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(54) **Title**: CIRCUIT BOARD CONNECTOR

(57) **Abstract**: A board-to-board connector comprises a first connector comprising a first terminal and a first housing having a first joining guide part formed on both longitudinal ends, a second connector comprising a second terminal joining together with the first terminal and a second housing having a second joining guide part joining with the first joining guide part and formed on both longitudinal ends, and a switch closing a detection circuit electrically detecting a complete joining of the first connector and second connector. The switch contains switching materials capable of contacting each other, the contact part of one switching material being an oblique part, and the direction of extension of the oblique part being diagonal with respect to the direction of extension of a straight part that is a contact part of the other switching material.

CIRCUIT BOARD CONNECTOR

REFERENCE TO RELATED APPLICATIONS

[0001] The Present Disclosure claims priority to prior-filed Japanese Patent Application No. 2011-083271, entitled "Circuit Board Connector For Circuit Boards," filed on 05 April 2011 with the Japanese Patent Office. The content of the aforementioned Patent Application is fully incorporated in its entirety herein.

BACKGROUND OF THE PRESENT DISCLOSURE

[0002] The Present Disclosure relates, generally, to a circuit board connector for circuit boards.

[0003] Previously, in order to electrically connect a pair of parallel circuit boards, a board-to-board connector was used. Such connectors were placed on mutually facing sides of a pair of boards and crimped together to create an electrical connection. In addition, technology has been proposed for causing retaining fixtures mounted at both ends to function as locking materials, retaining the crimped status with respect to the opposing connector. An example of this type of connector is disclosed in Japanese Patent Application No. 2004-55306, the content of which is fully incorporated in its entirety herein.

[0004] Fig. 14 illustrates an oblique drawing showing the status of a conventional board-to-board connector, before joining. Referring to Fig. 14, 801 is one connector, being one of a pair of board-to-board connectors, mounted on the front surface of first board 891. Also, 901 is a second connector, being the other of a pair of board-to-board connectors, and is mounted on the front surface of second board 991. The first contact 801 has first housing 811, and a multiplicity of first contacts 861 mounted on the first housing 811, and also the second connector 901 has second housing 911 and a multiplicity of second contacts 961 mounted on the second housing 911. In addition, corresponding first terminals 861 and second terminals 961 electrically connect first board 891 and second board 991 when first connector 801 and second connector 901 are joined.

[0005] Also, in first housing 811 is formed a recessed part 812 accommodating second housing 911, as well as a joining elevated part 813 that joins with the recessed part 812. Conversely, in second housing 911 is formed a joining recessed part 913 that contains a joining elevated part 813. In addition, a first fitting 851 is attached at the longitudinal end of first housing 811. The

first fitting 851 is provided with a first tail part 852 soldered onto the surface of first board 891, and also is provided with a protruding first locking protrusion 853. Also, a second fitting 951 is attached at the longitudinal end of second housing 911. The second fitting 951 is provided with a second tail part 952 soldered onto the surface of second board 991, and also is provided with a protruding second locking protrusion 953.

[0006] Thus, when first connector 801 and second connector 901 join, joining elevated part 813 and joining recessed part 913 join together, and also first locking protrusion 853 of first fitting 851, and second locking protrusion 953 of second fitting 951, join together. By this means, first connector 801 and second connector 901 are locked together, and the locked state is maintained. Note also that in joining, either one or the other of first connector 801 and second connector 901 are joined to the other in a in vertically inverted position.

SUMMARY OF THE PRESENT DISCLOSURE

[0007] However, in the conventional board-to-board connector, it is difficult to verify whether first connector 801 and second connector 901 are completely joined. In other words, when first connector 801 and second connector 901 join, either one or the other is vertically inverted and second housing 911 is contained within the recessed part 812 of first housing 811, and therefore it is not possible to visually verify whether first locking protrusion 853 of first fitting 851 positioned on the inside of the recessed part 812 has joined with second protrusion 953 of second fitting 951 attached to second housing 911.

[0008] Of course, it is possible visually to determine whether the joining of first connector 801 and second connector 901 is incomplete in the event that the protrusion of second housing 911 from the upper end of first housing 811 is large. However, because first board 891 and second board 991 are attached to the lower surfaces of first housing 811 and second housing 911, and are far larger than the lower surfaces of first housing 811 and second housing 911, it is difficult to visually verify the degree to which second housing 911 protrudes from the upper end of first housing 811. In particular, due to reduced sizes and lower profiles of board-to-board connectors in recent years, it is extremely difficult to accurately determine by visual inspection the degree to which second housing 911 protrudes from the upper end of first housing 811, and to determine accurately whether first connector 801 and second connector 901 are fully joined.

[0009] The Present Disclosure has the purpose of resolving the aforementioned problems with conventional board-to-board connectors, by providing a highly reliable board-to-board connector by means of electrical detection of complete joining of a first connector and second connector, thereby enabling accurate detection of complete joining of a first connector and second connector even in joining operations for smaller-size, lower-profile board-to-board connectors, and to accurately prevent the occurrence of incomplete joining in a joining process.

[0010] For this purpose, a board-to-board connector according to the Present Disclosure comprises a first connector comprising a first terminal and a first housing having a first joining guide part formed on both longitudinal ends, a second connector comprising a second terminal joining together with the first terminal and a second housing having a second joining guide part joining with the first joining guide part and formed on both longitudinal ends, and a switch closing a detection circuit electrically detecting a complete joining of the first connector and second connector. The switch contains switching materials capable of contacting each other, the contact part of one switching material being an oblique part, and the direction of extension of the oblique part being diagonal with respect to the direction of extension of a straight part that is a contact part of the other switching material.

[0011] In addition, the first connector has a first reinforcing fitting placed on the first joining guide, and the second connector has a second reinforcing fitting placed on the second joining guide. One of the switching materials is the first reinforcing fitting, and the other of the switching materials is the second reinforcing fitting.

[0012] In addition, the first reinforcing fitting contains a flexible contact piece, and the second reinforcing fitting contains a fixed contact piece. When the first connector and second connector move in the joining direction relatively to each other, the oblique part on the end of the flexible contact piece is displaced in elastic fashion while maintaining contact with the straight part on the tip of the fixed contact piece. In addition, the oblique part and straight part rub against each other in a wiping motion.

[0013] In addition, the first reinforcing fitting and second reinforcing fitting are electrically connected to a fixing pad on the circuit boards. Detection pads are formed on the boards, and the detection pads form the ends of the detection circuit.

[0014] By means of the Present Disclosure, a board-to-board connector electrically detects complete joining of a first connector and a second connector. It is then possible to accurately

detect complete joining of a first connector and second connector even in joining operations for smaller-size, lower-profile board-to-board connectors, and to accurately prevent the occurrence of incomplete joining in a joining process, thereby increasing reliability.

BRIEF DESCRIPTION OF THE FIGURES

[0015] The organization and manner of the structure and operation of the Present Disclosure, together with further objects and advantages thereof, may best be understood by reference to the following Detailed Description, taken in connection with the accompanying Figures, wherein like reference numerals identify like elements, and in which:

[0016] Figure 1 is an oblique view from the joining surface side of a first connector of the Present Disclosure;

[0017] Figure 2 is an oblique view from the mounting surface side of the first connector of Fig. 1;

[0018] Figure 3 is an oblique view showing a first reinforcing fitting according to the Present Disclosure;

[0019] Figure 4 is a drawing from the joining surface side of the first connector of Fig. 1, being an oblique view showing the first connector and a second connector in a mutually joined state;

[0020] Figure 5 is an oblique view from the joining surface side of the second connector of Fig. 2;

[0021] Figure 6 is an oblique view from the mounting surface side of the second connector of Fig. 2;

[0022] Figure 7 is an oblique view of a second reinforcing fitting according to the Present Disclosure;

[0023] Figure 8 is an oblique view showing the relation of a circuit board and a board-to-board connector according to the Present Disclosure;

[0024] Figure 9 is a cross sectional view along Line A-A of Fig. 4, being a cross sectional view showing the relation of a first terminal and second terminal in a state of complete joining of board-to-board connectors according to the Present Disclosure;

[0025] Figure 10 is a cross sectional view along Line B-B of Fig. 4, being a cross sectional view showing the relation of a first reinforcing fitting and a second reinforcing fitting in a state of complete joining of board-to-board connectors according to the Present Disclosure;

[0026] Figure 11 is an oblique view showing a state of connection of a switching contact piece and a first contact piece according to the Present Disclosure;

[0027] Figure 12 is an oblique view showing changes in positional relation between a straight part of a switching contact piece and an oblique part of a first contact piece according to the Present Disclosure, whereby (a) is a drawing showing the state wherein contact begins between the first contact piece and switching contact piece, and (b) is a drawing showing the state wherein the first contact piece is flexibly deformed;

[0028] Figure 13 is a flat drawing showing changes in positional relation between a straight part of a switching contact piece and an oblique part of a first contact piece according to the Present Disclosure, whereby (a) is a drawing showing the state wherein contact begins between the first contact piece and switching contact piece, and (b) is a drawing showing the state wherein the first contact piece is flexibly deformed; and

[0029] Figure 14 illustrates a conventional board-to-board connector.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] While the Present Disclosure may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the disclosure is to be considered an exemplification of the principles of the Present Disclosure, and is not intended to limit the Present Disclosure to that as illustrated.

[0031] As such, references to a feature or aspect are intended to describe a feature or aspect of an example of the Present Disclosure, not to imply that every embodiment thereof must have the described feature or aspect. Furthermore, it should be noted that the description illustrates a number of features. While certain features have been combined together to illustrate potential system designs, those features may also be used in other combinations not expressly disclosed. Thus, the depicted combinations are not intended to be limiting, unless otherwise noted.

[0032] In the embodiments illustrated in the Figures, representations of directions such as up, down, left, right, front and rear, used for explaining the structure and movement of the various elements of the Present Disclosure, are not absolute, but relative. These representations are appropriate when the elements are in the position shown in the Figures. If the description of the position of the elements changes, however, these representations are to be changed accordingly.

[0033] Referring to Figs. 1-4, 1 is a first connector, being a surface-mounted connector mounted on first board 91 described below, and is one of a pair of board-to-board connectors in the present preferred embodiment. Also, 101 is a second connector, being a surface mount type connector mounted on the surface of second board 191 described below, and is the other of a pair of board-to-board connectors in the present preferred embodiment. A board-to-board connector according to the Present Disclosure electrically connects first board 91 and second board 191, including the first connector 1 and second connector 101. Note also that first board 91 and second board 191 may be, for example, printed circuit boards used in electronic devices, preferably of FFC (flexible flat cable) or FPC (flexible printed circuit), but may be boards of any type.

