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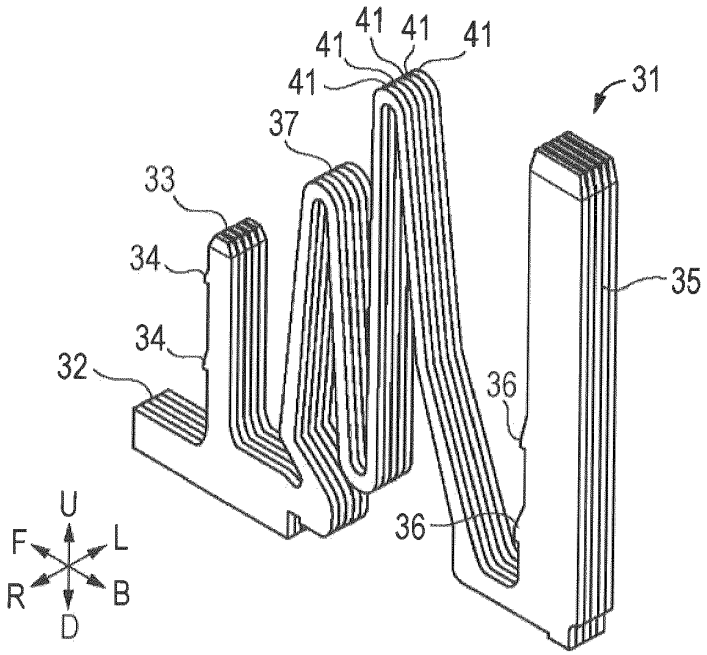
(54) **ELECTRICAL CONNECTOR**

(57) Provided is an electrical connector which includes: a terminal including a circuit connection portion connected to a circuit on a board, a contact portion configured to contact a terminal of a counterpart connector, and a spring portion connecting the circuit connection portion and the contact portion in such a manner as to enable the contact portion to move with respect to the circuit connection portion; a fixed housing fixed to the board; and a movable housing movable with respect to the fixed housing, the movable housing supporting the contact portion. The terminal is formed by laminating a plurality of terminal plates independent of each other in a thickness direction of the plurality of terminal plates.

FIG. 12



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Description

BACKGROUND

1. Technical Field

[0001] The present invention relates to an electrical connector having a floating function.

2. Related Art

[0002] Some of electrical connectors have a floating function. The floating function is the function of, when a connector and a counterpart connector are mated to each other, even if a mating portion of the connector and a mating portion of the counterpart connector are misaligned, enabling the connector to absorb the misalignment and mate with the counterpart connector. An electrical connector having the floating function is hereinafter referred to as a floating connector.

[0003] Each of a plurality of terminals provided to a floating connector includes a circuit connection portion that is connected to a circuit on a board, a contact portion that contacts a counterpart connector, and a spring portion that connects the circuit connection portion and the contact portion. Moreover, the floating connector includes a fixed housing fixed to the board, and a movable housing that is movable with respect to the board. The movable housing is provided with a mating portion that mates with the counterpart connector. Moreover, the circuit connection portion of the terminal is fixed to the board, and the contact portion of the terminal is fixed to the movable housing. This structure allows the movable housing to move with respect to the board on the basis of the elastic deformation of the spring portion of the terminal. When the counterpart connector is mated to the floating connector, if a mating portion of the counterpart connector is misaligned with the mating portion provided to the movable housing of the floating connector, the movement of the movable housing with respect to the board allows absorbing the misalignment.

[0004] The following JP-A-2019-33035 describes an example of the floating connector.

SUMMARY

[0005] An electrical connector according to an embodiment of the present disclosure includes: a terminal including a circuit connection portion connected to a circuit on a board, a contact portion configured to contact a terminal of a counterpart connector, and a spring portion connecting the circuit connection portion and the contact portion in such a manner as to enable the contact portion to move with respect to the circuit connection portion; a fixed housing fixed to the board; and a movable housing movable with respect to the fixed housing, the movable housing supporting the contact portion. The terminal is formed by laminating a plurality of terminal plates independent of each other in a thickness direction of the plurality of terminal plates.

BRIEF DESCRIPTION OF DRAWINGS

[0006]

Fig. 1 is a perspective view illustrating a connector of an embodiment of the present invention, a board where the connector is mounted, a counterpart connector, and a board where the counterpart connector is mounted;
Fig. 2 is a perspective view illustrating the counterpart connector;
Fig. 3 is a diagram illustrating the connector of the embodiment of the present invention as viewed from the front top left;
Fig. 4 is a diagram illustrating the connector of the embodiment of the present invention as viewed from above;
Fig. 5 is a diagram illustrating the connector of the embodiment of the present invention as viewed from below;
Fig. 6 is a cross-sectional view of the connector of the embodiment of the present invention as viewed along arrow VI-VI in Fig. 4;
Fig. 7 is a cross-sectional view of the connector of the embodiment of the present invention as viewed along arrow VII-VII in Fig. 4;
Fig. 8 is a cross-sectional view of the connector of the embodiment of the present invention as viewed along arrow VIII-VIII in Fig. 4;
Fig. 9 is a diagram illustrating a fixed housing of the connector of the embodiment of the present invention as viewed from below;
Fig. 10 is a diagram illustrating a movable housing of the connector of the embodiment of the present invention as viewed from above;
Fig. 11 is a diagram illustrating the movable housing of the connector of the embodiment of the present invention as viewed from below;
Fig. 12 is a perspective view illustrating a terminal of the connector of the embodiment of the present invention;
Fig. 13 is a perspective view illustrating a plurality of terminal plates configuring the terminal of the connector of the embodiment of the present invention;
Fig. 14 is a diagram of the connector of the embodiment of the present invention in a state where the movable housing has been moved, as viewed from below;
Figs. 15A and 15B are explanatory diagrams illustrating elastic deformation of a spring portion of the terminal in the connector of the embodiment of the present invention;
Fig. 16 is an explanatory diagram illustrating the current flowing through the terminal in the connector of the embodiment of the present invention;

Figs. 17A and 17B are explanatory diagrams illustrating a modification of the terminal of the connector of the embodiment of the present invention;
Figs. 18A and 18B are explanatory diagrams illustrating a modification of the terminal of the connector of the embodiment of the present invention;
Fig. 19 is an explanatory diagram illustrating a modification of the terminal of the connector of the embodiment of the present invention; and
Figs. 20A and 20B are explanatory diagrams illustrating a modification of the terminal of the connector of the embodiment of the present invention.

DETAILED DESCRIPTION

[0007] In the following detailed description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0008] For example, when a floating connector including a power supply terminal is realized, the power supply terminal needs to have a large current capacity.

[0009] Generally, if a terminal is made thick, it is possible for the terminal to have a large current capacity. However, if a terminal is thick, a spring portion of the terminal has a difficulty in deforming elastically, which leads to a reduction in the amount of movement of the movable housing with respect to the board.

[0010] Moreover, even if a terminal is made thick, an increase in the length of the terminal allows facilitating elastic deformation of the spring portion of the terminal and increasing the amount of movement of the movable housing with respect to the board. However, an increase in the length of the terminal leads to an increase in the outer dimensions of the floating connector.

[0011] The present invention has been made considering, for example, the above-mentioned problems. An object of the present invention is to provide an electrical connector that can have an increased current capacity of a terminal, can secure a sufficient amount of movement of a movable housing with respect to a board, and can have reduced outer dimensions thereof.

[0012] In order to solve the above-mentioned problems, an electrical connector according to the present invention includes: a terminal including a circuit connection portion connected to a circuit on a board, a contact portion configured to contact a terminal of a counterpart connector, and a spring portion connecting the circuit connection portion and the contact portion in such a manner as to enable the contact portion to move with respect to the circuit connection portion; a fixed housing fixed to the board; and a movable housing movable with respect to the fixed housing, the movable housing supporting the contact portion. The terminal is formed by laminating a plurality of terminal plates independent of each other in a thickness direction of the plurality of terminal plates.

[0013] In the electrical connector of the present invention, the contact portion of the terminal is supported by the movable housing. Moreover, when the electrical connector of the present invention is mounted on the board, the circuit connection portion of the terminal is connected to the circuit on the board. Consequently, the circuit connection portion is fixed to the board. As a result, the movable housing is supported via the terminal on the board. The contact portion of the terminal can move with respect to the circuit connection portion on the basis of the elastic deformation of the spring portion. Therefore, the movable housing can move with respect to the board and the fixed housing fixed to the board on the basis of the elastic deformation of the spring portion of the terminal. When an external force acts on the movable housing, the movable housing moves. The contact portion of the terminal then moves together with the movable housing. When the contact portion of the terminal moves, the spring portion of the terminal deforms elastically. The terminal is formed by laminating the plurality of independent terminal plates in a thickness direction of the plurality of terminal plates. Accordingly, when the spring portion deforms elastically, a portion, which forms the spring portion, of each of two adjacent terminal plates among the plurality of terminal plates configuring the terminal slides. The structure where the terminal plates slide in this manner upon elastic deformation of the spring portion allows facilitating the elastic deformation of the spring portion. Therefore, a sufficient amount of movement of the movable housing with respect to the board can be secured without increasing the length of the spring portion of the terminal. On the other hand, the terminal in the present invention is formed by laminating the plurality of terminal plates in the thickness direction thereof; accordingly, the terminal in the present invention has a current capacity equal to a terminal formed by working one metal plate with a thickness dimension, which is the sum of the thickness dimensions of the plurality of terminal plates configuring the terminal, into the same outer shape as the terminal in the present invention. From the above points, according to the electrical connector of the present invention, it is possible to secure a sufficient amount of movement of the movable housing with respect to the board without increasing the length of the spring portion of the terminal, and increase the current capacity of the terminal. Hence, an electrical connector having a large current capacity and small outer dimensions can be realized.

[0014] Further, in the electrical connector according to the present invention, it is preferred that two adjacent terminal plates among the plurality of terminal plates are in contact with each other. It is also preferred that, in the electrical connector according to the present invention, the plurality of terminal plates has the same shape. Moreover, in the electrical connector according to the present invention, each of the terminal plates may include: a con-

nection plate portion forming the circuit connection portion; a contact plate portion forming the contact portion; and a spring plate portion forming the spring portion. The electrical connector may be configured such that: the circuit connection portion is formed by laminating the connection plate portions of the plurality of terminal plates in the thickness direction of the connection plate portions of the plurality of terminal plates, the contact portion is formed by laminating the contact plate portions of the plurality of terminal plates in the thickness direction of the contact plate portions of the plurality of terminal plates, and the spring portion is formed by laminating the spring plate portions of the plurality of terminal plates in the thickness direction of the spring plate portions of the plurality of terminal plates.

[0015] Further, in the electrical connector according to the present invention, it may be configured that the movable housing is provided with a supporting hole or a supporting groove for supporting the contact portion, and the contact plate portions of the plurality of terminal plates are all inserted together into the supporting hole or the supporting groove in a laminated form.

[0016] Further, in the electrical connector according to the present invention, it may be configured that the contact plate portion of each of the terminal plates curves in the thickness direction of the contact plate portion, the supporting hole or supporting groove extends linearly, and the contact plate portion of each of the terminal plates is inserted into the supporting hole or supporting groove in a linearly and elastically deformed state.

[0017] Moreover, in the electrical connector according to the present invention, it may be configured that a protruding portion is formed on one of opposing surfaces of the contact plate portions of two adjacent terminal plates among the plurality of terminal plates, a recessed portion is formed on the other surface, and the protruding portion is inserted into the recessed portion.

[0018] According to the present invention, it is possible to increase the current capacity of the terminal, secure a sufficient amount of movement of the movable housing with respect to the board, and reduce the outer dimensions of the floating connector.

