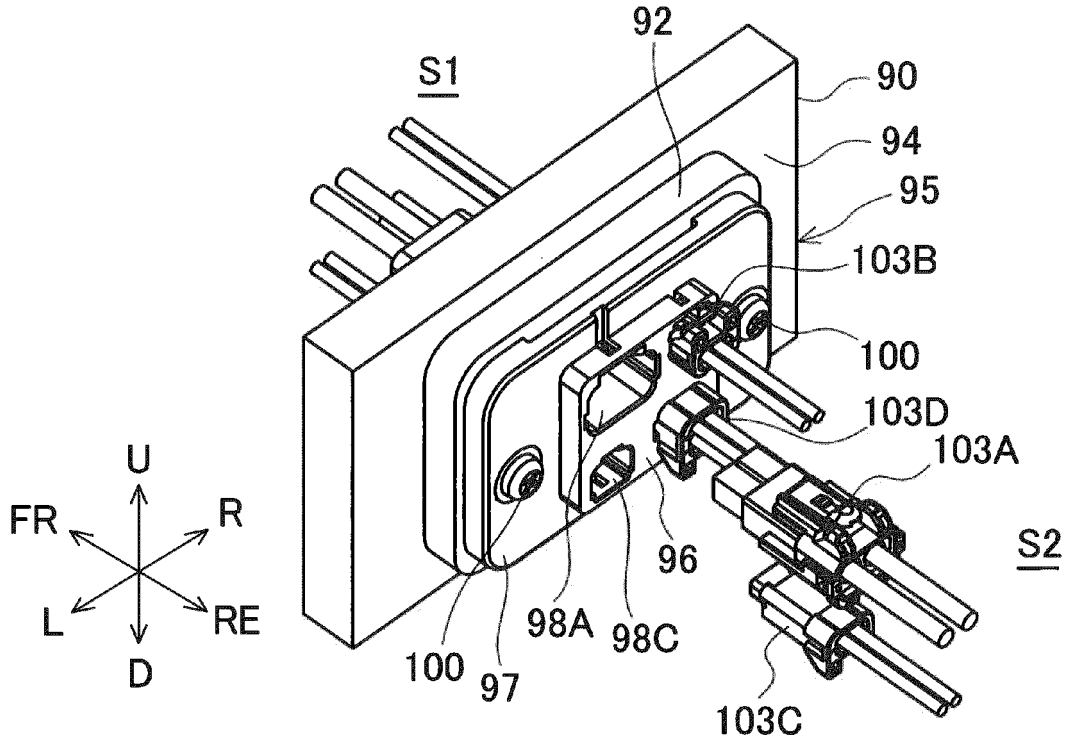
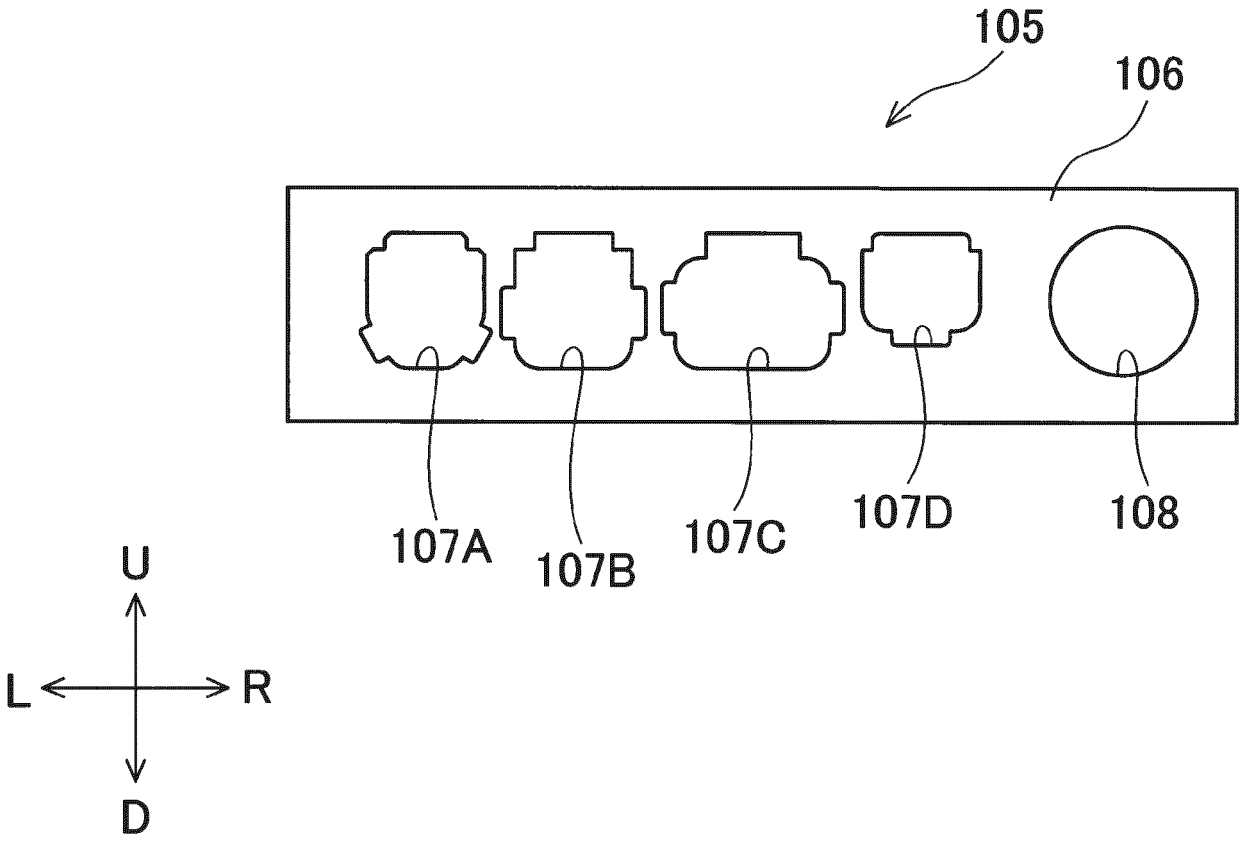


FIG. 13



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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 9751

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	CN 209 045 951 U (SUZHOU INOVANCE AUTOMOTIVE CO LTD) 28 June 2019 (2019-06-28) * figures 1-5 * * abstract *	1-8	ADD. H01R13/424
Y	WO 2011/097007 A1 (TYCO ELECTRONICS CORP [US]; RHEIN DAVID JAMES [US]) 11 August 2011 (2011-08-11) * figures 1-8 * * pages 3-14 *	3	
Y	WO 2016/091251 A1 (HARTING ELECTRONICS GMBH [DE]) 16 June 2016 (2016-06-16) * figures 1-5 * * pages 6-10 *	5	

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H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 October 2020	Kandyla, Maria

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28-10-2020

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