[0034] The first conductor 1 has a first housing 11, being a connector body formed as one unit from an insulative material. The first housing 11 has the approximate shape of a rectilinear thick slab as shown in the drawing, and recessed part 12, approximately rectangular in shape and enclosed around its periphery, is formed on the joining surface thereof, namely the side where it joins with second connector 101 (the top side in Figure 1). The first connector 1 has dimensions of, for example, approximately 10.0 mm vertically, approximately 2.5 mm horizontally, and approximately 1.0 mm in thickness; however the dimensions may be changed as appropriate. Also, inside the recessed part 12 is formed first elevated part 13, like an island formed as one unit with first housing 11, and on both sides of the first protruding part 13, side wall part 14 is formed as one unit with first housing 11, extending parallel to the first elevated part 13. In this case, the first elevated part 13 and side wall part 14 protrude from the bottom surface of recessed part 12 and extend in the longitudinal direction of first housing 11. By this means, groove part 12a, a long narrow recessed part extending in the longitudinal direction of first housing 11, is formed as a part of recessed part 12, between the two sides of the first elevated part 13, specifically between first elevated part 13 and side wall part 14. Note also that in the example shown in the drawing, the elevated part 13 is singular, however it may also be plural, and the number thereof may be any number. Also the elevated part 13 has dimensions of, for example, approximately 0.6 mm in width, but the dimensions may be changed as appropriate.

[0035] Thus, first terminal receiving inner side cavities 15a are formed in a groove shape in the side surfaces of both sides of the first elevated part 13. Also, first terminal receiving outer side cavities 15b are formed in a groove shape in the side surfaces on the inside of the side wall part

14. As the first terminal receiving inner side cavities 15a and first terminal receiving outer side cavities 15b form one body in the bottom surface of groove part 12a, we will collectively describe first terminal receiving inner side cavities 15a and first terminal receiving outer side cavities 15b together, speaking of first terminal receiving cavities 15.

[0036] The first terminal receiving cavities 15 are formed, for example six each in number, at a spacing of approximately 0.4 mm in both sides of first elevated part 13. Also, first terminals 61 contained in each first terminal receiving cavity 15, are placed, for example six each in number, at a spacing of approximately 0.4 mm in both sides of first elevated part 13. Note also that the spacing and number of first terminal receiving cavities 15 may be varied as appropriate.

[0037] The first terminals 61 are formed as one unit by processes such as punching, bending etc. Further, they are comprised of retained parts 63 and tail parts 62 connected to the lower end of the retained parts 63, upper side connecting parts 67 connecting to the upper end of the retained parts 63, second connecting parts 66 formed as second contact protruding parts in the inner terminal vicinity of the upper side connecting parts 67, lower side connecting parts 64 connected to the second connecting parts 66, and first connecting parts 65 formed as first connecting protrusions in the vicinity of the free end of the lower side connecting parts 64.

[0038] Also, the retained parts 63 extend in the vertical direction, namely the direction of thickness of first housing 11, and are the parts joined and retained to the first terminal receiving outer side cavities 15b. The tail parts 62 are bent against and connected to retained parts 63, and extend in the left-to-right direction, namely in the direction of the width of and towards the outside of first housing 11, and are connected to a terminal connecting pad communicating to an electroconductive trace on first board 91. In addition, the upper side connecting parts 67 are bent against and connected to retained parts 63, and extend in the direction of the width of and towards the inside of first housing 11.

[0039] The inner end of the upper side connecting parts 67 is bent downward, and forms second contact parts 66 bent and to protrude towards the inside in the direction of the width of first housing 11. Also the lower side connecting parts 64 are parts that have a U-shaped side surface contacting the lower end of the second contact parts 66. The free end of the lower side connecting parts 64, namely the vicinity of the upper end of the inner part, is bent in a U-shape, and forms first contact parts 65 bent and protruding toward the outer side in the direction of the width of first housing 11.

[0040] The first terminals 61 are joined into first terminal receiving cavity 15 from the mounting surface side (the upper side in Fig. 2), and retained parts 63 are affixed to first housing 11 by being pinched from both sides by the side walls of first terminal receiving outer side cavities 15b formed on the side surfaces of the inner side of side walls 14. In this state, where the first terminals 61 are being pushed into first housing 11, the first contact parts 65 and second contact parts 66 are positioned on both the left and right sides of groove part 12a face each other.

[0041] Note also that first terminals 61 are of a material formed as one unit by applying processes to a metal sheet, and therefore have a degree of resilience. And as is clear from this shape, the space between first connecting parts 65 and second connecting parts 66, as they face each other, can be flexibly changed. Specifically, when second terminals 161 of second connector 101 are inserted between first connecting parts 65 and second connecting parts 66, the space between first connecting parts 65 and second connecting parts 66 is thereby flexibly elongated.

[0042] Also, first protruding end parts 21 are placed respectively as a first joining guide part at each longitudinal ends of the first housing 11. At each first protruding end part 21, a protruding end recessed part 22 is formed as one unit with the recessed part 12. The protruding end recessed part 22 is an approximately rectangular recessed part, and is connected to both longitudinal ends of each groove part 12a. In addition, when first connector 1 and second connector 101 are joined, the protruding end recessed parts 22 function as insertion channels wherein second protruding ends 122 provided on the second connector 101, described below, are inserted.

[0043] Further, the first protruding end part 21 is provided with side wall extension parts 21b extending from both longitudinal ends of side wall part 14 in the longitudinal direction of first housing 11, and end wall parts 21c extending in the lateral direction of first housing 11 and with both ends connecting to side wall extension parts 21b. Each first protruding end part 21, end wall parts 21c and side wall extension parts 21b connected to both ends thereof form a continuous side wall with a three-sided open square channel shape, describing three sides of a square section of approximately rectangular protruding end recessed part 22.

[0044] In addition, the first protruding part 21 has first reinforcing fittings 51 attached as a reinforcing fitting. Specifically, two first reinforcing fittings 51 are placed inside each protruding end recessed part 22, and are retained by being contained inside first fitting retaining

recessed part 26 formed in protruding end recessed part 22. Note also that the first reinforcing fittings 51 include first switch fittings 51b and first non-switch fittings 51a, which function as switching materials in a switch for electrically detecting complete joining of first connector 1 and second connector 101. Also, first non-switch fitting retaining slit parts 26a are formed in the side wall extension part 21b, and extend in the direction of the thickness of first housing 11, and first switch fitting retaining slit parts 26b are formed in the end wall part 21c and extend in the direction of the thickness of first housing 11. Note also that the first fitting retaining recessed part 26 is divided left and right (the direction of the width of first housing 11) into two parts by first fitting position restraining part 27 formed as a stopper within protruding end recessed part 22, in the lateral center of first housing 11.

[0045] In the present preferred embodiment, first reinforcing fittings 51 are formed as one unit in an approximately L-shaped form by processes such as punching from a material such as metal and bending, etc. They are connected to retained parts 57 extending in the direction of the thickness of first housing 11 by bending the retained parts 57 at both left and right ends, and also are connected to first board connecting part 56 extending as a main body along the direction of the mounting surface of first housing 11, by the first board connecting part 56, and in addition has first contact piece 58 extending along the mounting surface of first housing 11 as a flexible contact piece. Note that in describing the various parts of first reinforcing fittings 51, a distinction is made between first non-switch fittings 51a and first switch fittings 51b by using a and b after the number for each part.

[0046] In the first reinforcing fittings 51, retained parts 57a, b are inserted from the mounting surface side into first non-switch fitting retaining slit part 26a and first switch fitting retaining slit part 26b, and are fixed to first housing 11 by being pinched from both sides by first non-switch fitting retaining slit part 26a and first switch fitting retaining slit part 26b. Also, the first board connecting parts 56a,b, function as soldering tail parts of first reinforcing fitting 51, and the lower surface thereof is formed essentially parallel to the mounting surface of first housing 11 (the upper surface in Fig. 2), and fixed to first fixing pad 93 of first board 91, described below.

[0047] In addition, the first contact piece 58 is contained within first fixture retaining recessed part 26 so as to be essentially parallel to the mounting surface. Note that a offset level is formed in place of contact between the first board connecting parts 56a, b and first connecting pieces 58a, b, such that first connecting pieces 58a, b are parallel to first board connecting parts 56a, b,

but are positioned more towards the joining surface than are first board connecting parts 56a, b, and the distance from the lower surface thereof to first board 91 is set so as to be greater than the distance from the lower surface of first board connecting parts 56a, b to first board 91.

[0048] Fig. 3 shows the respective positioning of first non-switch fitting 51a and first switch fitting 51b as they are affixed to first housing 11. Fig. 3 may also be described as Fig. 1 with first housing 11 and first terminals 61 deleted. Referring to Fig. 3, first non-switch fitting 51a is positioned so that first contact piece 58a extends towards the lateral center of first housing 11. Also, the end of the first contact piece 58a (the free end) is restrained by first fitting position restraining part 27 in the upper direction (the direction of deflection towards the joining surface).

[0049] Additionally, first switch fitting 51b is positioned so that first contact piece 58b extends towards the longitudinal center of first housing 11. In other words, the direction of extension of first contact piece 58b of first switch fitting 51b is at a right angle to the extension of first contact piece 58a of first non-switch fitting 51a. Also, oblique part 59 is formed at the end of first contact piece 58b and diagonal thereto without crossing the direction of extension thereof. That is, the end of first contact piece 58b is cut so as to be diagonal thereto without crossing the direction of extension thereof. Also, the oblique part 59 functions as a contact part of first switch fitting 51b, and contacts second reinforcing fitting 151 of second connector 101, described below.

[0050] Referring to Figs. 5-7, second connector 101 has a second housing 111, being a connector body formed as one unit from an insulative material. The second housing 111 has dimensions of, for example, approximately 8.0 mm vertically, approximately 1.5 mm horizontally, and about 0.8 mm in thickness; however the dimensions may be changed as appropriate. Also, long and narrow groove parts 113 extending in the longitudinal direction of second housing 111, and second raised parts 112 as long narrow protruding parts extending in the longitudinal direction of second housing 111, are formed as one body on the side where second housing 111 joins with first connector 1, namely the joining surface side (the top side as shown in Fig. 5). The second raised parts 112 are formed along both sides of groove part 113 and along both sides of second housing 111. Also, second terminals 161 are placed as terminals on each second raised part 112.