[0019] An electrical connector of an embodiment of the present invention is described, using the drawings. The mention of directions, up (U), down (D), front (F), back (B), left (L), and right (R), in the embodiment of the present invention is based on arrows drawn at the bottom right or bottom left corner in Figs. 1, 3 to 14, 17A and 17B, 19, and 20A and 20B for the convenience of explanation.

[0020] Fig. 1 illustrates a connector 1 being an embodiment of the electrical connector of the present invention, and a counterpart connector 91 that can be connected to the connector 1. In Fig. 1, the connector 1 is a floating connector. Moreover, the connector 1 is mounted on a board 85. The counterpart connector 91 is mounted on a counterpart board 95. The connector 1 and the counterpart connector 91 are connected to each other as illustrated in Fig. 1. Accordingly, a circuit on the board 85 and a circuit on the counterpart board 95 can be connected to each other. Moreover, in the embodiment, each of the connector 1 and the counterpart connector 91 is used as a power connector that supplies power supply current from the board 85 to the counterpart board 95, or from the counterpart board 95 to the board 85.

[0021] Fig. 2 illustrates the counterpart connector 91. As illustrated in Fig. 2, the counterpart connector 91 includes a plurality of terminals 92 having a sufficient current capacity to pass the power supply current therethrough, and a housing 93 that holds the terminals 92. Moreover, the housing 93 is provided with a mating hole 94 for mating with a mating portion 19 of the connector 1. Each terminal 92 is placed in the mating hole 94.

[0022] Fig. 3 illustrates the connector 1 as viewed from the front top left. Fig. 4 illustrates the connector 1 as viewed from above. Fig. 5 illustrates the connector 1 as viewed from below. Fig. 6 illustrates a cross-section of the connector 1 as viewed along arrow VI-VI in Fig. 4. Fig. 7 illustrates a cross-section of the connector 1 as viewed along arrow VII-VII in Fig. 4. Fig. 8 illustrates a cross-section of the connector 1 as viewed along arrow VIII-VIII in Fig. 4.

[0023] As illustrated in Fig. 3, the connector 1 includes a fixed housing 11, a movable housing 18, and a plurality of terminals 31.

[0024] The fixed housing 11 is formed with, for example, an insulating material such as resin into a tubular shape having a rectangular outer shape in top view. The fixed housing 11 has the functions of holding the terminals 31 and movably holding the movable housing 18 with respect to the board 85.

[0025] As illustrated in Fig. 1, the fixed housing 11 is placed on the board 85, and fixed to the board 85. Specifically, as illustrated in Fig. 4, a fitting mounting portion 12 where a fixing fitting 16 is mounted is provided at each of the bottom left and right of an outer surface of a peripheral wall portion 11A on the front side of the fixed housing 11, and at each of the bottom left and right of an outer surface of a peripheral wall portion 11B on the back side. The fixed housing 11 is fixed to the board 85 in an immovable manner, using the fixing fittings 16.

[0026] Moreover, an overhang portion 13 is provided to each of the front peripheral wall portion 11A and the back peripheral wall portion 11B of the fixed housing 11. The overhang portion 13 is placed in the middle of each of the peripheral wall portions 11A and 11B in the left-and-right direction, and extends inward in the front-and-back direction from an upper end portion of each of the peripheral wall portions 11A and 11B. The overhang portions 13 have the function of restricting the moving area of the movable housing 18 in the front-and-back direction.

[0027] Moreover, a notch 14 is formed in each of a peripheral wall portion 11C on the left side of the fixed housing 11 and a peripheral wall portion 11D on the right side. The notch 14 is placed in the middle of a lower part of each of the peripheral wall portions 11C and 11D in

the front-and-back direction, and is formed into a U-shape that is open downwards. Protruding portions 20 of the movable housing 18 are inserted in the notches 14. The left and right protruding portions 20 of the movable housing 18 are inserted into the left and right notches 14 of the fixed housing 11; accordingly, the movable housing 18 is movably held by the fixed housing 11.

[0028] Fig. 9 is a diagram of the fixed housing 11 where the movable housing 18 and the terminals 31 have been removed, as viewed from below. As illustrated in Fig. 9, a plurality of holding holes 15 respectively for holding the plurality of terminals 31 is formed in the fixed housing 11. One half of the plurality of holding holes 15 is arranged in a line in the left-and-right direction in the middle portion of the front peripheral wall portion 11A in the left-and-right direction, and the other is arranged in a line in the left-and-right direction in the middle portion of the back peripheral wall portion 11B in the left-and-right direction. Moreover, as illustrated in Fig. 7, the holding holes 15 extend upwards from undersurfaces of the peripheral wall portions 11A and 11B.

[0029] As illustrated in Fig. 3, the movable housing 18 is formed with, for example, an insulating material such as resin into a substantially cuboid shape. The movable housing 18 is placed in an inner space of the fixed housing 11.

[0030] As illustrated in Fig. 4, gaps are formed between front, back, left, and right outer surfaces of the movable housing 18 and inner surfaces of the peripheral wall portions 11A, 11B, 11C, and 11D of the fixed housing 11. Moreover, a gap is formed between the front outer surface of the movable housing 18 and a back end portion of the overhang portion 13 overhanging backwards from the peripheral wall portion 11A of the fixed housing 11. Moreover, a gap is also formed between the back outer surface of the movable housing 18 and a front end portion of the overhang portion 13 overhanging forward from the peripheral wall portion 11B of the fixed housing 11. Consequently, the movable housing 18 can move in the front-and-back direction and the left-and-right direction with respect to the fixed housing 11 and the board 85. Moreover, as can be seen from Fig. 6, when the connector 1 is mounted on the board 85, a gap is formed between an undersurface of the movable housing 85 and a top surface 85A of the board 85. Therefore, the movable housing 18 can also move in the up-and-down direction.

[0031] Moreover, as illustrated in Fig. 6, a lower part of the movable housing 18 is smaller in width in the front-and-back direction than an upper part of the movable housing 18. Consequently, large spaces are formed between the front outer surface of the lower part of the movable housing 18 and the inner surface of the peripheral wall portion 11A of the fixed housing 11, and between the back outer surface of the lower part of the movable housing 18 and the inner surface of the peripheral wall portion 11B of the fixed housing 11, respectively. Spring portions 37 of the terminals 31 are placed in these spaces.

[0032] Moreover, as illustrated in Fig. 3, the upper part of the movable housing 18 is the mating portion 19 that mates with the mating hole 94 of the counterpart connector 91. As illustrated in Fig. 1, when the connector 1 and the counterpart connector 91 are connected, the mating portion 19 of the movable housing 18 enters the mating hole 94 of the counterpart connector 91.

[0033] Moreover, the protruding portion 20 is provided to each of the left and right parts of the movable housing 18. The protruding portion 20 provided on the left part of the movable housing 18 protrudes leftwards from the middle in the front-and-back direction of the lower part on the left outer surface of the movable housing 18. The protruding portion 20 provided on the right part of the movable housing 18 protrudes rightwards from the middle in the front-and-back direction of the lower part on the right outer surface of the movable housing 18. As illustrated in Figs. 5 and 8, each protruding portion 20 is placed in the notch 14 formed in the fixed housing 11. Moreover, each protruding portion 20 is apart from the notch 14, and can move in the notch 14.

[0034] Fig. 10 is a diagram of the movable housing 18 where the fixed housing 11 and the terminals 31 have been removed, as viewed from above. Fig. 11 is a diagram of the movable housing 18 in Fig. 10 as viewed from below. As illustrated in Fig. 10, for example, three terminal insertion recessed portions 21 are formed in the movable housing 18. The terminal insertion recessed portions 21 are arranged in a line in the left-and-right direction in the middle of the movable housing 18 in the front-and-back direction. Moreover, as can be seen from Figs. 6 and 8, each terminal insertion recessed portion 21 is open upwards. When the mating portion 19 of the movable housing 18 is inserted into the mating hole 94 of the counterpart connector 91, the terminals 92 of the counterpart connector 91 enter the terminal insertion recessed portions 21.

[0035] Moreover, as illustrated in Fig. 10, a plurality of supporting grooves 22 is formed on left and right inner surfaces of the terminal insertion recessed portions 21 of the movable housing 18. Moreover, as illustrated in Fig. 11, a plurality of supporting holes 23 is formed in a bottom portion of the movable housing 18. As illustrated in Figs. 7 and 8, the supporting grooves 22 and supporting holes 23 support the terminals 31. The supporting grooves 22 and the supporting holes 23 extend in the up-and-down direction. The supporting grooves 22 correspond in position to the supporting holes 23. The supporting groove 22 and the corresponding supporting hole 23 are continuous. In the embodiment, as illustrated in Fig. 10, 12 supporting grooves 22 are formed in the movable housing 18. The supporting grooves 22 are placed in such a manner that six lines each having two aligned supporting grooves 22 are formed in the left-and-right direction. Moreover, as illustrated in Fig. 11, 12 supporting holes 23 are formed in the movable housing 18. The supporting holes 23 are placed in such a manner as to correspond to the 12 supporting grooves 22.

[0036] As can be seen from Figs. 4 and 5, the connector 1 in the embodiment is provided with 12 terminals 31. Six of the 12 terminals 31 are arranged in a line in the left-and-right direction on the front part of the connector 1. The other six terminals 31 are arranged in a line in the left-and-right direction on the back part of the connector 1. Each of the 12 terminals 31 has the same shape and structure. Fig. 12 illustrates one of the terminals 31. As illustrated in Fig. 12, the terminal 31 includes a circuit connection portion 32, a holding portion 33, a contact portion 35, and the spring portion 37.

[0037] The circuit connection portion 32 is a portion that is connected to the circuit on the board 85 by, for example, soldering. The circuit connection portion 32 extends in the front-and-back direction. The circuit connection portion 32 in the embodiment is a surface-mount circuit connection portion that is soldered to the circuit formed on the top surface 85A of the board 85. The illustration of the circuit formed on the board 85 is omitted in Fig. 1.

[0038] The holding portion 33 is a portion for holding the terminal 31 in the fixed housing 11. The holding portion 33 extends upwards from the circuit connection portion 32. As illustrated in Fig. 7, the holding potion 33 is inserted into the holding hole 15 formed in the fixed housing 11 and, accordingly, the terminal 31 is held in the fixed housing 11. Moreover, the holding portion 33 is provided with a projection 34 for retaining the holding portion 33 in the holding hole 15. The projection 34 lodges in an inner surface of the holding hole 15 to prevent the holding portion 33 from coming out of the holding hole 15.

[0039] The contact portion 35 is a portion that contacts the terminal 92 of the counterpart connector 91. As illustrated in Fig. 12, the contact portion 35 extends in the up-and-down direction. As illustrated in Figs. 7 and 8, the contact portion 35 is inserted into the supporting hole 23 and the supporting groove 22 of the movable housing 18, and supported therein. Moreover, as illustrated in Fig. 12, the contact portion 35 is provided with a projection 36 for retaining the contact portion 35 in the supporting hole 23. The projection 36 lodges in an inner surface of the supporting hole 23 to prevent the contact portion 35 from coming out of the supporting hole 23.

[0040] The spring portion 37 is a portion that connects the circuit connection portion 32 and the contact portion 35 to make the contact portion 35 movable with respect to the circuit connection portion 32. The spring portion 37 connects a back end of the circuit connection portion 32 and a lower end of the contact portion 35. The spring portion 37 has a shape obtained by bending a long slender rod-like member (as described below, this is formed by laminating spring plate portions 47 of a plurality of terminal plates 41) at a plurality of points to reduce the coefficient of elasticity and facilitate elastic deformation. The spring portion 37 deforms elastically to enable the contact portion 35 to move with respect to the circuit connection portion 32 in the front-and-back direction, the up-and-down direction, and the left-and-right direction.

