



- (51) **International Patent Classification:**
H01R 24/00 (2011.01) *H01R 31/02* (2006.01)
- (21) **International Application Number:**
PCT/US2012/042264
- (22) **International Filing Date:**
13 June 2012 (13.06.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
2011-132146 14 June 2011 (14.06.2011) JP
- (71) **Applicant (for all designated States except US):** **MOLEX INCORPORATED** [US/US]; 2222 Wellington Court, Lisle, Illinois 60532 (US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **NAGASE, Teruki** [JP/JP]; c/o Molex Incorporated, 2222 Wellington Court, Lisle, Illinois 60532 (US). **CHIKANO, Koji** [JP/JP]; c/o Molex Incorporated, 2222 Wellington Court, Lisle, Illinois 60532 (US). **YAGI, Masanori** [JP/JP]; c/o Molex Incorporated, 2222 Wellington Court, Lisle, Illinois 60532 (US).
- (74) **Agent:** **MORELLA, Timothy M.**; Molex Incorporated, 2222 Wellington Court, Lisle, Illinois 60532 (US).

- (81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) **Title:** MULTIPOLE CONNECTOR

(57) **Abstract:** A terminal comprises a body portion received by a terminal receiving cavity of a housing, a solder tail connected to a lower end of the body portion and surface-mounted on a circuit board, a contact portion connected to an upper end of the body portion and contacting a counterpart terminal, and a held portion connected to both side edges of the body portion and held on holding side walls formed on both sides of the terminal receiving cavity; the held portion extends in a vertical direction and has a vertical dimension greater than the vertical dimension of the body portion; an anchor portion locking into a holding side wall is formed on the side edges of the upper part of said held portion; and a stabilizing portion that contacts the holding side walls is formed on the side edges of the lower part of said held portion.



MULTIPOLE CONNECTOR

REFERENCE TO RELATED APPLICATIONS

[0001] The Present Disclosure claims priority to prior-filed Japanese Patent Application No. 2011-132146, entitled "Multipole Connector," filed on 14 June 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 multipole connector.

[0003] Conventionally, a multipole connector, which is a pin grid array connector provided with a plurality of terminals, is used for connecting semiconductor devices to a circuit board or for connecting circuit boards to each other. An example of such a connector is disclosed in Japanese Patent Application No. 2002-331965. The content of the aforementioned Patent Application is fully incorporated in its entirety herein.

[0004] Fig. 12 illustrates a cross-sectional view of a terminal attachment part in a conventional connector. In the drawing, 811 designates a connector housing that is a plate-like member made from an insulating material, and having a plurality of through holes 813. A plurality of projecting studs 815 is formed on the undersurface of the housing 811. The aforementioned studs 815 are provided with recesses 816, and these recesses communicate with the through holes 813. In addition, the peripheries of the studs 815 are coated with a conductive coating 871.

[0005] A terminal pin 861 is received by each of the through holes 813. After insertion, a tab portion 864 formed on the upper end of the terminal pin 861 projects from the upper surface of the housing 811, and a contact portion 862 formed on the lower end of the terminal pin 861 enters the recess 816 of the stud 815, contacting the conductive coating 871.

[0006] After solder 881 is attached to the peripheries of the studs under the above conditions, the lower ends of the studs 815 are brought into contact with and soldered to electrodes 951 formed on the surface of the printed circuit board 911. Thus, the solder 881 electrically and mechanically connects the electrodes 951 and the conductive coating 871 on the periphery of the studs 815, thereby establishing an electrical connection between the electrodes 951 and the terminal pins 861.

SUMMARY OF THE PRESENT DISCLOSURE

[0007] However, when the housing of the conventional multipole connector thermally expands in the horizontal direction, the connective portion between the stud and the electrode of the PCB is subjected to stress, generating cracks in the solder. Furthermore, when the vertical dimension of the terminal pins is shortened to reduce height, the distance from the contact part to the stud is reduced, and the problem known as “solder rising” or “flux rising” occurs. Furthermore, a decrease in the height of the contact pins impairs the stability of the contact pins within the through holes.

[0008] It is thus an object of the Present Disclosure to solve the problems of the conventional multipole connector and to provide a highly reliable multipole connector enabling, by increasing the vertical dimension of the portion of the terminals held by the housing, the distance from the stabilizer to the anchor formed on the held portion to be increased even if the height of the connector as a whole is reduced, stability of the terminals to be maintained even upon thermal expansion of the housing, a multipolar construction, and easy manufacture and mounting of the connector to a circuit board.

[0009] For the above purpose, the multipole connector of the Present Disclosure comprises an integrally formed housing and a plurality of terminals attached to the housing so as to form a plurality of pairs of rows. The terminal includes a body portion placed into a terminal receiving cavity of the housing, a solder tail connected to the lower end of the body portion and surface-mounted on a circuit board, a contact portion connected to the upper end of the body portion and for contacting a mating terminal, and held portion that are connected to both side ends of the body portion and that are held by holding side walls formed on both sides of the terminal receiving cavity. The held portions extend in the vertical direction, and have a vertical dimension greater than the vertical dimension of the body portion, anchor portions that lock into the holding side walls formed on the side edges of the upper parts thereof and stabilizing portions that abut the holding side walls formed on the side edges of the lower parts thereof.