[0051] As shown, groove part 113 is closed off on the bottom by the side where it is mounted on second board 191, namely the mounting surface (the upper surface in Fig. 6). Note also that in the example shown, there are two of the second raised parts 112 however there may be only one,

or any number. Also, the groove 113 is provided with the dimension of approximately 0.7 mm in width, but the dimension may be varied as appropriate.

[0052] The second terminals 161 are formed as one unit by processes such as punching from electroconductive metal sheet and bending etc. They have a main body not pictured, and tail parts 162 connected to the lower end of the main body, and a first contact part 165 connected to the upper end of the main body, and a connecting part connected to the upper end of the first contact part 165, and a second contact part 166 connected to the outer end of the contact part 164. Note also that on the surface of second contact part 166 is formed second contact groove part 166a where first terminals 61 mate with second contact parts 66.

[0053] Also, the main body is surrounded and retained by the periphery of second housing 11, and is not shown in Figs. 5 or 6. Also, the tail parts 162 extend towards the outside of second housing 111, and extends in the left-to-right direction along the main body (the direction of the width of second housing 111), contacts it at the lower end thereof, and are connected to a terminal contact pad communicating with an electroconductive trace on second board 191.

[0054] In addition, the first contact parts 165 are contacted by the main body, and are flat shaped parts extending in the up-and-down direction (the direction of thickness of second housing 111). Also, the contact parts 164 are bent against first contact parts 165, and extend towards the outside in the direction of the width of second housing 111. Further, the second contact parts 166 are parts bent downward and contacted by the outer ends of connection parts 164.

[0055] The second terminals 161 are made integral with second housing 111 by overmolding. Specifically, the second housing 111 is formed by filling resin into a mold cavity wherein second terminals 161 have previously been internally placed. By this means, the main body of second terminals 161 is embedded within second housing 111, and attached to second housing 111 with the surfaces of first contact part 165, connecting part 164, and second contact part 166 exposed on each side surface on the joining surface of second raised parts 112. In this case the second terminals 161 are placed six each right and lift at a spacing of, for example, approximately 0.4 mm. Note however that the spacing and number of second terminals 161 may be varied.

[0056] In addition, second protruding end parts 122 are respectively placed as second joining guide parts at each longitudinal end of the second housing 111. The second protruding end parts 122 are thick materials connected at each end to the longitudinal ends of each second raised parts 112 and extending in the lateral direction of second housing 111, and have upper surfaces that

are approximately rectangular in shape. Also, in a state where first connector 1 and second connector 101 are joined, the second protruding end parts 122 function as inserted protrusions inserted into protruding end groove part 22 of first protruding end part 21 on the first connector 1.

[0057] Also, restraining part receiving groove part 127 is formed on the surface on the joining surface side of the second protruding end 122 (the upper surface). The restraining part receiving groove part 127 is a groove shaped insertion channel extending in the longitudinal direction of second housing 111, and first fitting position restraining part 27 advances therein when second protruding end part 122 is inserted into protruding groove part 22 of first connector 1.

[0058] Further, the second protruding end part 122 has second reinforcing fitting 151 attached as a reinforcing fitting. The second reinforcing fitting 151 is received and retained within second fitting retaining groove part 126 formed in second protruding end part 122. Note also that the slot-shaped aperture of second fitting retaining groove part 126 in the upper surface of second protruding end part 122 extends in the lateral direction of second housing 111, and cuts across the restraining part receiving groove part 127.

[0059] Second reinforcing fitting 151 is formed as one unit of a metal by processes such as punching etc. It is comprised overall of long and narrow band-shaped second main body 152 extending in the lateral direction of second housing 111, and second board connecting parts 156 connecting to the left and right ends of the second main body 152 and extending in the direction of the mounting surface, and fixed contact pieces 158 extending so as to further protrude from the upper side of the second main body 152. Note that the fixed contact pieces 158 include both non-switch contact pieces 158a and switch contact pieces 158b.

[0060] Also, second reinforcing fitting 151 is jointed from the joining surface side into the second fitting retaining groove part 126, and is fixed to second housing 111 by being pinched from both sides by the side walls of the second fitting retaining groove part 126. At this time, positioning of second reinforcing fitting 151 is accomplished by the fact that reinforcing fitting side reference surface 152a, which is the edge surface of the mounting surface side of second main body 152, is making contact against housing side reference surface 126a, which is placed inside the second fitting retaining groove part 126 and is described below. In the positioned state, non-switch contact pieces 158a and switch contact pieces 158b are protruding from the upper surface of second protruding end piece 122. Note also that retraining part receiving groove 157,

which is the part between non-switch contact pieces 158a and switch contact pieces 158b in the edge surface of the fitting surface side of second main body part 152, does not protrude from restraining part receiving groove 127.

[0061] Fig. 7 shows the respective positions of second reinforcing fittings 151 when they are affixed to second housing 111. Fig. 7 may also be considered Fig. 5 with second housing 111 and second terminals 161 deleted. In Fig. 7, the upper end of switch contact piece 158b is wider than the upper end of non-switch contact piece 158a, and forms straight part 159 extending in the lateral direction of second housing 111. The straight part 159 functions as the contact part of second reinforcing fitting 151, which functions as a switching material of a switch for the purpose of electrically detecting complete joining of first connector 1 and second connector 101, and also contacts first switching fitting 51b of the first connector 1. Accordingly, straight part 159 is formed in a position corresponding to the range of position of oblique part 59 of first switch fixture 51b in the opposing connector, first connector 1.

[0062] In addition, the upper edge part of non-switch contact piece 158a also contacts the upper surface of first contact piece 58a of first non-switch fixture 51a, in the state wherein joining of first connector 1 and second connector 101 is complete. Accordingly, non-switch contact piece 158a is formed in a position corresponding to the range of positions of the free end of first contact piece 58a of first non-switch fixture 51a in the first connector 1. Further, the second board connecting part 156 functions as a solder tail part of second retaining fitting 151, is formed so that the lower surface thereof is essentially parallel to the mounting surface of second housing 111, and is fixed to second fixing pad 193, described below, on second board 191.

[0063] Figs. 8-10 illustrate the operation of joining first connector 1 and second connector 101. As shown in Fig. 8, first fixing pads 93-1 through 93-4, and detection pads 94-1 and 94-2 are arranged as fixing pads on first board 91. Note also that in providing a comprehensive description of first fixing pads 93-1 through 93-4, and detection pads 94-1 and 94-2, we describe respectively first fixing pad 93 and detection pad 94. Also, in Fig. 8, the terminal connecting pads connected to tail parts 62 of first terminals 61 are omitted for convenience in the description.

[0064] The fixing pads 93 are the pads whereby first board connecting parts 56 of first reinforcing fitting 51 are fixed, are made of metal, and are placed in positions corresponding to each of first board connecting parts 56 of first reinforcing fitting 51. Also, the detection pads 94

are the pads whereby each pair of terminals in a detection instrument are connected, are made of metal, and are placed in the vicinity of the position where first connector 1 is mounted.

[0065] Also, detection pad 94-1 is electrically connected to first fixing pad 93-1, to which one set of first board connection parts 56b of first switch fixture 51b are affixed and connected, through first detection electroconductive trace 95-1, and detection pad 94-2 is electrically connected to first fixing pad 93-4, to which the other set of first board connection parts 56b of first switch fixture 51b are affixed and connected, through first detection electroconductive trace 95-2. Note also that in describing first detection electroconductive traces 95-1 and 95-2 we will speak of first electroconductive traces 95. In other words, the pads 94 are respectively connected to the pair of first fixing pads 93 to which first board connection parts 56b of first switch fixtures 51b are affixed, through first detection electroconductive traces 95, at diagonally opposite positions.

[0066] In addition, second fixing pads 193-1 through 193-4 are placed as fixing pads on second board 191, as shown in Fig. 8. Note also that in collectively describing second fixing pads 193-1 through 193-4 we will speak of second fixing pads 193. Also in Fig. 8, in contrast to second fixing pads 193 which are drawn in solid lines, second board 191 itself is drawn in virtual representation. This is because second fixing pads 193 are placed on the lower face of second board 191 in the drawing, and therefore would otherwise not be visible because they would be obscured by second board 191. Also, the terminal connecting pad to which tail part 162 of second terminal 161 is connected is omitted for purposes of description.

[0067] The second fixing pads 193 are pads to which second board connecting part of second reinforcing fitting 151 are fixed, are made of metal, and placed in a position corresponding to second board connecting parts 156 of each second reinforcing fitting 151. Also, both second fixing pad 193-1 and second fixing pad 193-4 are electrically connected to each other through second detection electroconductive trace 195. In other words, each of the pair of second fixing pads 193 placed diagonally to each other is electrically connected to the other through second detection electroconductive trace 195. The mutually electrically connected second fixing pads 193 is in a position essentially corresponding to first fixing pads 93 which are electrically connected to detection pads 94 on first board 91.

[0068] Also, when first connector 1 and second connector 101 are joined, first connector 1 is already previously surface mounted to first board 91, by connections whereby tail parts 62 of

first terminals 61 are connected to terminal connecting pads on first board 91, and also first board connecting part 56 of first reinforcing fitting 51 is connected to first fixing pads 93 on first board 91. Also, second connector 101 is already previously surface mounted on second board 191, by connections whereby tail part 162 of second terminal 161 is connected to terminal connecting pads on second board 191, and also second board connecting parts 156 on second reinforcing fitting 151 are connected to second fixing pads 193 on second board 191.

[0069] Note also that in Figs 9-10 first board 91 and second board 191 are omitted from the drawing for purposes of description.

[0070] The operator performs position alignment of first connector 1 and second connector 2 with the joining surface of first connector 1 and the joining surface of second connector 101 mutually facing each other, and then moves first connector 1 and/or second connector 101 towards the other, namely in the direction of joining. By this means, second protruding parts 112 on the left and right of second connector 101 are inserted into groove parts 12a on the left and right of first connector 1. Then, second terminals 161 of second connector 101 are inserted between first contact parts 65 and second contact parts 66 of each first terminals 61, first contact parts 65 of first terminals 61 are brought into contact with the surface of first contact part 165 of second terminal 161, and second contact parts 66 of first terminals 61 are brought into contact with the surface of second contact parts 166 of second terminal 161. By this means, the spaces between first contact parts 65 and second contact parts 66 of first terminals 61 are pressed apart by second terminal 161 and flexibly extended.