[0041] The circuit connection portion 32 of each terminal 31 is fixed to the board 85 by, for example, soldering. Moreover, the circuit connection portion 32 of each terminal 31 is fixed to the fixed housing 11 via the holding portion 33. The fixed housing 11 is fixed to the board 85 via the fixing fittings 16. On the other hand, the contact portion 35 of each terminal 31 is inserted into the supporting hole 23 and the supporting groove 22 of the movable housing 18, and fixed to the movable housing 18. As a result, the movable housing 18 can move with respect to the fixed housing 11 and the board 85 in the front-and-back direction, the left-and-right direction, and the up-and-down direction on the basis of the elastic deformation of the spring portions 37 of the terminals 31. This structure allows realizing the floating function of the connector 1.

[0042] Fig. 13 illustrates the plurality of terminal plates 41 configuring one terminal 31. As illustrated in Fig. 13, each terminal 31 is formed by laminating the plurality of terminal plates 41, for example, five terminal plates 41, in a thickness direction of the terminal plates 41. Each terminal plate 41 is made of a conductive material, for example, a metal such as brass. Moreover, the terminal plates 41 are independent of each other. Each terminal plate 41 is formed by, for example, being blanked out of a metal plate.

[0043] The plurality of terminal plates 41 has the same shape. The outer shape of the terminal plate 41 as viewed from the left or right is the same as the outer shape of the terminal 31 as viewed from the left or right. Each terminal plate 41 is a flat plate, and left and right surfaces of each terminal plate 41 are flat.

[0044] Each terminal plate 41 includes a connection plate portion 42 forming the circuit connection portion 32 of the terminal 31, a holding plate portion 43 forming the holding portion 33 of the terminal 31, a contact plate portion 45 forming the contact portion 35 of the terminal 31, and a spring plate portion 47 forming the spring portion 37 of the terminal 31. The connection plate portions 42 of the plurality of terminal plates 41 are laminated in the thickness direction to form the circuit connection portion 32 of one terminal 31. Moreover, the holding plate portions 43 of the plurality of terminal plates 41 are laminated in the thickness direction to form the holding portion 33 of one terminal 31. Moreover, the contact plate portions 45 of the plurality of terminal plates 41 are laminated in the thickness direction to form the contact portion 35 of one terminal 31. Moreover, the spring plate portions 47 of the plurality of terminal plates 41 are laminated in the thickness direction to form the spring portion 37 of one terminal 31.

[0045] As can be seen from Figs. 5 and 9, the holding plate portions 43 of the plurality of terminal plates 41 configuring one terminal 31 are all inserted together into one holding hole 15 in a laminated form. The contact plate portions 45 of the plurality of terminal plates 41 configuring one terminal 31 are all inserted together into one supporting hole 23 in a laminated form. Consequently,

the plurality of terminal plates 41 configuring one terminal 31 is integrated. As illustrated in Fig. 12, two adjacent terminal plates 41 among the plurality of terminal plates 41 configuring one terminal 31 are in surface contact with each other. However, two adjacent terminal plates 41 are not fastened by each other.

[0046] The terminal 31 of the connector 1 of the embodiment has the following mechanical characteristics. Fig. 14 illustrates the connector 1 in a state where the movable housing 18 has moved to the left with respect to the fixed housing 11, as viewed from below. For example, when, as illustrated in Fig. 14, an external force acts on the movable housing 18, and the movable housing 18 is pushed leftwards, the spring portions 37 of the terminals 31 deform elastically, and the movable housing 18 moves leftwards with respect to the fixed housing 11. At this point in time, two adjacent terminal plates among the plurality of terminal plates 41 configuring one terminal 31 are not fastened by each other; accordingly, the spring plate portion 47 of one of the two terminal plates 41 slides with respect to the spring plate portion 47 of the other.

[0047] The slide of the spring plate portion 47 is further described, using Figs. 15A and 15B. Fig. 15A schematically illustrates a state where the spring plate portions 47 of the plurality of terminal plates 41 configuring one terminal 31 are not elastically deformed. Fig. 15B schematically illustrates a state where the spring plate portions 47 of the plurality of terminal plates 41 configuring one terminal 31 are elastically deformed. As can be seen from Figs. 15A and 15B, an external force acts on the movable housing 18; consequently, a force is applied to the contact portion 35 of the terminal 31 fixed in the supporting hole 23 of the movable housing 18, and each of the spring plate portions 47 of the plurality of terminal plates 41 configuring the terminal 31 deforms elastically. At this point in time, the spring plate portion 47 of one of two adjacent terminal plates among the plurality of terminal plates 41 slides with respect to the spring plate portion 47 of the other.

[0048] In this manner, when a force is applied to the contact portion 35 of the terminal 31, each of the spring plate portions 47 of the plurality of terminal plates 41 configuring the terminal 31 slides. Accordingly, if, for example, the terminal 31 formed by laminating five terminal plates 41 with a thickness of a millimeters as illustrated in Fig. 13 (this is hereinafter referred to as the "five-thin-plate-laminated terminal") is compared with a terminal obtained by working one metal plate with a thickness of ($a \times 5$) millimeters into the same outer shape as the terminal 31 (this is hereinafter referred to as the "one-thick-plate terminal"), the spring portion of the five-thin-plate-laminated terminal is lower in the coefficient of elasticity and more likely to deform elastically than the spring portion of the one-thick-plate terminal. Therefore, if leftward forces of the same magnitude are applied to the contact portion of the five-thin-plate-laminated terminal and the contact portion of the one-thick-plate terminal, respectively, the contact portion of the five-thin-plate-laminated terminal moves to the left more largely than the contact portion of the one-thick-plate terminal. Hence, the employment of the five-thin-plate-laminated terminal as the terminal 31 of the connector 1 allows increasing the amount of movement of the movable housing 18 with respect to the fixed housing 11 and the board 85 as compared to a case where the one-thick-plate terminal is employed.

[0049] Moreover, the terminal 31 of the connector 1 of the embodiment has the following electrical characteristics. Fig. 16 schematically illustrates a state where the terminal 92 of the counterpart connector 91 contacts the contact portion 35 of the terminal 31, and a power supply current flows from the terminal 92 of the counterpart connector 91 through the terminal 31 of the connector 1 to a circuit 86 on the board 85. In Fig. 16, the plurality of connection plate portions 42 configuring the circuit connection portion 32 of the terminal 31 is connected with solder 87 to the circuit 86 formed on the top surface 85A of the board 85. Moreover, as illustrated in Fig. 16, the terminal 92 of the counterpart connector 91 contacts a surface, which faces outwards, of the contact plate portion 45 of the terminal plate 41 situated furthest to the right or left among the plurality of terminal plates 41 configuring one terminal 31. Therefore, the power supply current flows from the terminal 92 of the counterpart connector 91 into the contact plate portion 45 of the terminal plate 41, which is situated furthest to the right or left, of the terminal 31 of the connector 1. Two adjacent terminal plates among the plurality of terminal plates 41 configuring the terminal 31 are in contact with each other. Accordingly, the power supply current that has flown into the contact plate portion 45 of the terminal plate 41, which is situated furthest to the right or left, of the terminal 31 flows through each of the plurality of terminal plates 41 configuring the terminal 31, and is supplied to the circuit 86 on the board 85. It can be seen from this point that the above five-thin-plate-laminated terminal has electrical resistance and a current capacity equal to the one-thick-plate terminal. Hence, also in a case where the five-thin-plate-laminated terminal is employed as the terminal 31 of the connector 1, a current capacity equal to the case where the one-thick-plate terminal is employed can be secured.

[0050] As described above, each terminal 31 of the connector 1 of the embodiment of the present invention is formed by laminating the plurality of terminal plates 41 independent of each other in the thickness direction of the plurality of terminal plates 41. This configuration allows increasing the current capacity of each terminal 31 and facilitating the elastic deformation of the spring portion 37 of each terminal 31. Facilitating the elastic deformation of the spring portion 37 of each terminal 31 allows increasing the amount of movement of the movable housing 18 with respect to the fixed housing 11 and the board 85 at least in the left-and-right direction. Moreover, facilitating the elastic deformation of the spring portion 37 of each terminal 31 allows securing a sufficient amount of

movement of the movable housing 18 and reducing the length of the spring portion 37 of each terminal 31. Therefore, it is possible to achieve excellent floating performance for the connector 1 and reduce the outer dimensions of the connector 1. Hence, according to the embodiment of the present invention, it is possible to realize a small floating connector that can pass a power supply current of, for example, several amperes to upwards of ten amperes, or of a greater magnitude, and has high floating performance.

[0051] Moreover, two adjacent terminal plates among the plurality of terminal plates 41 configuring each terminal 31 of the connector 1 of the embodiment of the present invention are in contact with each other. Therefore, the terminal 31 formed by laminating n terminal plates 41 with a thickness dimension of a millimeters can be electrically equated with a terminal having the same outer shape as the terminal 31, the terminal being formed of one metal plate with a thickness dimension of ($a \times n$) millimeters. Therefore, it is possible to increase the current capacity of each terminal 31 while reducing the coefficient of elasticity of the spring portion 37 of each terminal 31.

[0052] Moreover, the plurality of terminal plates 41 configuring one terminal 31 in the connector 1 of the embodiment of the present invention has the same shape. Upon forming the terminal plates 41 by, for example, blanking, this configuration allows easily forming the terminal plates 41 by means of a common die (punch). Therefore, according to the embodiment, it is possible to easily and at low cost form the terminals 31 that have a large current capacity and are likely to deform elastically.

[0053] Moreover, each terminal plate 41 configuring the terminal 31 of the connector 1 of the embodiment of the present invention includes the portion forming the circuit connection portion 32 of the terminal 31, the portion forming the holding portion 33 of the terminal 31, the portion forming the contact portion 35 of the terminal 31, and the portion forming the spring portion 37 of the terminal 31. This configuration allows easily forming the circuit connection portion 32, the holding portion 33, the contact portion 35, and the spring portion 37 of the terminal 31 simply by laminating the plurality of terminal plates 41.

[0054] Moreover, the contact plate portions 45 of the plurality of terminal plates 41 configuring the terminal 31 are all inserted together into the supporting hole 23 or the supporting groove 22 formed in the movable housing 18 in a laminated form in the connector 1 of the embodiment of the present invention. Moreover, the holding plate portion 43 of the plurality of terminal plates 41 configuring the terminal 31 are all inserted together into the holding hole 15 formed in the fixed housing 11 in a laminated form. These configurations allow easily holding the plurality of terminal plates 41 configuring each terminal 31 in the laminated form in the movable housing 18 and the fixed housing 11.

[0055] Each terminal plate 41 configuring the terminal 31 is formed into a flat plate shape in the above embodiment, but may have a configuration where the contact plate portion 45 of each terminal plate 41 is curved in the thickness direction of the contact plate portion 45 as illustrated in Fig. 17A, and is inserted into the supporting hole 23 and the supporting groove 22, which extend linearly, in a state of being deformed elastically and linearly as illustrated in Fig. 17B.

[0056] Specifically, the contact plate portion 45 of each terminal plate 41 that is inserted into the supporting groove 22 formed in the left surface of each terminal insertion recessed portion 21 of the movable housing 18, and the corresponding supporting hole 23 is curved in such a manner as to tilt the upper end portion of the contact plate portion 45 leftwards with respect to the lower end portion. Moreover, the contact plate portion 45 of each terminal plate 41 that is inserted into the supporting groove 22 formed in the right surface of each terminal insertion recessed portion 21 of the movable housing 18, and the corresponding supporting hole 23 is curved in such a manner as to tilt the upper end portion of the contact plate portion 45 rightwards with respect to the lower end portion. On the other hand, each supporting groove 22 and each supporting hole 23 are formed in such a manner as to extend linearly in the up-and-down direction.