[0071] Next, the operator again moves first connector 1 in the direction of joining with respect to second connector 101, and when joining of first connector 1 and second connector 101 is completed, if the joining is complete then as shown in Fig. 9, first contact parts 65 of first terminals 61 contact second terminal 161, and second contact parts 66 of first terminals 61 are matched with second contact recession 166a of second terminal 161. As a result thereof, electrical connection is made between the electroconductive traces contacting terminal connection pads on first board 91 that are contacted by tail parts 62 of first terminals 61, and the electroconductive traces connected to terminal connection pads on second board 191 that are contacted by tail part 162 of second terminal 161.

[0072] Also, when joining of first connector 1 and second connector 101 is completed, once they are fully joined, as shown in Fig. 10, the end of first contact piece 58b of first switch fitting 51b

of first connector 1 is in contact with and electrically connected to the upper end (in Fig. 10, the lower end) of switch contact piece 158b of second reinforcing fixture 151 of second connector 101. In other words, oblique part 59 is in contact with and electrically connected to straight part 159. The result is closing of the detection circuits that detect completion of joining of first connector 1 and second connector 101, and the fact that first connector 1 and second connector 101 are completely joined is electrically detected. Specifically, first switch fitting 51b and second reinforcing fitting 151 function as switching parts in detecting complete joining, and first contact piece 58b is in contact with switch contact piece 158b. Accordingly, by connecting a pair of terminals of a detection device capable of detecting a state of electrical connection in a circuit, such as a testing device, to detection pad 94-1 and detection pad 94-2, it is possible to detect the fact that the detection circuit is closed in in a state of electrical connection. Thus, it is possible to electrically detect the complete joining of first connector 1 and second connector 101.

[0073] Also, reinforcing fitting side reference surface 152 of second main body 152 is in contact with housing side reference side 126a of second fitting retaining recessed part 126. Typically, the retaining fixture side reference surface 152a and housing side reference surface 126 will be made with greater precision than other parts. For this reason, the reinforcing fitting side reference surface 152a is in contact with housing side reference surface 126a, and its location and position with respect to second housing 111 is accurately maintained. As a result, the position of switch contact piece 158b with respect to second housing 111, specifically its position in second connector 101, is also accurate. Thus, it is possible to accurately detect complete joining of first connector 1 and second connector 101.

[0074] However, when joining of first connector 1 and second connector 101 is complete as shown in Fig. 10, the end of first contact piece 58a of non-switch fitting 51a of first connector 1 is also in contact with the upper end (in Fig. 10, the lower end) of non-switch contact piece 158a of second reinforcing fitting 151 of second connector 101. Because the first contact piece 58a of non-switch contact piece 158a does not function as a switching part in a switch for detecting complete joining, either or both could be omitted from the standpoint of electrically detecting complete joining of first connector 1 and second connector 101.

[0075] Further, first contact piece 58b of first switch fitting 51b functions as a cantilever spring material providing resilience, and applies an upward force in Fig. 10 with respect to switch contact piece 158b of second reinforcing fitting 151. Accordingly, when one considers the

balance of the force exerted from below on second reinforcing fitting 151 and second connector 101 in their left-right orientation in Fig. 10, it is preferable not to omit the non-switch contact piece 158a and first contact piece 58a, so that force applied from first contact piece 58a functioning as a cantilever spring material is received by non-switch contact piece 158a.

[0076] Figs. 11-3 illustrate the operation whereby the first contact piece 58b and switch contact piece 158b come into contact. When first connector 1 and second connector 101 are joined, and oblique part 59 of first contact piece 58b of first switch fitting 51b of first connector 1 is in contact with straight part 159 of switching contact piece 158b of second reinforcing fitting 151 of the second connector 101, the positional relationship of second reinforcing fitting 151 and first switch fitting 51b is as shown in Figs. 11, 12(a) and 13(a). As described above, straight part 159 extends in the direction of the width of second housing 111, and oblique part 59 extends in the direction of the length of the first housing 11, diagonally to but without crossing the direction of extension of first contact piece 58b. Therefore, when straight part 159 and oblique part 59 are in contact, the direction of extension of oblique part 59 is diagonal with respect to the direction of extension of straight part 159, as shown in Figs. 11, 12(a) and 13(a).

[0077] Thus, when first connector 1 and second connector 101 join, from a state whereby oblique part 59 of first contact piece 58b of first switch fitting 51b is in contact with straight part 159 of switch contact piece 158b of second reinforcing fitting 151 as shown in Figs. 11, 12(a) and 13(a), the second connector 101 moves further in the direction of joining with respect to first connector 1, and the joining is completed, namely in a state whereby joining of first connector 1 and second connector 101 is complete. Specifically, first contact piece 58b of first switch fitting 51b, having a shape similar to a flat cantilever, is flexibly deformed overall by receiving a pressing force, downward in Fig. 12, from switch contact piece 158 of second reinforcing fitting 151, and oblique part 59 formed at its end is flexibly displaced downward. Also, because the direction of extension of oblique part 59 of first contact piece 58b is diagonal with respect to the direction of extension of straight part 159 of switch contact piece 158b, the contact point of oblique part 59 and straight part 159 is displaced in the direction of extension of oblique part 59 according to the displacement downward of oblique part 59.

[0078] By comparing the state shown in Fig. 13(a) and that shown in Fig. 13(b), it can be seen that from the time when straight part 159 and oblique part 59 have begun to be in contact until joining of first connector 1 and second connector 101 is completed, the point of contact between

oblique part 59 and straight part 159 moves only a slight distance along oblique part 59 toward the end of first contact piece 58b. Thus, by amplifying the slight downward displacement of the point of contact of oblique part 59 and straight part 159 by the displacement in the direction of extension of oblique part 59, it is possible to obtain a wiping motion. For this reason, the surfaces of oblique part 59 and straight part 159 are reliably cleaned by wiping, preventing poor contact.

[0079] Incidentally, because the areas of first board 91 and second board 191 are normally substantially larger than the area of the joining surface of first connector 1 and second connector 101, an operator will be unable to see the joining surface of first connector 1 and second connector 101, and therefore will be unable to perform the joining operation manually. For this reason, the operator will be unable to ascertain the positional relationship of the joining surface of first connector 1 and the joining surface of second connector 101, and will be unable to determine whether joining of first connector 1 and second connector 101 is complete or not, and therefore the operator may further attempt to move first connector 1 and/or second connector 101 in the direction of joining even after joining of first connector 1 and second connector 101 is complete.

[0080] In such a case, first contact piece 58, by deforming flexibly downward in Fig. 2, namely in the direction of joining, absorbing further displacement of second connector 101 with respect to first connector 1, and specifically absorbing further displacement of fixed contact piece 158. Thus, even if second connector 101 is further displaced with respect to first connector 1, further in the direction of joining than beyond the fully joined position, contact is maintained between first contact piece 58 and fixed contact piece 158, thus contact reliability between first contact piece 58 and fixed contact piece 158 is therefore enhanced. Also, the scope wherein oblique part 59 and straight part 159 mutually rub is broadened, and thus the surfaces of oblique part 59 and straight part 159 are cleaned by wiping over a wider range. As a result, the reliability of the detection circuit is enhanced, and accuracy of detection of complete joining of first connector 1 and second connector 10 is enhanced.

[0081] While a preferred embodiment of the Present Disclosure is shown and described, it is envisioned that those skilled in the art may devise various modifications without departing from the spirit and scope of the foregoing Description and the appended Claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A board-to-board connector, the board-to-board connector comprising;

a first connector, the first connector comprising a first terminal and a first housing having a first joining guide part formed on both longitudinal ends;

a second connector, the second connector comprising a second terminal joining together with the first terminal and a second housing having a second joining guide part joining with the first joining guide part and formed on both longitudinal ends; and

a switch, the switch closing a detection circuit electrically detecting a complete joining of the first connector and second connector;

wherein:

the switch contains switching materials capable of contacting each other; and

the contact part of one switching material being an oblique part, and the direction of extension of the oblique part being diagonal with respect to the direction of extension of a straight part that is a contact part of the other switching material.

2. The board-to-board connector of Claim 1, wherein the first connector has a first reinforcing fitting placed on the first joining guide.

3. The board-to-board connector of Claim 2, wherein the second connector has a second reinforcing fitting placed on the second joining guide.

4. The board-to-board connector of Claim 3, wherein one of the switching materials is the first reinforcing fitting.

5. The board-to-board connector of Claim 4, wherein the other of the switching materials is the second reinforcing fitting.