[0057] When each terminal plate 41 where the contact plate portion 45 is curved in such a manner that the upper end portion is tilted leftwards with respect to the lower end portion is inserted into the supporting groove 22 formed in the left surface of each terminal insertion recessed portion 21 of the movable housing 18, and the corresponding supporting hole 23, the upper end portion of the contact plate portion 45 of the leftmost terminal plate 41 touches the bottom surface of the supporting groove 22, and deforms elastically rightwards into a linear shape. At the same time, the upper end portion of the contact plate portion 45 of the second leftmost terminal plate 41 is pushed by the leftmost terminal plate 41, and deforms elastically rightwards into a linear shape. Similarly, the upper end portions of the contact plate portions 45 of the rest of the plurality of terminal plates 41 configuring the terminal 31 also deform elastically into a linear shape. Moreover, when each terminal plate 41 where the contact plate portion 45 is curved in such a manner that the upper end portion tilts rightwards with respect to the lower end portion is inserted into the supporting groove 22 formed in the right surface of each terminal insertion recessed portion 21 of the movable housing 18, and the corresponding supporting hole 23, the upper end portion of the contact plate portion 45 of the rightmost terminal plate 41 touches the bottom surface of the supporting groove 22, and deforms elastically leftwards into a linear shape. At the same time, the upper end portion of the contact plate portion 45 of the second rightmost terminal plate 41 is pushed by the rightmost terminal plate 41, and deforms elastically leftwards into a linear shape. Similarly, the upper end portions of the contact plate portions

45 of the rest of the plurality of terminal plates 41 configuring the terminal 31 also deform elastically into a linear shape. Consequently, the upper end portions of the contact plate portions 45 of two adjacent terminal plates among the plurality of terminal plates 41 configuring one terminal 31 push and contact each other strongly. Consequently, it is possible to ensure an electrical connection between these contact plate portions 45 and an increase in the current capacity of the terminal 31.

[0058] Moreover, as illustrated in Figs. 18A and 18B, it may be configured in such a manner that a protruding portion 51 is formed on one of opposing surfaces of the contact plate portions 45 of two adjacent terminal plates 41 among the plurality of terminal plates 41 configuring each terminal 31, a recessed portion 52 is formed on the other surface, and the protruding portion 51 is inserted into the recessed portion 52 when these terminal plates 41 are laminated. Such a configuration also allows ensuring an electrical connection between two adjacent terminal plates 41 in the terminal 31 and an increase in the current capacity of the terminal 31.

[0059] Moreover, the shape of the terminal of the connector of the present invention is not limited to the one taken up as the above-mentioned embodiment. For example, it may be configured in such a manner that a contact portion 62 is placed in the middle of a terminal 61, circuit connection portions 63 and 64 are placed at both ends of the terminal 61 in the front-and-back direction, respectively, and spring portions 65 and 66 connect the contact portion 62 and the front circuit connection portion 63, and the contact portion 62 and the back circuit connection portion 64, respectively, as illustrated in Fig. 19. This terminal 61 is formed by laminating a plurality of terminal plates 67. According to the terminal 61, it is possible to further increase the current capacity.

[0060] Moreover, it may be configured in such a manner that a contact point portion 73 that is elastically displaced is formed on a contact portion 72 of a terminal 71 as illustrated in Fig. 20A. In this case, as illustrated in Fig. 20B, a terminal 97 of a counterpart connector contacts a surface, which faces outwards in the front-and-back direction, of the contact point portion 73. The contact point portion 73 is pushed by the terminal 97, deforms elastically, and is displaced in an arrow d direction in Fig. 20B. The contact point portion 73 then pushes the terminal 97 in a direction opposite to the arrow d direction on the basis of an elastic force thereof. Hence, the contact point portion 73 ensures contact with the terminal 97. The terminal 71 includes a circuit connection portion 74 and a spring portion 75 similarly to the terminal 31 of the above embodiment. The terminal 71 having such a contact point portion 73 is also formed by laminating a plurality of terminal plates 76.

[0061] Moreover, the case where each terminal 31 of the connector 1 is formed of the plurality of terminal plates 41 having the same shape is taken as an example in the above embodiment. However, the present invention is not limited to this. The shape of each of the plurality of terminal plates 41 forming one terminal 31 may not be completely the same as each other, and may be partially different from each other.

[0062] Moreover, as illustrated in Fig. 3, the most part of the movable housing 18 is housed in the space inside the fixed housing 11 in the connector 1 of the above embodiment. However, a part of the movable housing 18 may jut out largely from the fixed housing 11. For example, the dimension of the movable housing 18 in the up-and-down direction may be much larger than the dimension of the fixed housing 11 in the up-and-down direction, and the movable housing 18 may protrude largely upwards from the space inside the fixed housing 11.

[0063] Moreover, the case where two adjacent terminal plates 41 among the terminal plates 41 configuring each terminal 31 are in surface contact with each other as illustrated in Fig. 12 is taken as an example in the connector 1 of the above embodiment. However, the present invention is not limited to this. In other words, the entire opposing surfaces of two adjacent terminal plates 41 may be in contact with each other, or there may be portions that are apart from each other on these surfaces. Moreover, for example, a conductive resin material may be disposed between two adjacent terminal plates 41.

[0064] Moreover, the case where the connector is for a power supply is taken as an example in the above embodiment. However, the connector of the present invention is not limited to for a power supply.

[0065] Moreover, the case where each terminal 31 of the connector 1 is provided with the surface-mount circuit connection portion 32 is taken as an example in the above embodiment. However, the present invention is not limited to this. Each terminal may be provided with a through-hole circuit connection portion.

[0066] Moreover, the number of the terminals is not limited in the connector of the present invention. Moreover, the number of the terminal plates configuring the terminal of the connector of the present invention is simply required to be two or greater. Moreover, a plurality of terminals for different uses may be provided to the connector of the present invention, and the number of the terminal plates configuring each terminal may vary depending on the use. For example, the connector of the present invention may be provided with a power supply terminal including five terminal plates and a signal terminal including three terminal plates.

[0067] Moreover, the present invention can be modified appropriately within the scope that does not contradict the gist or principles of the invention that can be read from the claims and the entire specification. The technical principles of the present invention also include an electrical connector involving such a modification.

[0068] The foregoing detailed description has been presented for the purposes of illustration and description. Many modifications and variations are possible in light of the above teaching. It is not intended to be exhaustive or to limit the subject matter described herein to the precise form disclosed. Although the subject matter has

been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims appended hereto.

Claims

1. An electrical connector comprising:

   a terminal including a circuit connection portion connected to a circuit on a board, a contact portion configured to contact a terminal of a counterpart connector, and a spring portion connecting the circuit connection portion and the contact portion in such a manner as to enable the contact portion to move with respect to the circuit connection portion;
   a fixed housing fixed to the board; and
   a movable housing movable with respect to the fixed housing, the movable housing supporting the contact portion, wherein
   the terminal is formed by laminating a plurality of terminal plates independent of each other in a thickness direction of the plurality of terminal plates.

2. The electrical connector according to claim 1, wherein two adjacent terminal plates among the plurality of terminal plates are in contact with each other.

3. The electrical connector according to claim 1 or 2, wherein the plurality of terminal plates has the same shape.

4. The electrical connector according to any of claims 1 to 3, wherein
   each of the terminal plates includes: a connection plate portion forming the circuit connection portion; a contact plate portion forming the contact portion; and a spring plate portion forming the spring portion,
   the circuit connection portion is formed by laminating the connection plate portions of the plurality of terminal plates in the thickness direction of the connection plate portions of the plurality of terminal plates,
   the contact portion is formed by laminating the contact plate portions of the plurality of terminal plates in the thickness direction of the contact plate portions of the plurality of terminal plates, and
   the spring portion is formed by laminating the spring plate portions of the plurality of terminal plates in the thickness direction of the spring plate portions of the plurality of terminal plates.

5. The electrical connector according to claim 4, wherein
   the movable housing is provided with a supporting hole or a supporting groove for supporting the contact portion, and
   the contact plate portions of the plurality of terminal plates are all inserted together into the supporting hole or the supporting groove in a laminated form.

6. The electrical connector according to claim 5, wherein
   the contact plate portion of each of the terminal plates curves in the thickness direction of the contact plate portion,
   the supporting hole or supporting groove extends linearly, and
   the contact plate portion of each of the terminal plates is inserted into the supporting hole or supporting groove in a linearly and elastically deformed state.

7. The electrical connector according to claim 4 or 5, wherein
   a protruding portion is formed on one of opposing surfaces of the contact plate portions of two adjacent terminal plates among the plurality of terminal plates,
   a recessed portion is formed on the other surface, and
   the protruding portion is inserted into the recessed portion.

FIG. 1

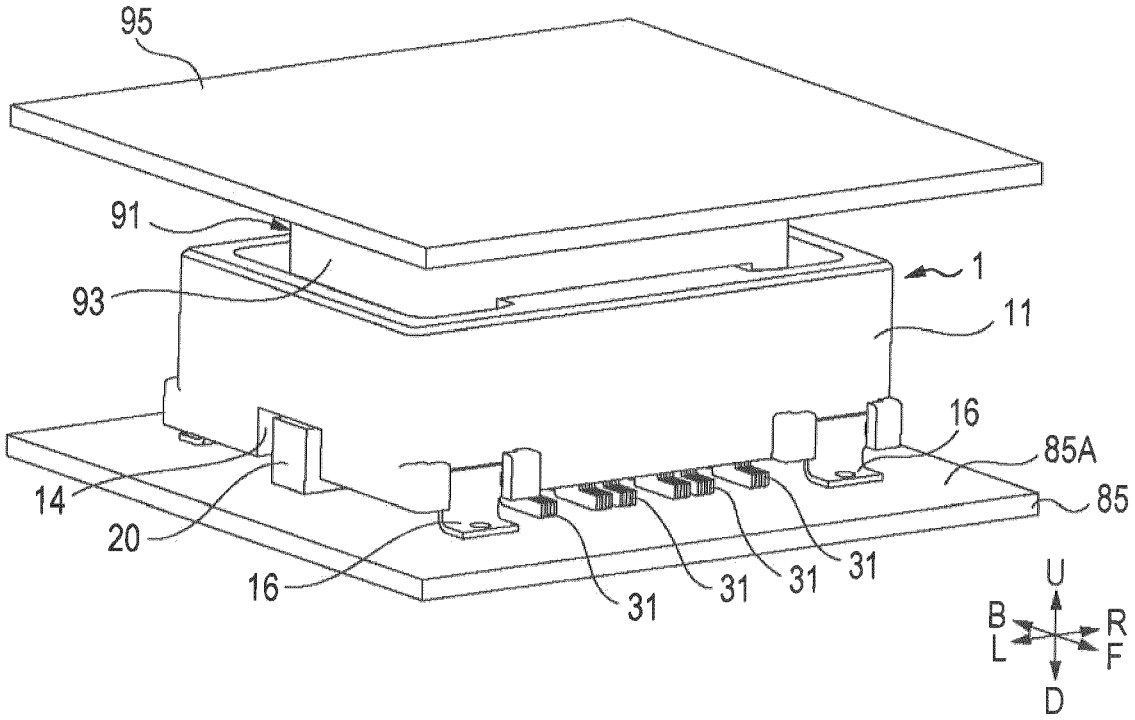

FIG. 2

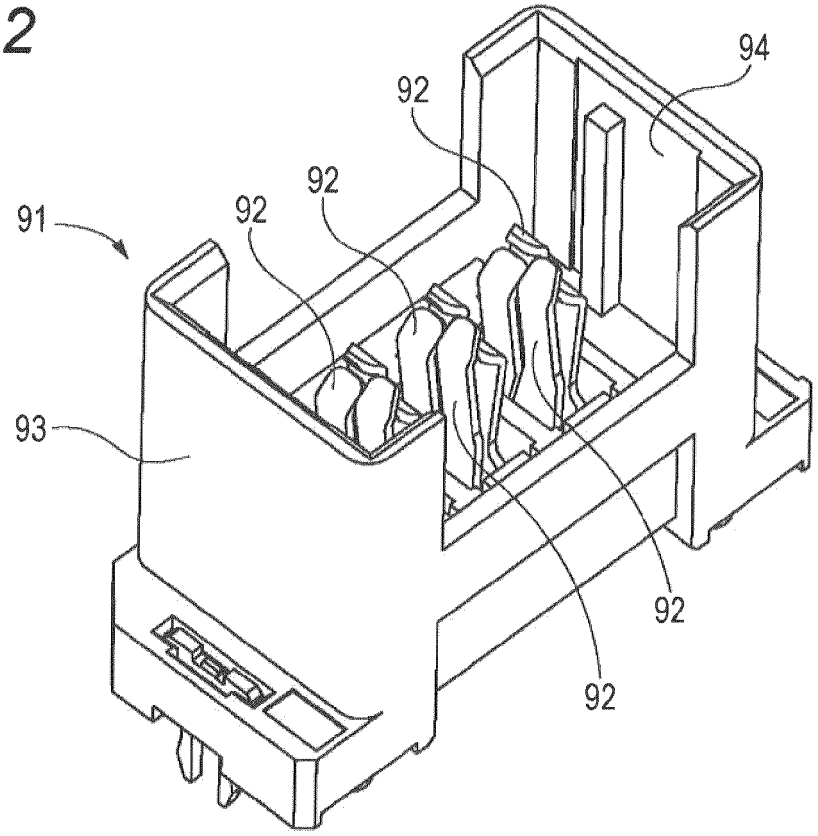
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FIG. 3

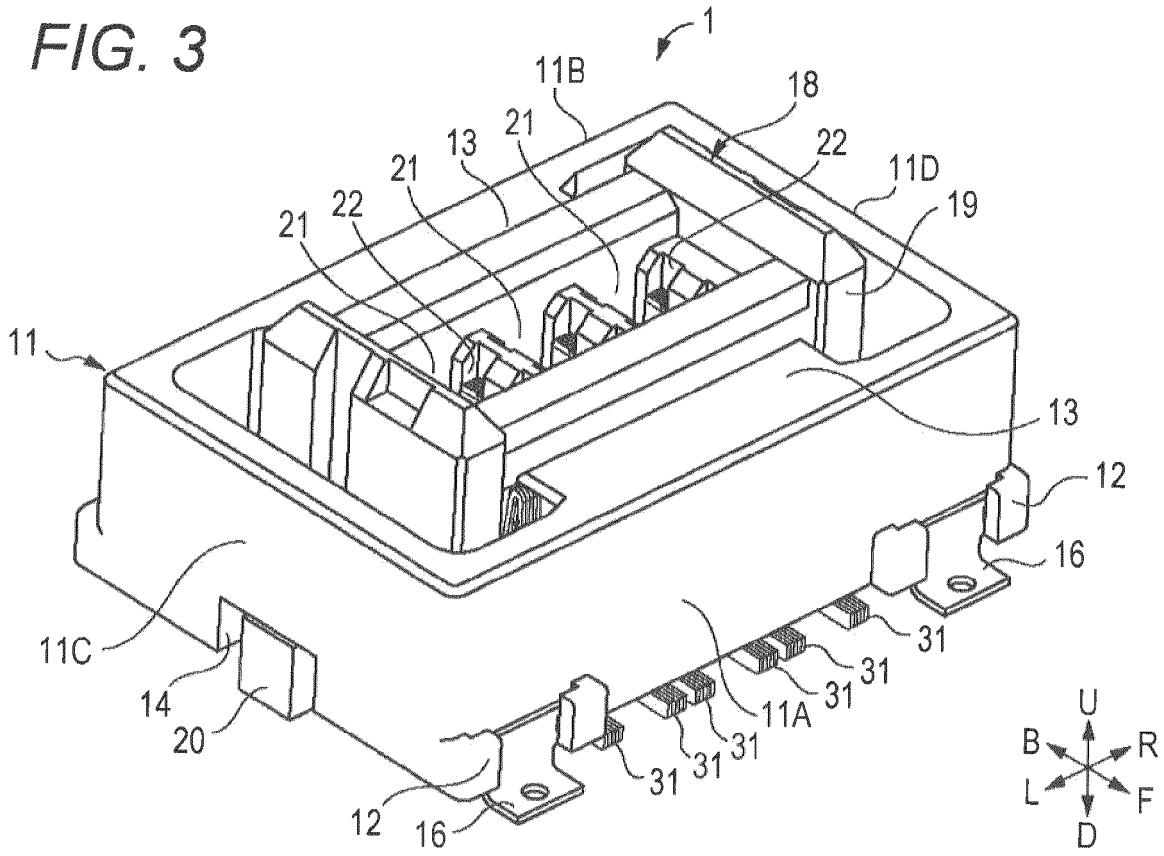
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FIG. 4

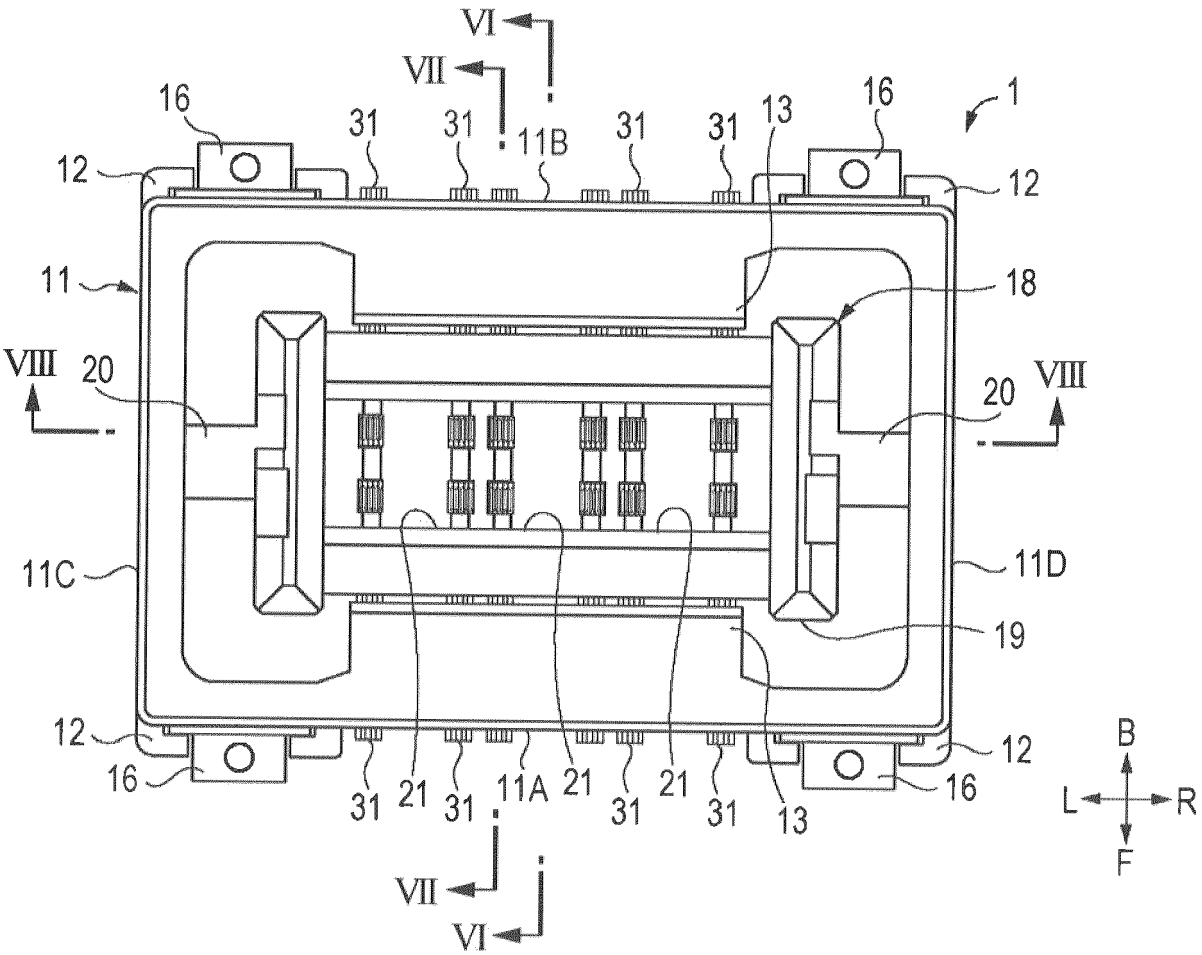
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FIG. 5

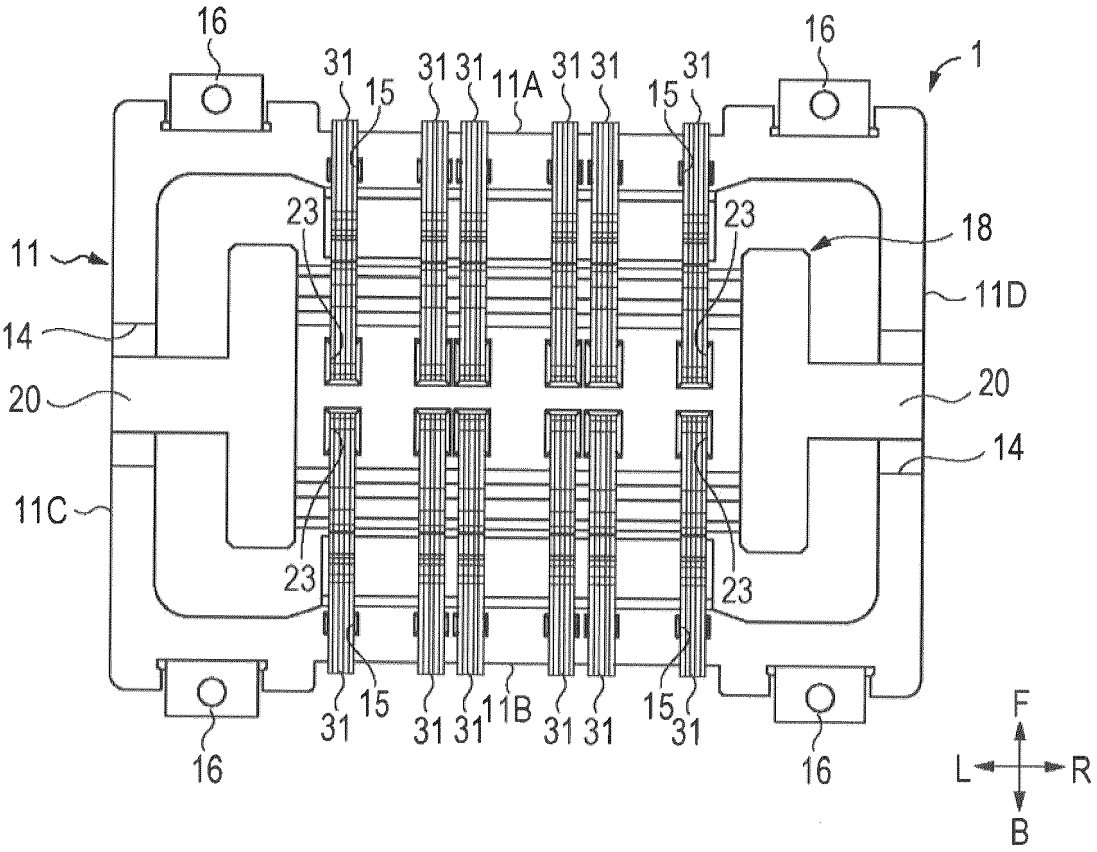
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FIG. 6