6. The board-to-board connector of Claim 5, wherein the first reinforcing fitting contains a flexible contact piece.

7. The board-to-board connector of Claim 6, wherein the second reinforcing fitting contains a fixed contact piece.

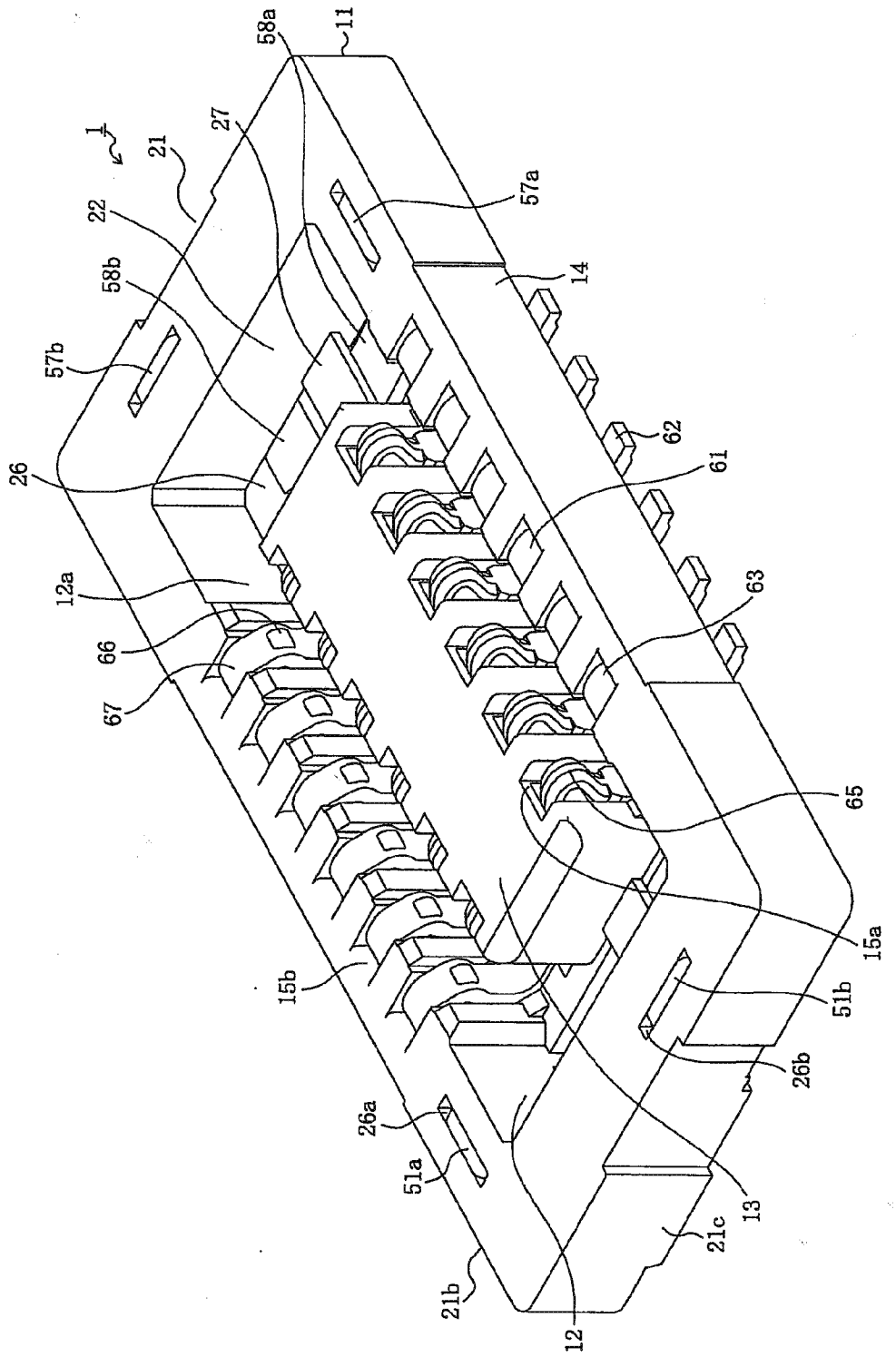
8. The board-to-board connector of Claim 7, wherein when the first connector and second connector move in the joining direction relative to each other, the oblique part on the end of the flexible contact piece is displaced in elastic fashion while maintaining contact with the straight part on the tip of the fixed contact piece.

9. The board-to-board connector of Claim 8, wherein the oblique part and straight part rub against each other in a wiping motion.

10. The board-to-board connector of Claim 9, wherein the first reinforcing fitting and second reinforcing fitting are electrically connected to a fixing pad on circuit boards.

11. The board-to-board connector of Claim 10, wherein detection pads are formed on the boards.

12. The board-to-board connector of Claim 11, wherein the detection pads form the ends of the detection circuit.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21
22
58b
57b
57a
14
62
61
26
12a
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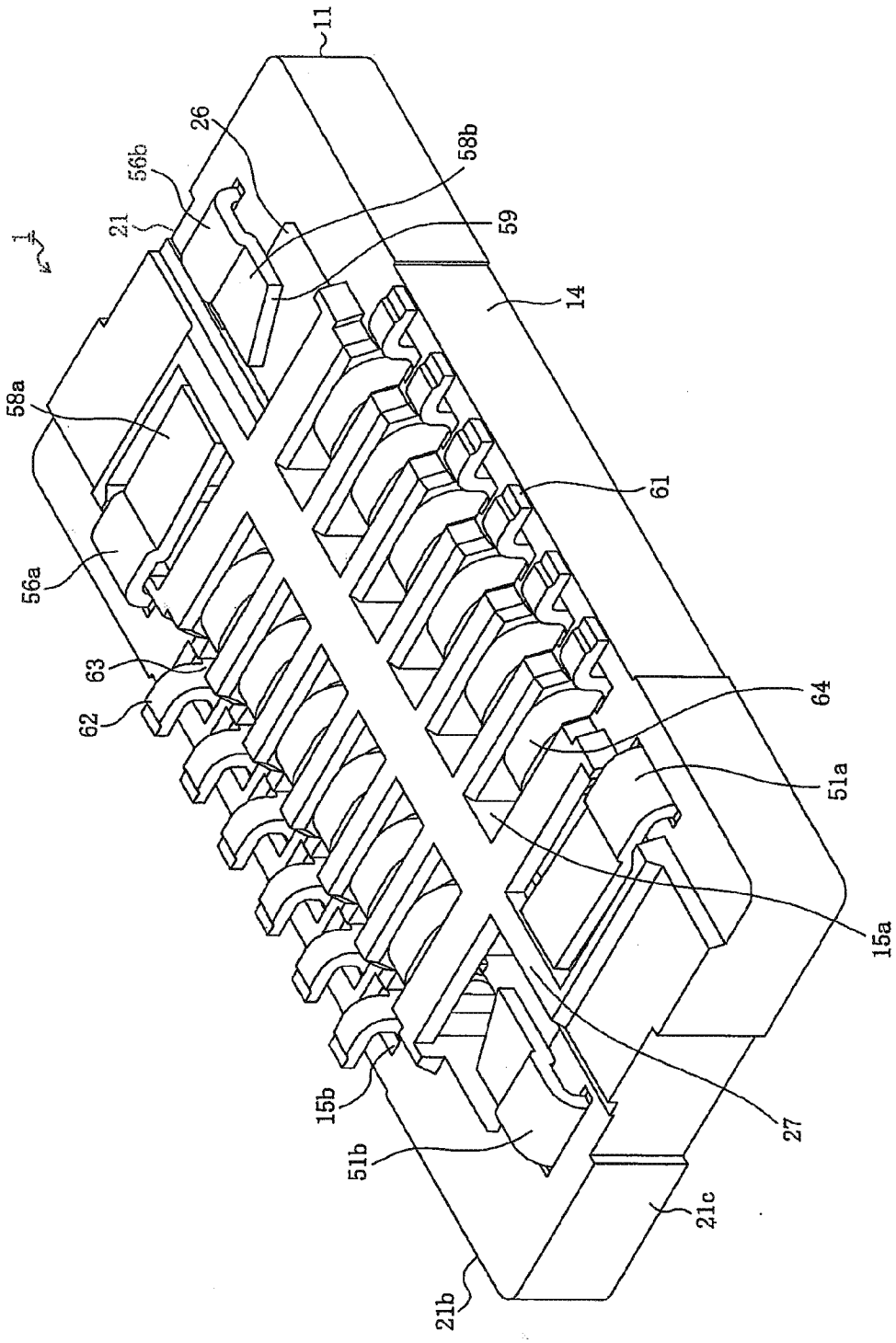
26b
26a
51a
13
21c
21b
12

FIG. 1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58b
21
59
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63
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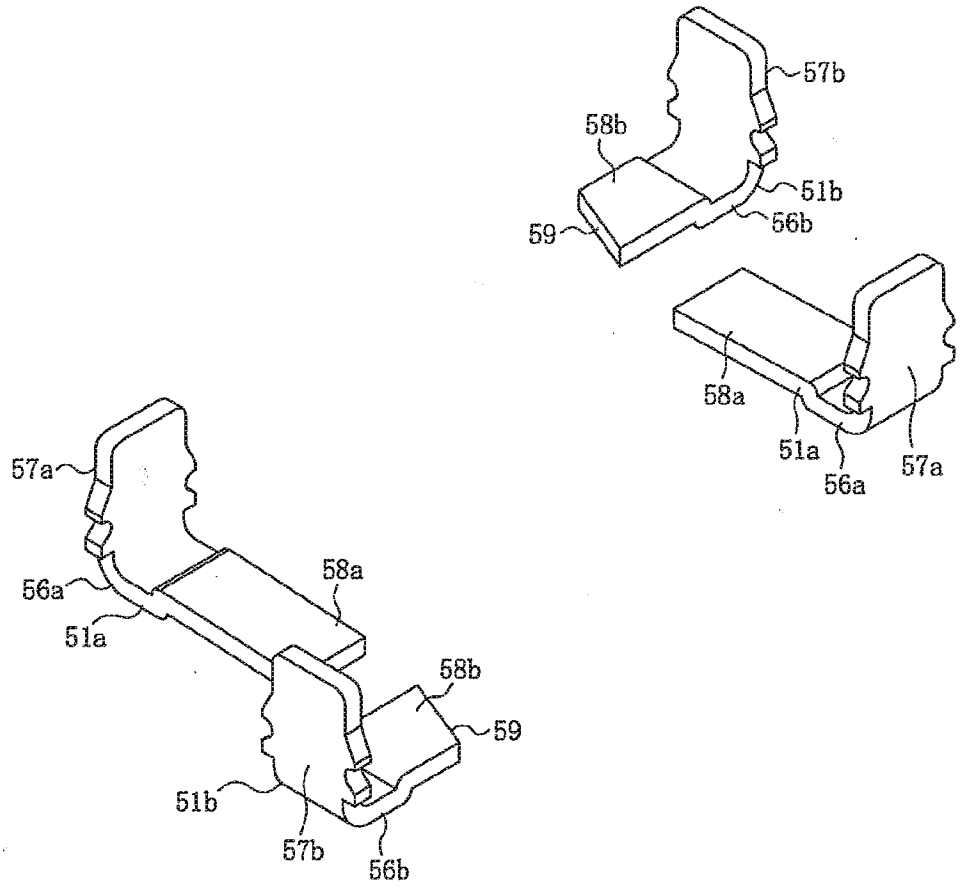
21c
21b