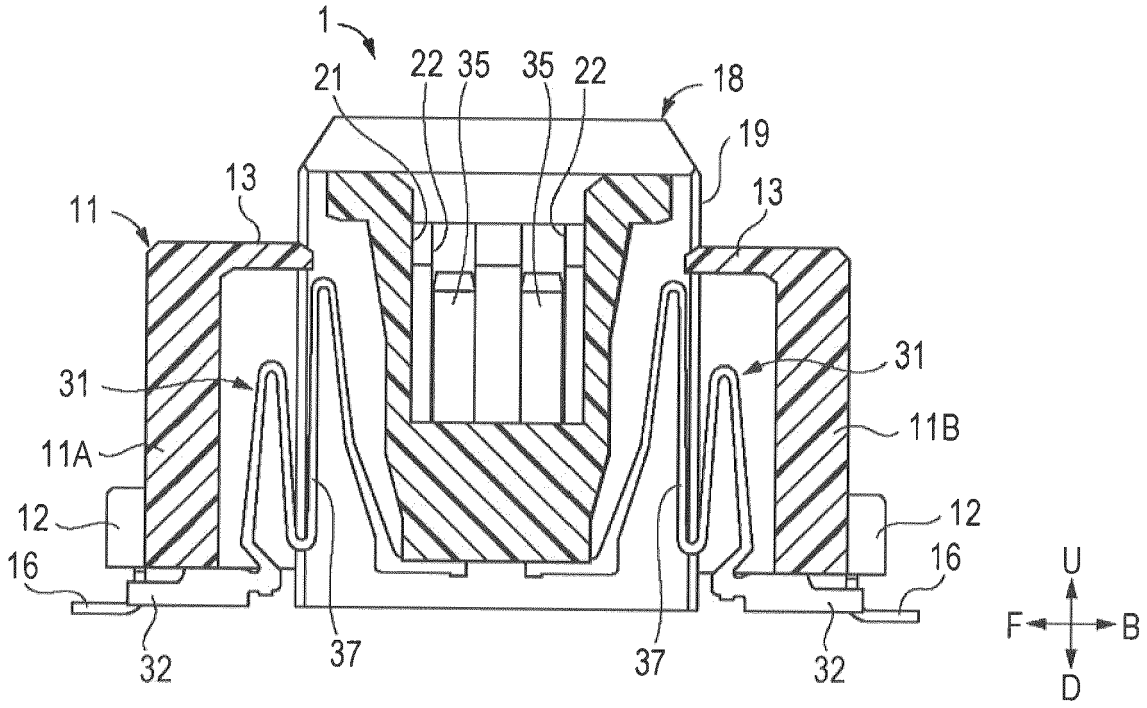
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FIG. 7

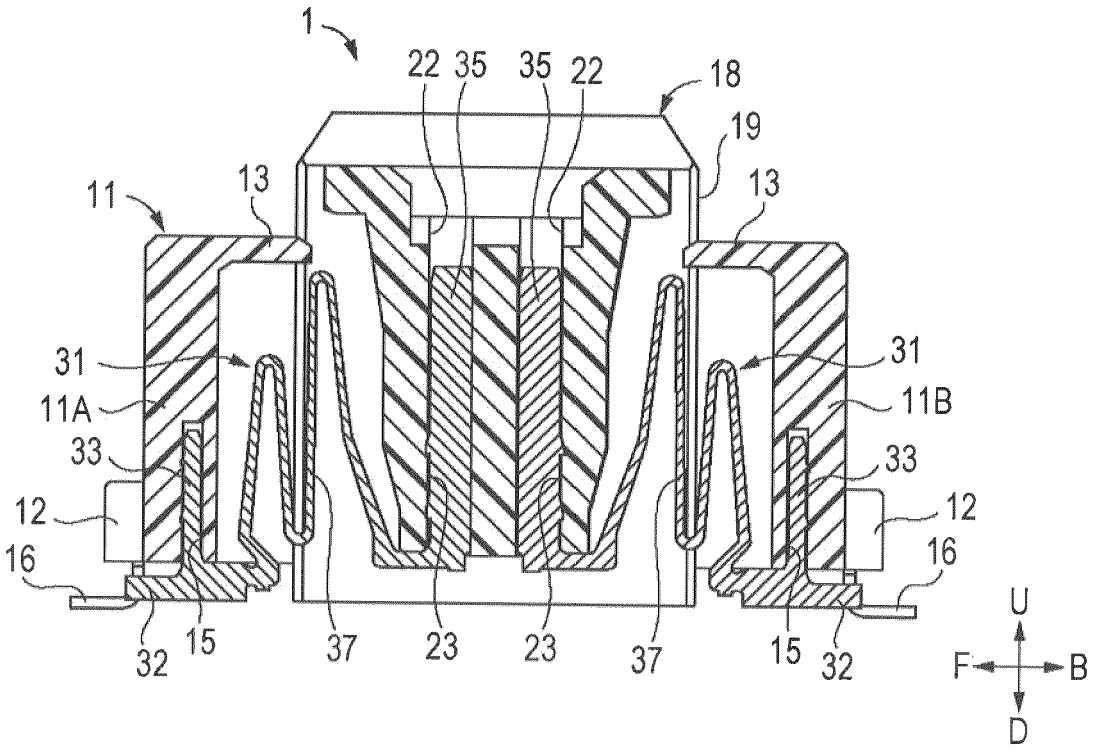
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FIG. 8

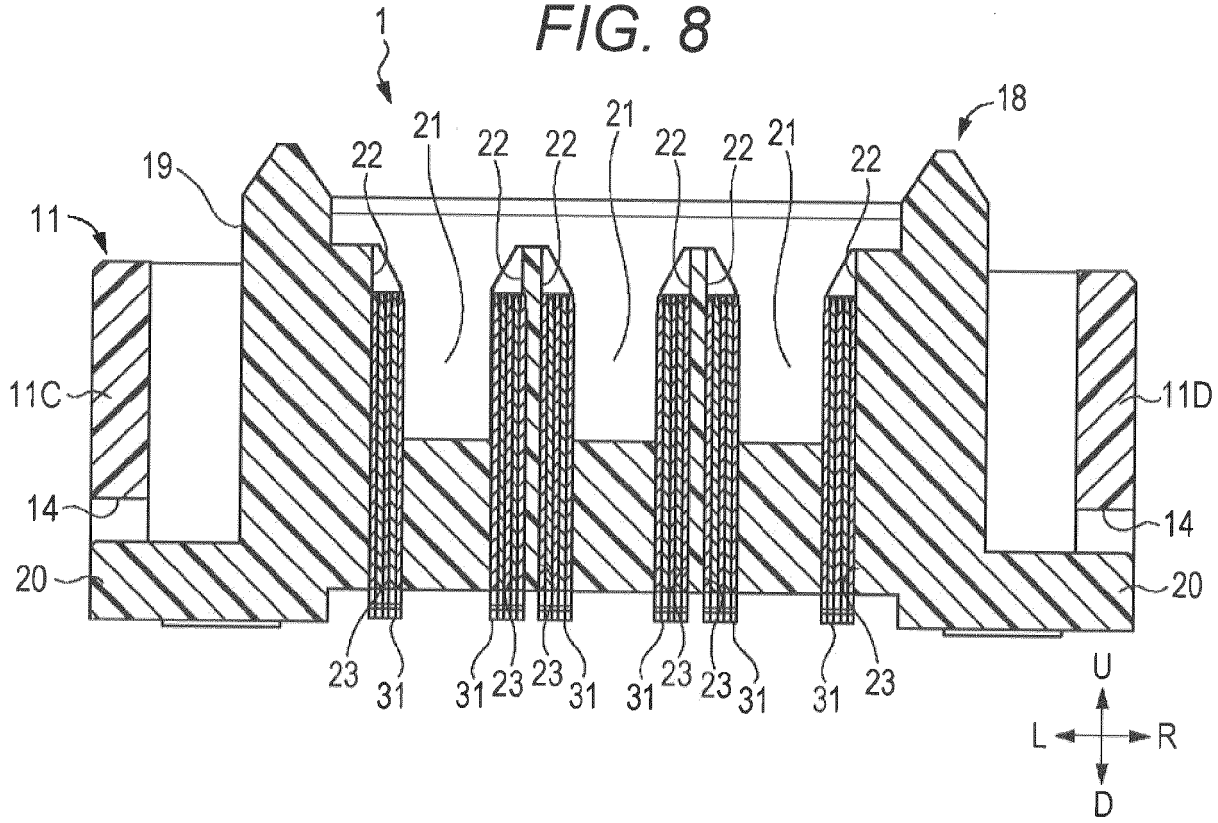
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FIG. 9

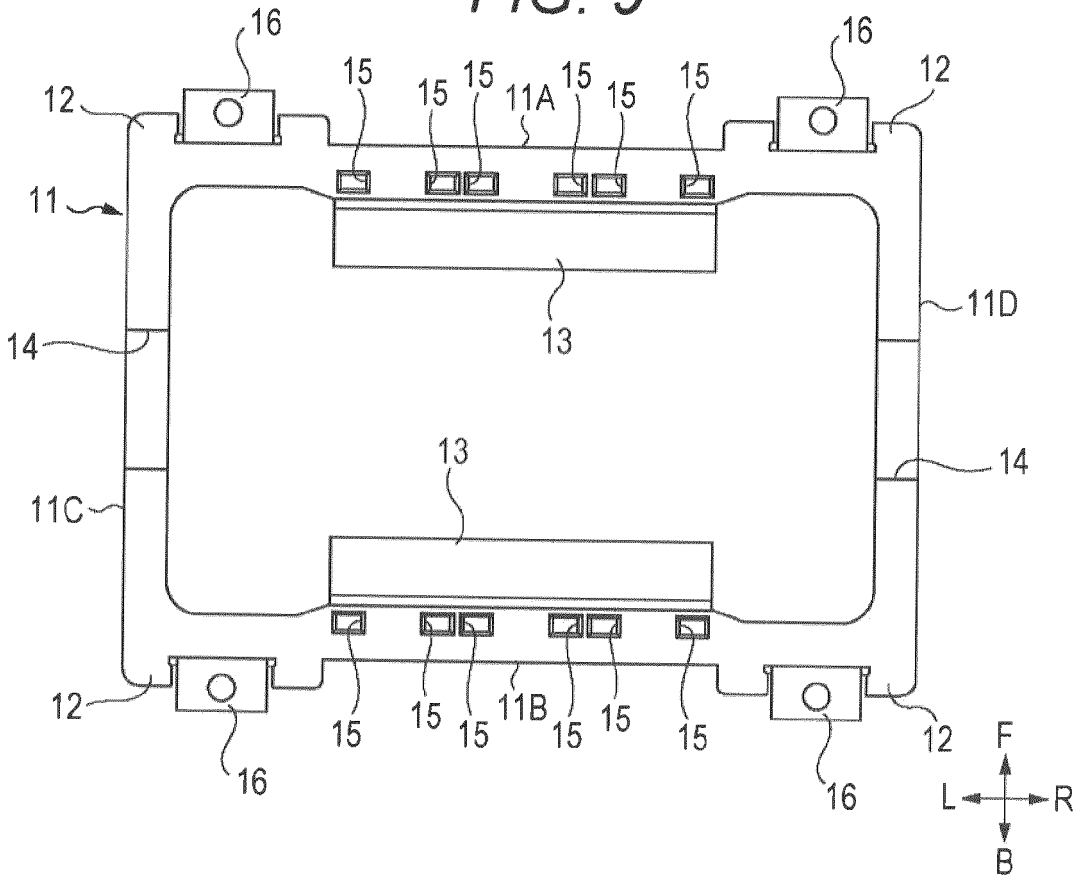
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FIG. 10

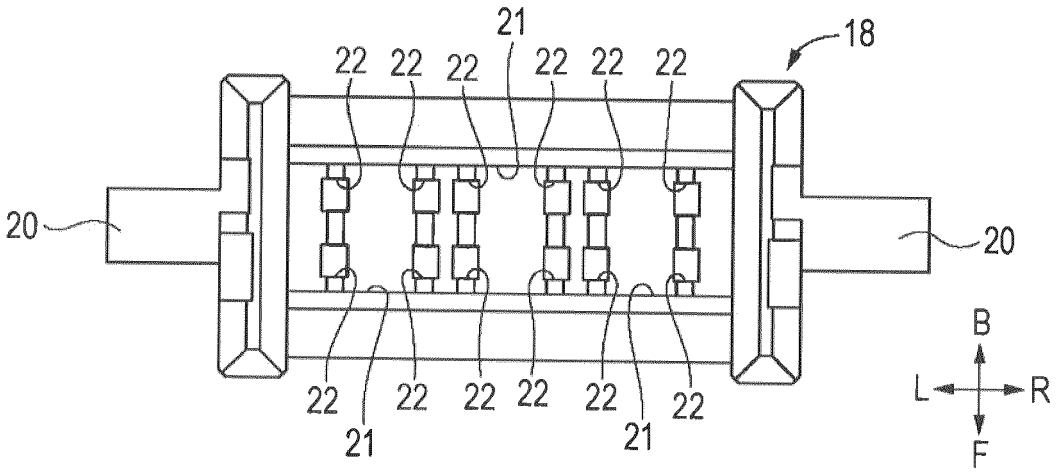
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FIG. 11

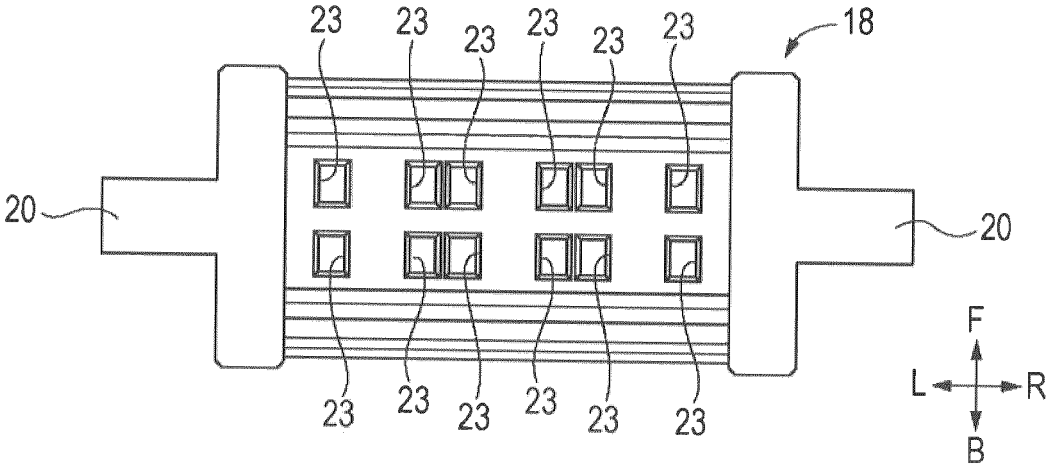
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FIG. 12

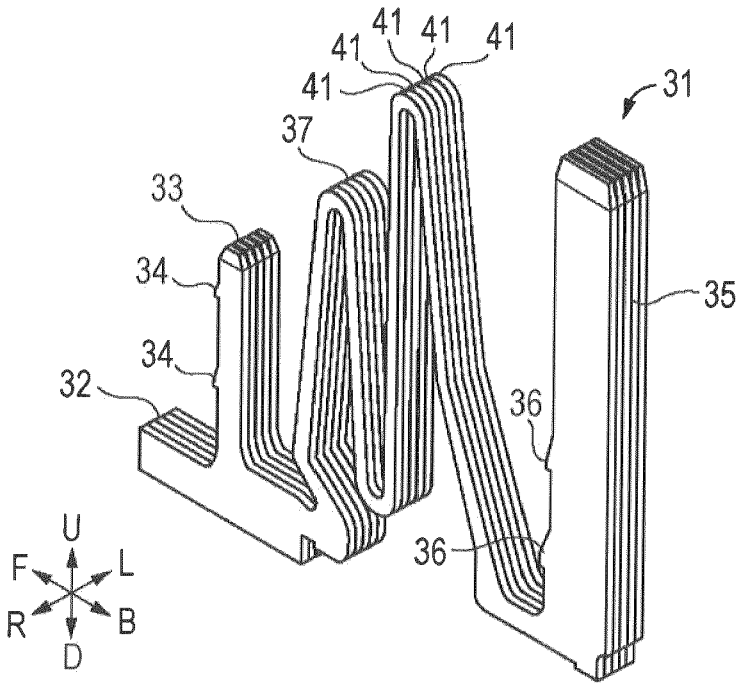
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FIG. 13

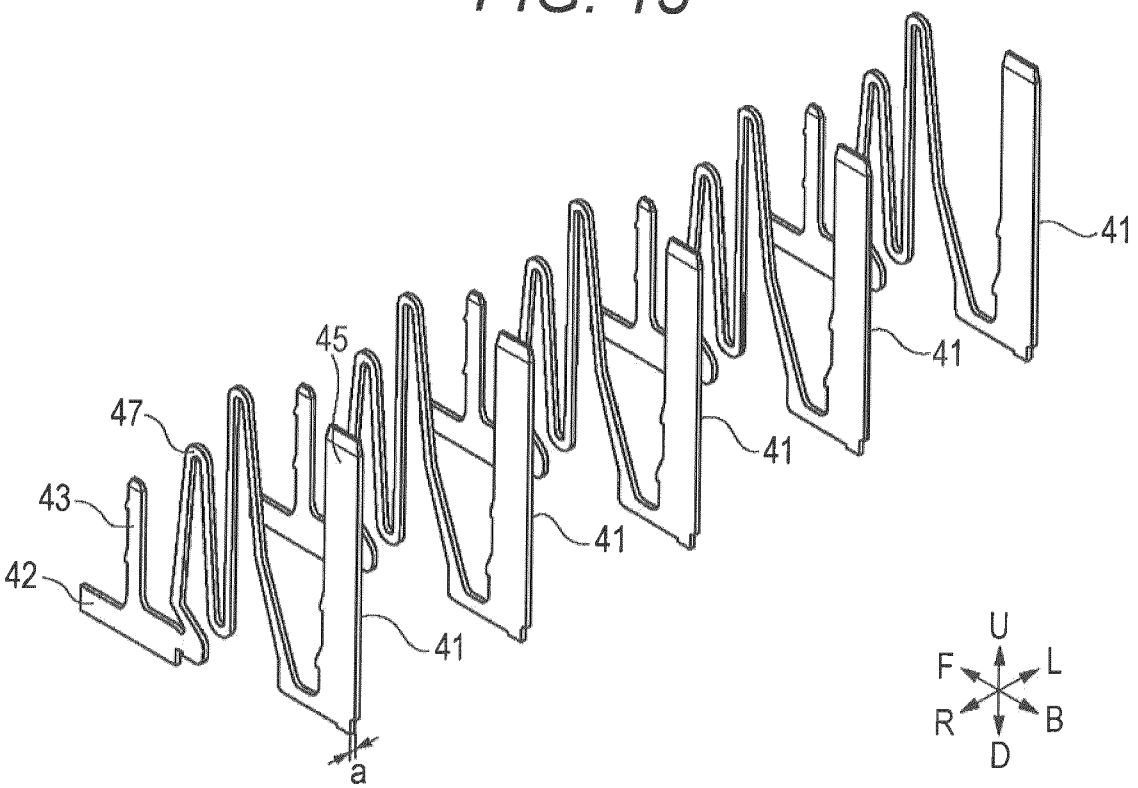
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FIG. 14