FIG. 2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59
51b
57b
56b

FIG. 3

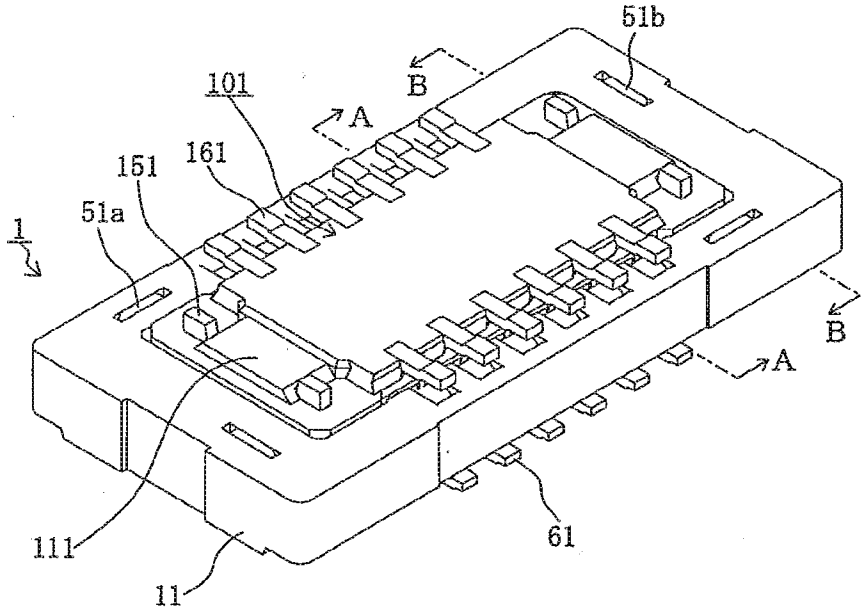
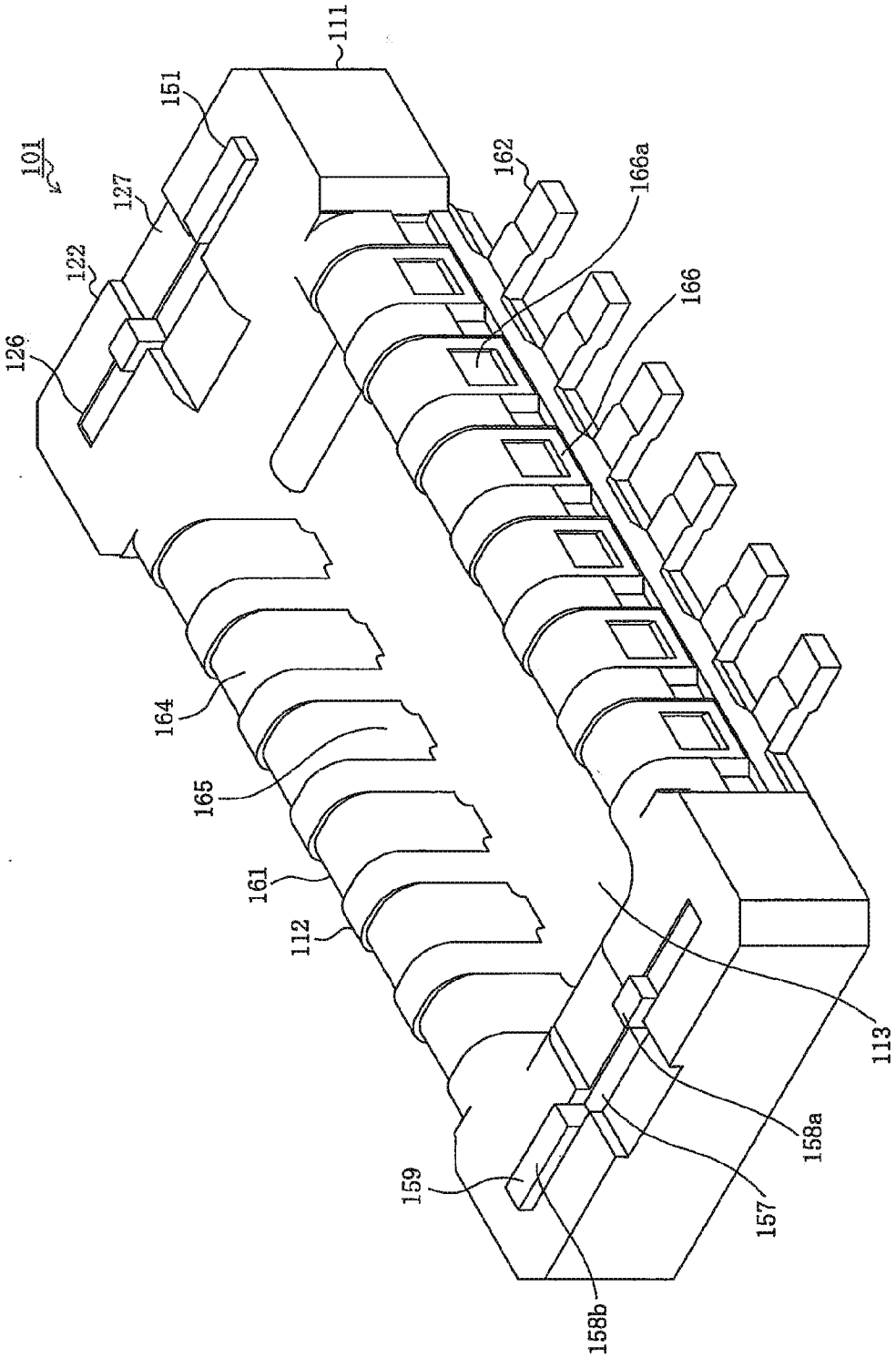


FIG. 4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127
122
126
162
166a
166
164
165
161
112
113
158a
159
157
158b

FIG. 5

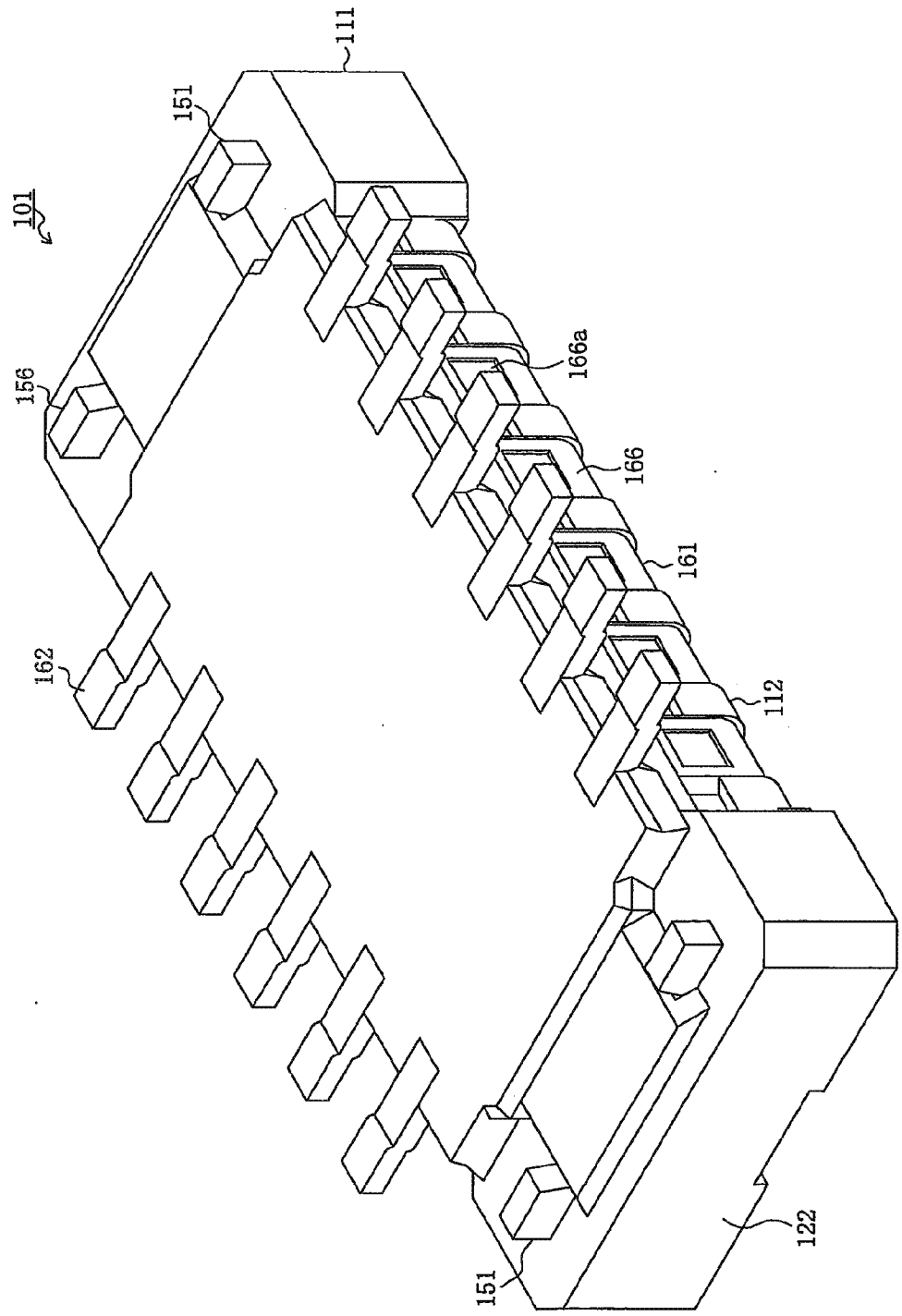
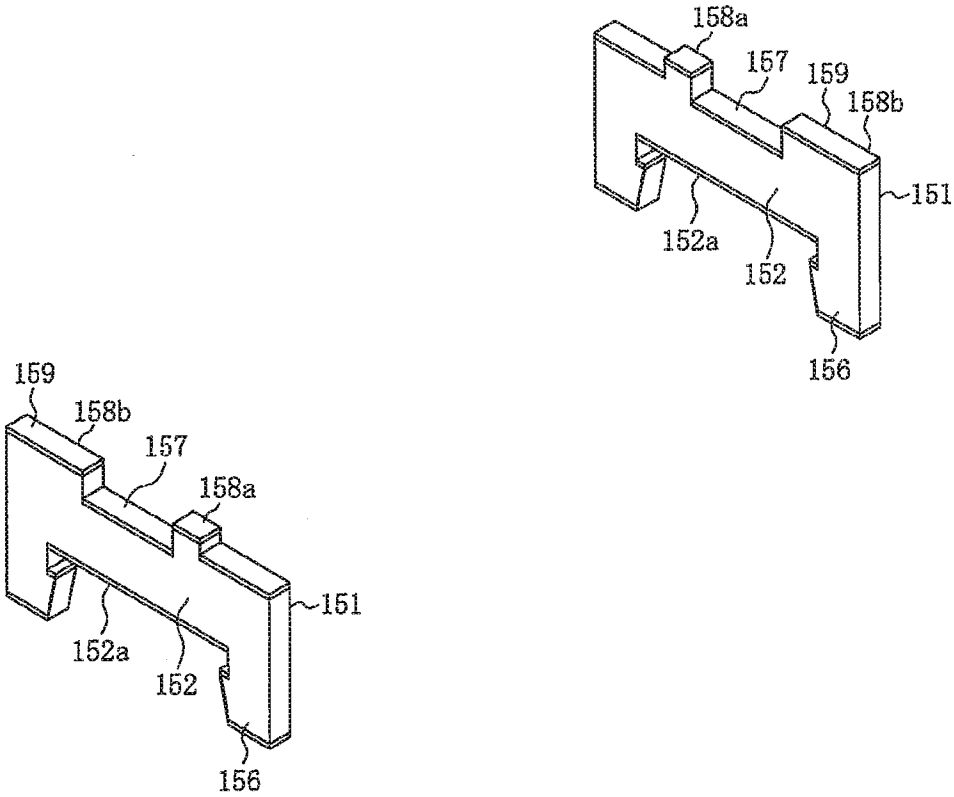