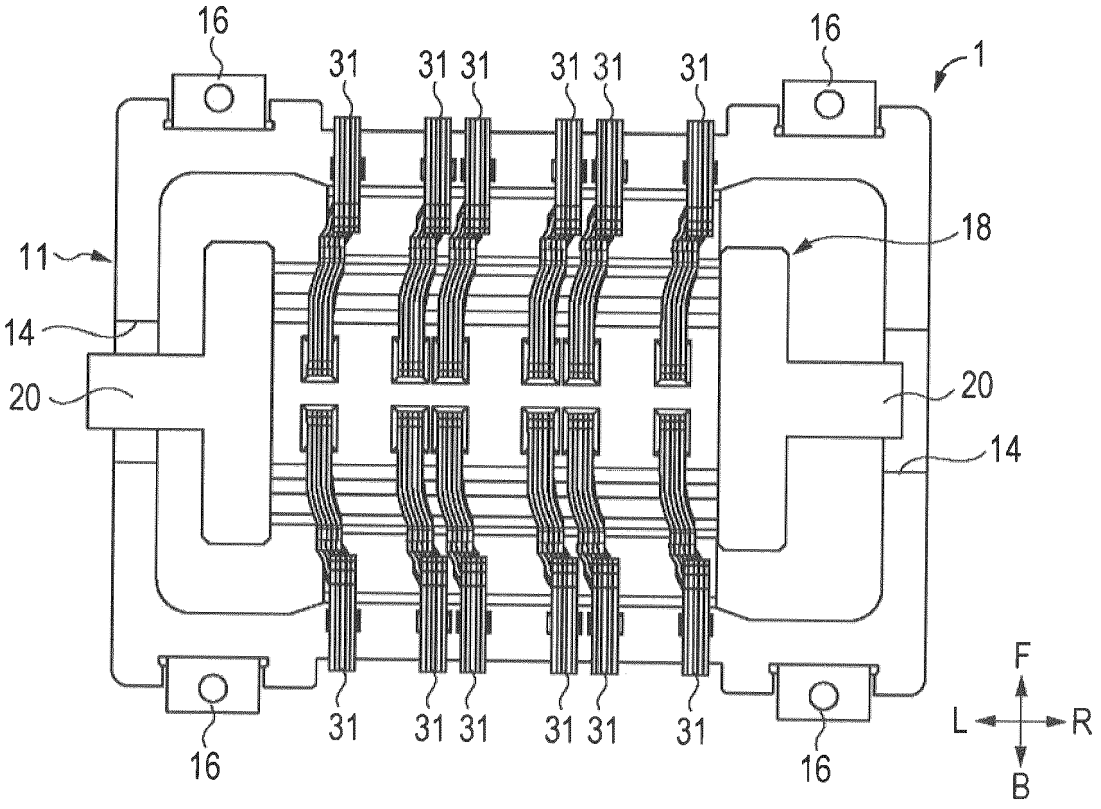


FIG. 15A

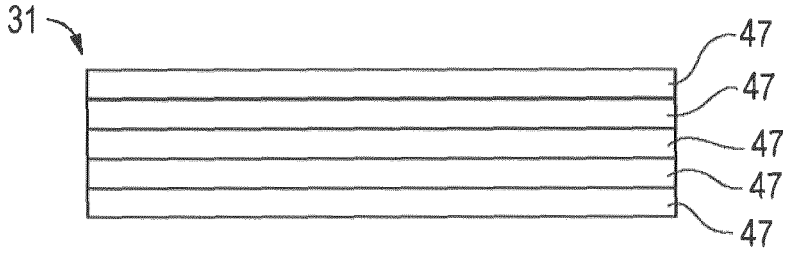


FIG. 15B

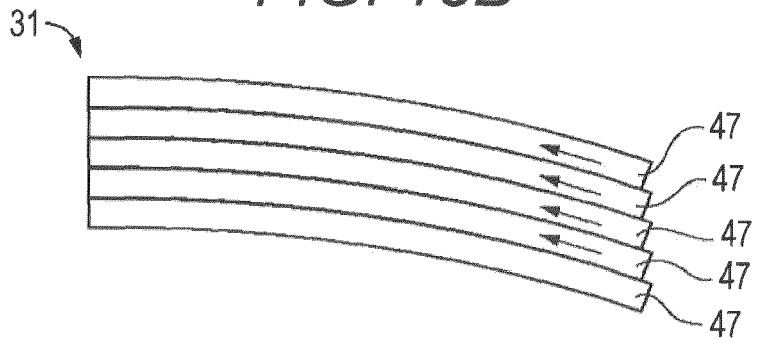


FIG. 16

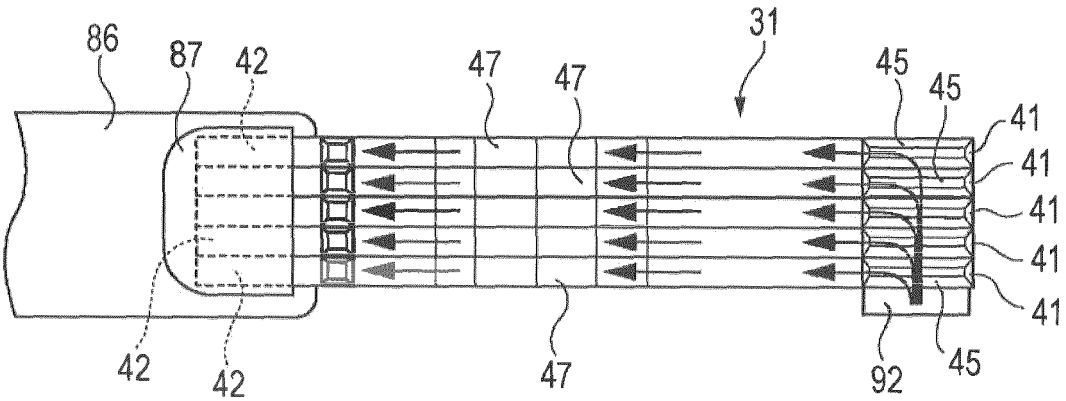


FIG. 17B

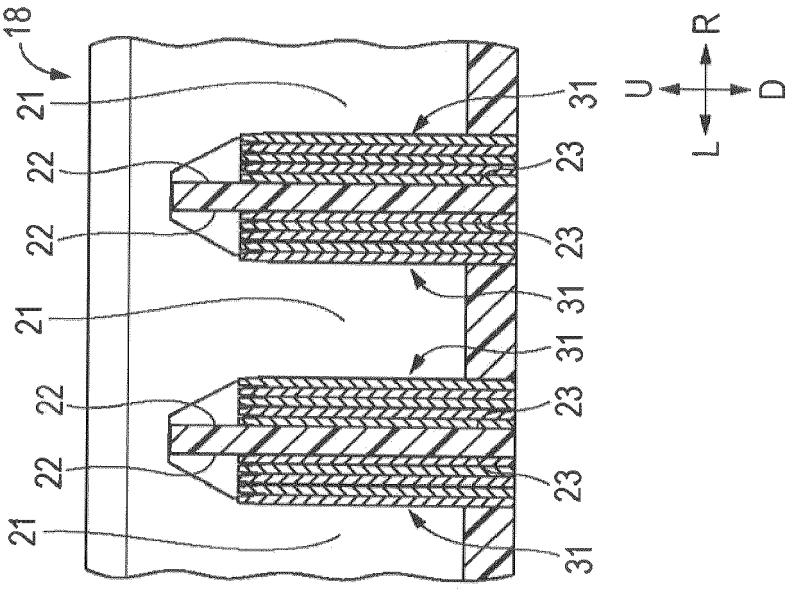


FIG. 17A

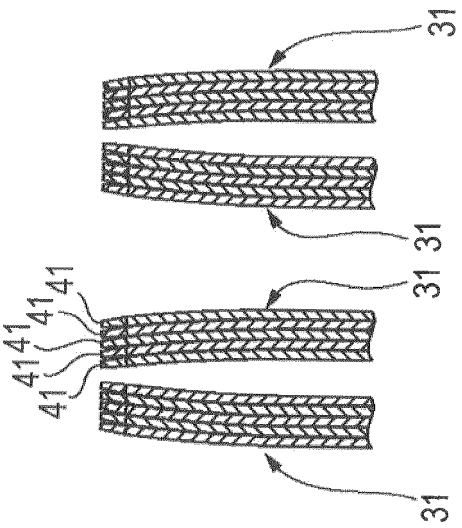


FIG. 18B

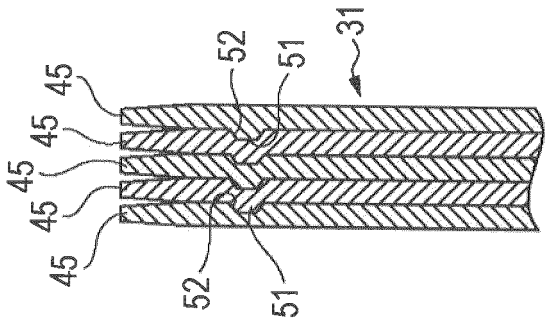


FIG. 18A

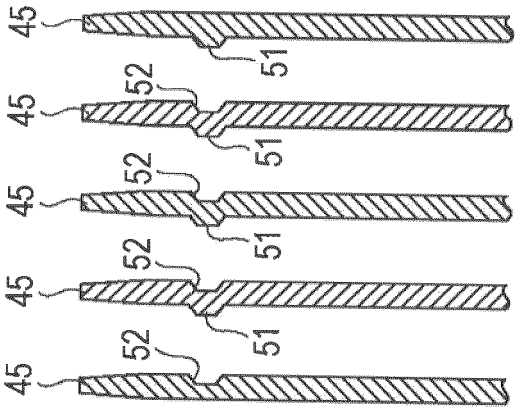


FIG. 19

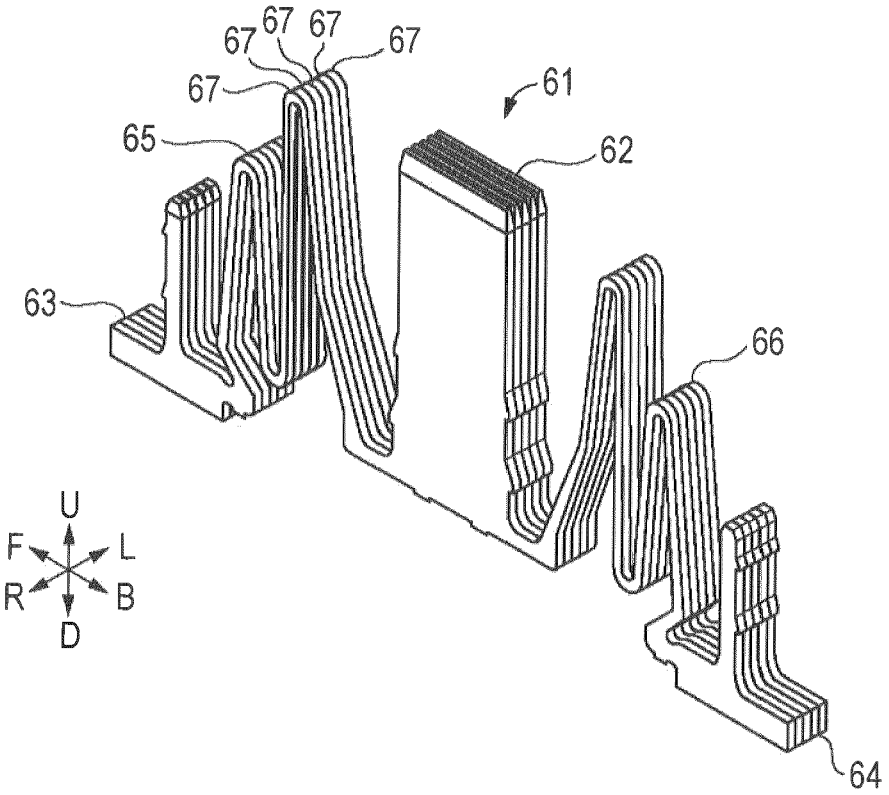


FIG. 20A

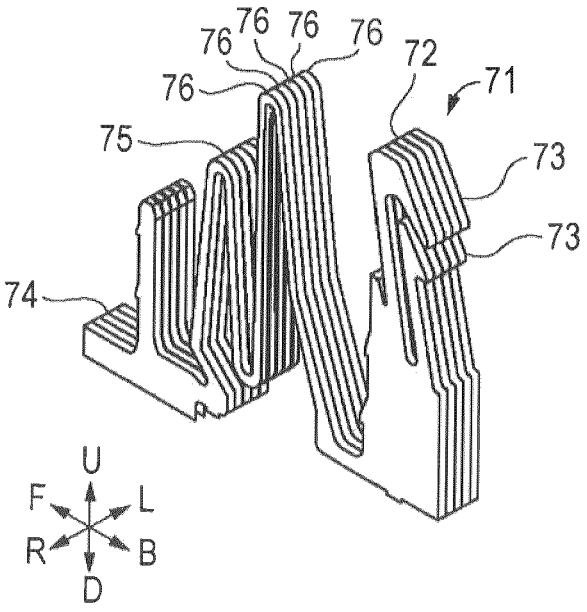
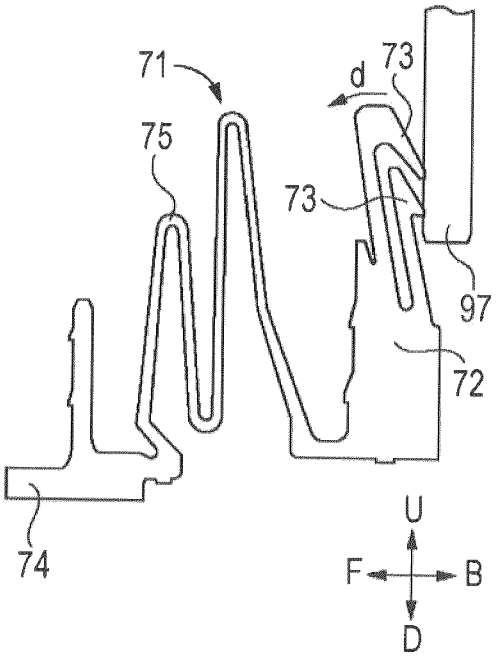


FIG. 20B



Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 7408

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2019/052002 A1 (HASEGAWA YOHEI [JP] ET AL) 14 February 2019 (2019-02-14) * paragraphs [0057], [0035]; figures 2(A),2(B),4 * -----	1-7	INV. H01R12/57 H01R12/73 H01R12/91
Y	WO 2018/039123 A1 (INTERPLEX IND INC [US]) 1 March 2018 (2018-03-01) * paragraph [0020]; figure 2 * -----	1-7	ADD. H01R12/71 H01R13/41
Y	EP 2 110 888 A2 (MORSETTITALIA SPA [IT]) 21 October 2009 (2009-10-21) * figure 3a * -----	1-7	
Y	EP 3 249 752 A1 (HIROSE ELECTRIC CO LTD [JP]) 29 November 2017 (2017-11-29) * figure 3(B) * -----	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 January 2021	Vautrin, Florent

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