FIG. 6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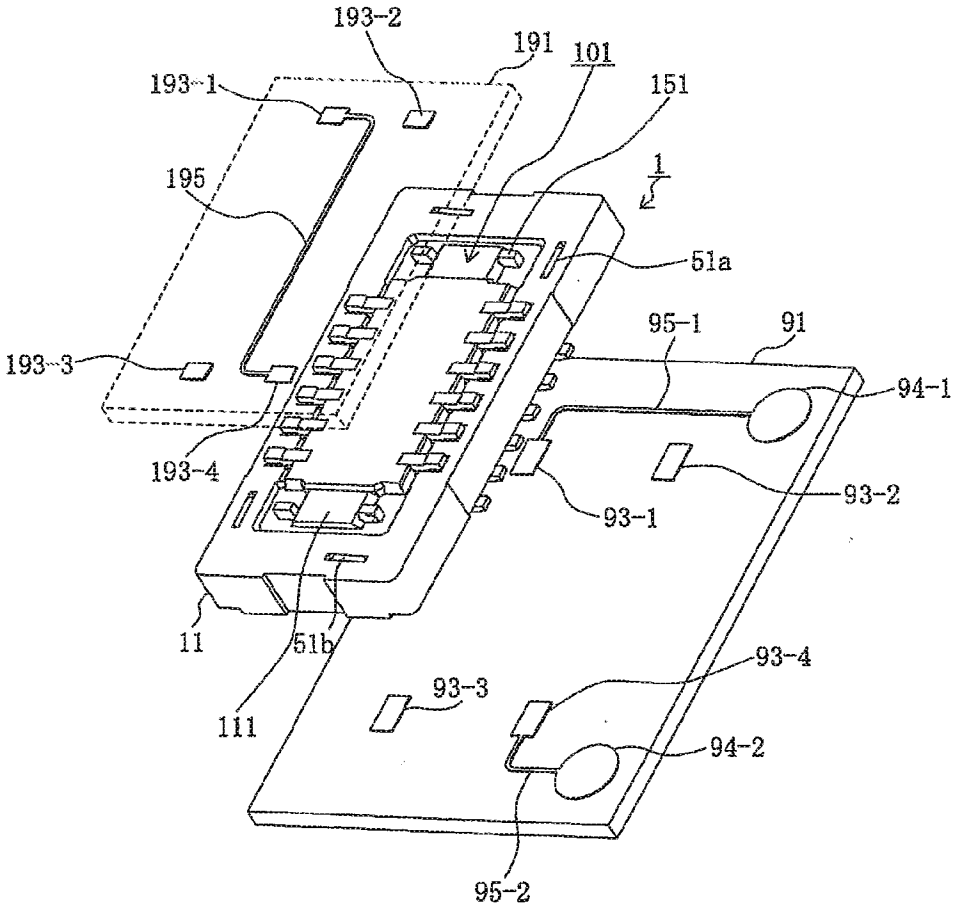
157
159
158b
151
152a
152
156
159
158b
157
158a
151
152a
152
156

FIG. 7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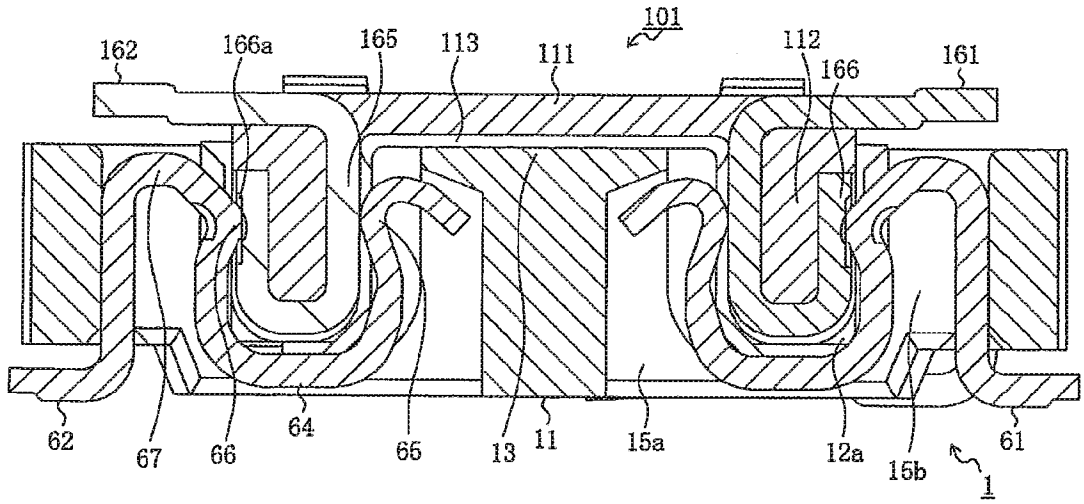
191
101
151
193-1
1
195
51a
95-1
91
193-3
94-1
193-4
93-2
93-1
11
51b
93-4
93-3
111
94-2
95-2

FIG. 8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162
166a
165
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166
161
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67
66
64
65
13
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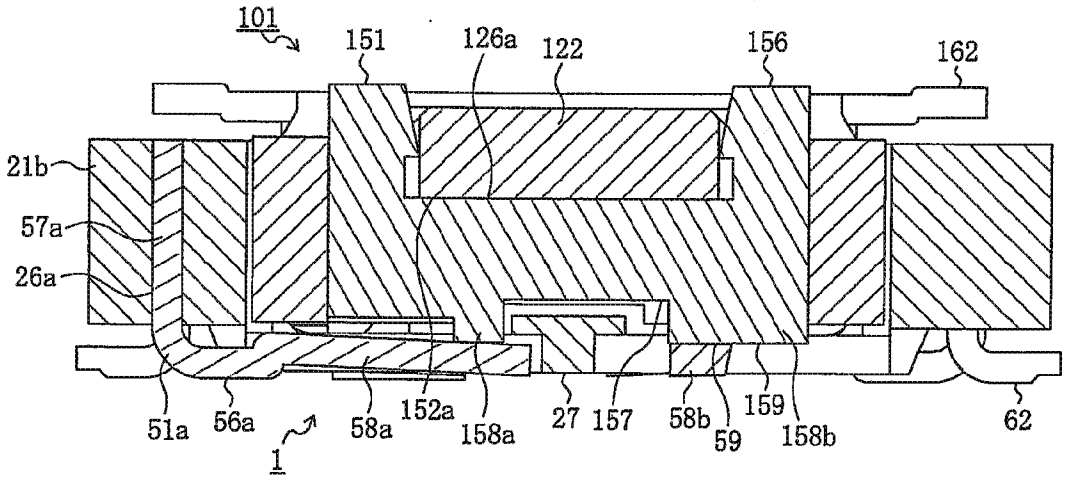
15a
12a
15b
61
1

FIG. 9


101
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126a
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156
162
21b
57a
26a
51a
56a
58a
152a
158a
27
157
58b
59
159
158b
62
1

FIG. 10

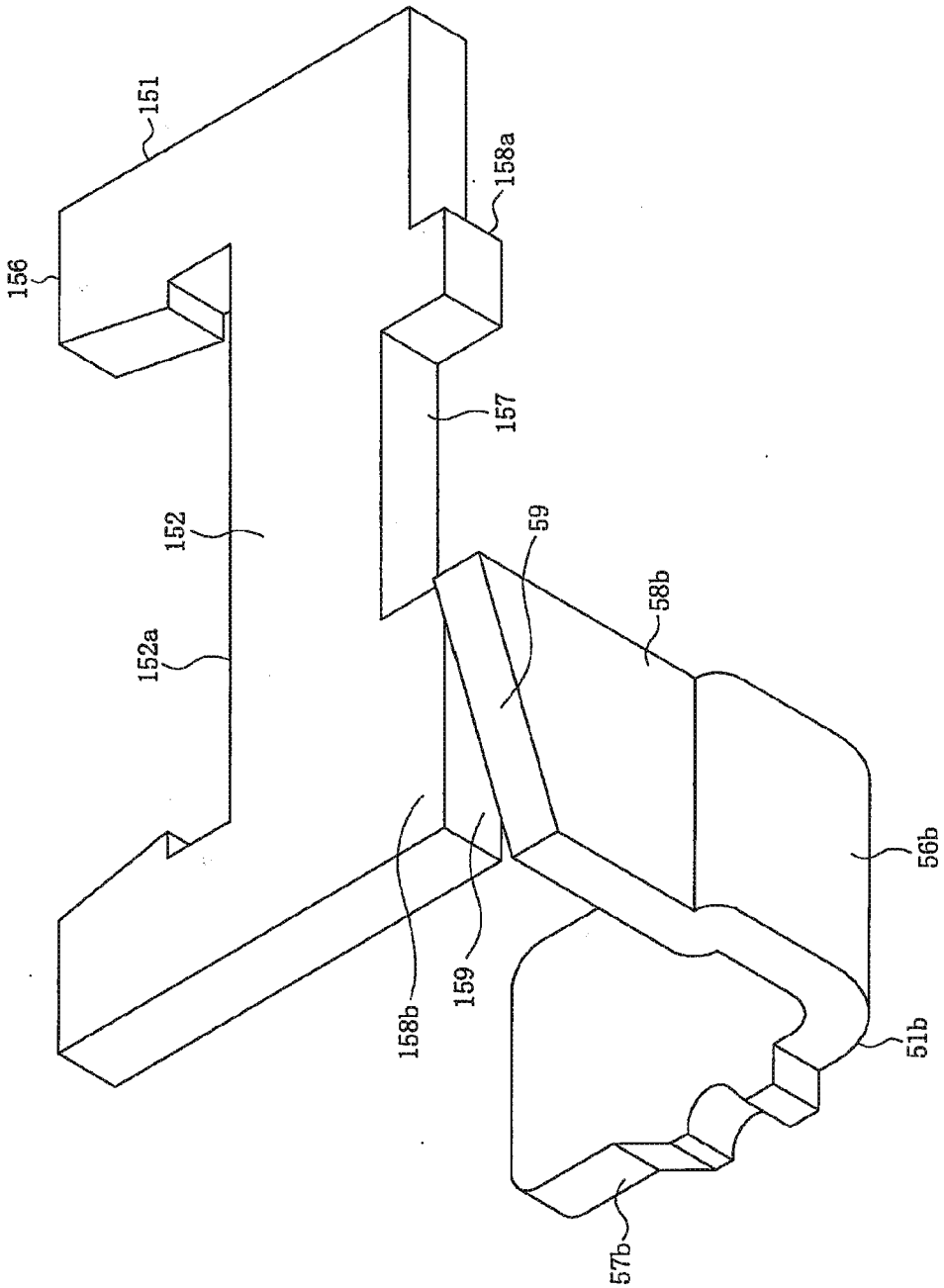


FIG. 11

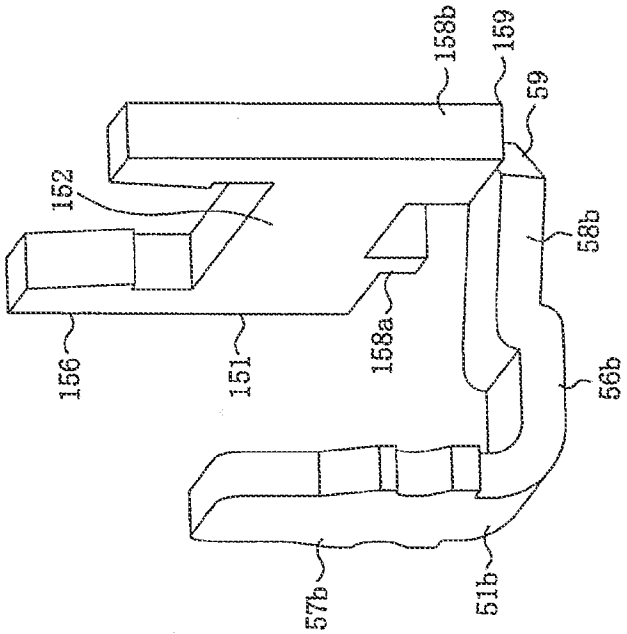


FIG. 12B

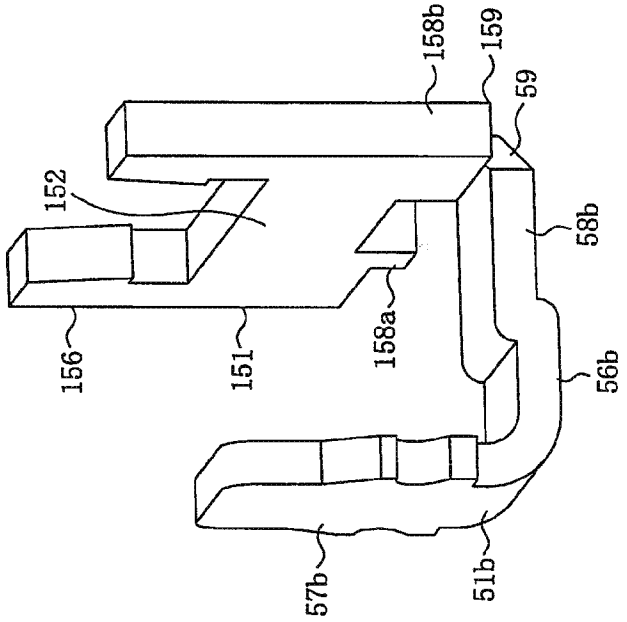


FIG. 12A

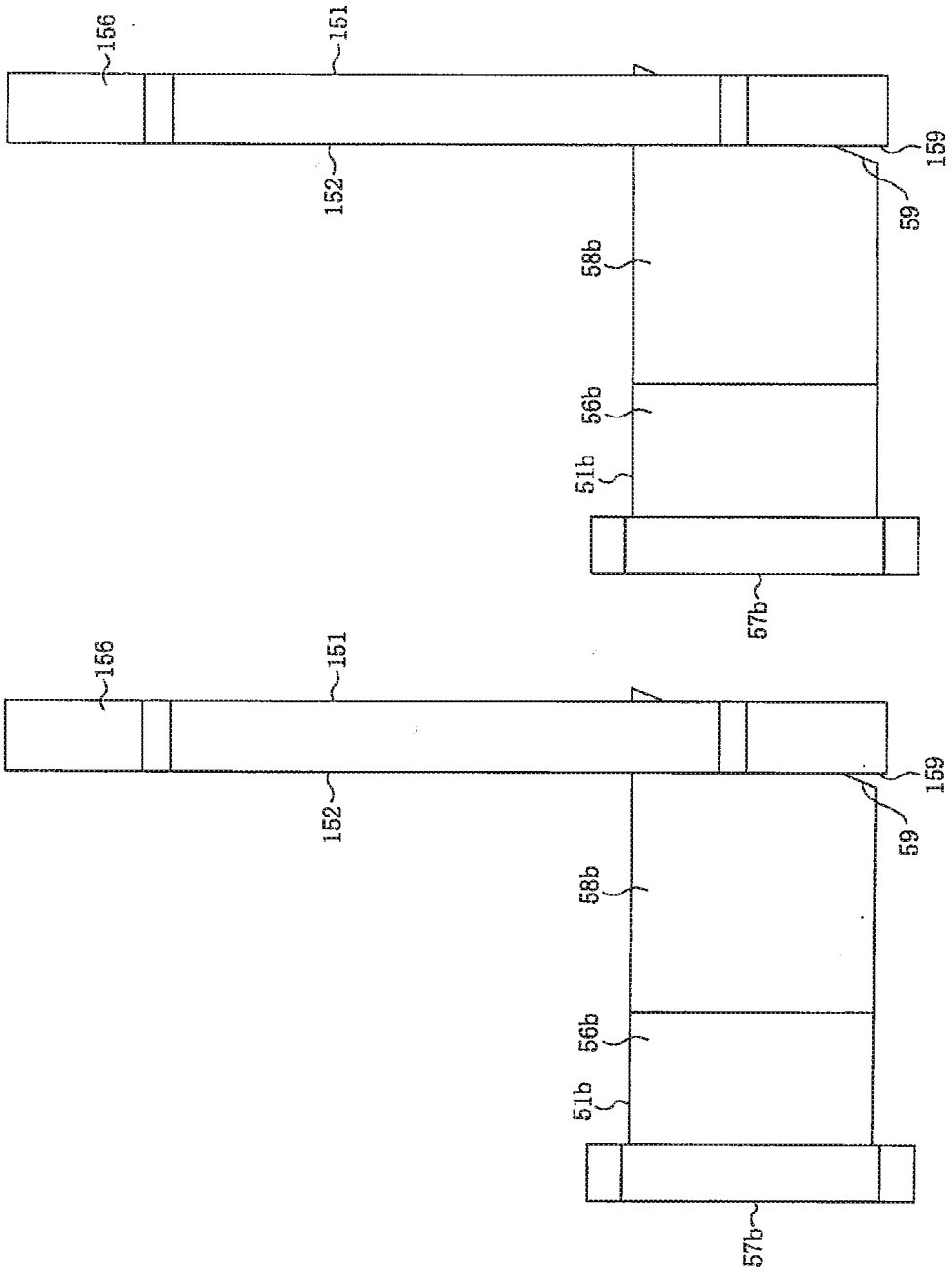
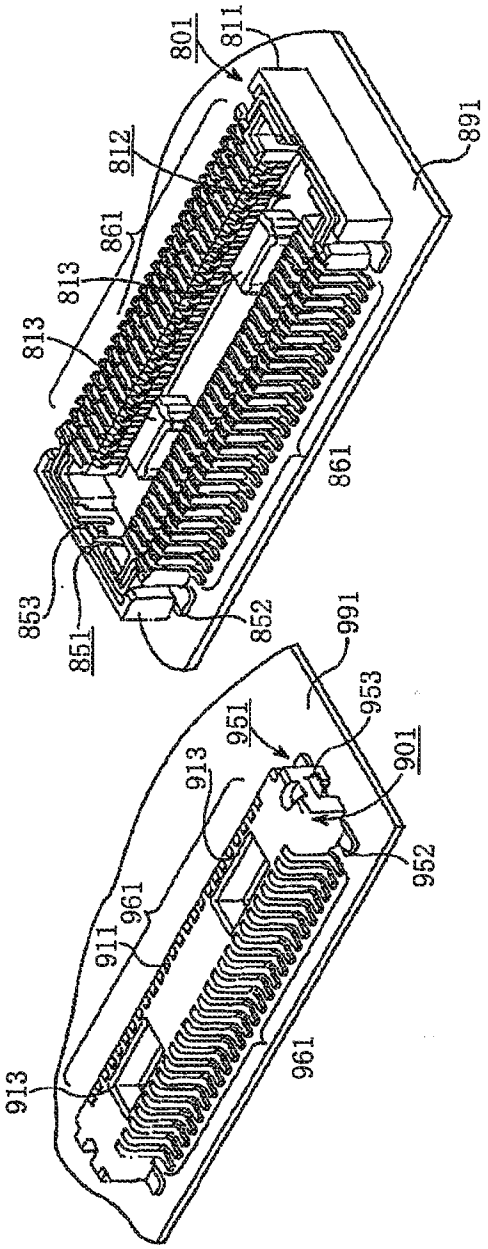


FIG. 13B

FIG. 13A



Prior art

FIG. 14