[0010] In another multipole connector of the Present Disclosure, the terminal receiving cavity includes a narrow portion that extends in the vertical direction and a wide portion that is connected to the lower end of the narrow portion, is wider than the narrow portion, and extends in the vertical direction. At least an upper part of the contact portion is received by the narrow portion, the body portion and the held portion being placed into the wide portion. The rear

surface of the body portion contacts the back surface of the terminal receiving cavity in the wide portion. The held portion is held by the holding side walls of the terminal receiving cavity in the wide portion.

[0011] In another multipole connector of the Present Disclosure, the solder tail includes a stress alleviating portion connected to the lower end of the body portion and a connecting portion connected to the lower end of the stress alleviating portion, the connecting portion protruding downward from the lower end of the terminal receiving cavity and being connected to a terminal connection pad on the surface of the circuit board. In another multipole connector of the Present Disclosure, the connection portion has a circular shape and is positioned in front of the front surface of the body portion. Finally, in another multipole connector of the Present Disclosure, the stress alleviating portion has a width that is narrower than the body portion, extends forward substantially perpendicularly to the body portion before curving, and has its tip facing in the backward direction.

[0012] According to the Present Disclosure, the vertical dimension of the terminal held portion held by the housing is increased. Therefore, even if the height of the connector as a whole is reduced, it is possible to increase the distance between the stabilizer portion and the anchor portion formed on the held portion and to maintain stability of the terminals even upon thermal expansion of the housing. This allows for a multipolar construction, simplicity of manufacture and mounting of the connector to a circuit board, and improved reliability.

BRIEF DESCRIPTION OF THE FIGURES

[0013] 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:

[0014] Figure 1 is a perspective view of a first connector according to the Present Disclosure;

[0015] Figure 2 is a first pair of views of the first connector of Fig. 1, wherein (a) is a top view and (b) is a first side view;

[0016] Figure 3 is a second pair of views of the first connector of Fig. 1, wherein (a) is a second side view and (b) is a bottom view;

[0017] Figure 4 is a three-dimensional view of a first terminal according to the Present Disclosure, wherein (a) is a front three-dimensional view from the left upper side, (b) is a rear three-dimensional view from the right upper side, (c) is a front three-dimensional view from the left lower side, and (d) is a rear three-dimensional view from the right lower side;

5 [0018] Figure 5 is a drawing illustrating the relationship between the first terminal and a first-terminal receiving cavity in the Present Disclosure, wherein (a) is a front view of the first-terminal accommodation cavity, (b) is a side sectional view of the first-terminal receiving cavity, (c) is a front view of the first-terminal receiving cavity terminal with the first terminal received therein, and (d) is a side sectional view of the first-terminal receiving cavity with the first
10 terminal received therein;

[0019] Figure 6 is a three-dimensional view of a second connector according to the Present Disclosure;

[0020] Figure 7 is a first pair of views of the second connector of Fig. 6, wherein (a) is a top view and (b) is a first side view;

15 [0021] Figure 8 is the second pair of views of the second connector of Fig. 6, wherein (a) is a second side view and (b) is a bottom view;

[0022] Figure 9 is a three-dimensional view of a second terminal according to the Present Disclosure, wherein (a) is a front three-dimensional view from the left upper side, (b) is a rear three-dimensional view from the right upper side, (c) is a front three-dimensional view from the
20 left lower side, and (d) is a rear three-dimensional view from the right lower side;

[0023] Figure 10 illustrates the relationship between the second terminal and a second-terminal receiving cavity in the Present Disclosure, wherein (a) is a front view of the second-terminal receiving cavity, (b) is a side sectional view of the second-terminal receiving cavity, (c) is a front view of the second-terminal receiving cavity terminal with the second terminal received therein, and (d) is a side sectional view of the second-terminal receiving cavity with the second terminal
25 received therein;

[0024] Figure 11 illustrates an operation of mating the first connector and the second connector in the Present Disclosure, wherein (a) is a sectional view that shows the condition of the first connector and the second connector before mating, and (b) is a sectional view that shows the first
30 connector and the second connector in a mated state; and

[0025] Figure 12 is a sectional view of a terminal attachment part in a conventional connector.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] 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.

[0027] 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.

[0028] 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.

[0029] Referring to the Figures, 10 designates a first connector constituting one multipole connector of the connector pair according to the illustrated embodiment, and is a surface-mounted type of connector for mounting on the front side of a first circuit board, which is not shown in the drawings. The first connector 10 mates with a second connector 101, which is described below. The second connector 101 is a second connector constituting a counterpart multipole connector of the pair of the present embodiment, and is a surface-mounted type of connector for mounting on the front side of a second circuit board, which is not shown in the drawings. The multipole connector of the present embodiment of the Present Disclosure includes the aforementioned first connector 10 and the second connector 101, and electrically connects the first and second circuit boards as a circuit board pair. The aforementioned first circuit board and the second circuit board may be, *e.g.*, printed circuit boards used in electronic devices, flexible flat cables (FFC), flexible printed circuits (FPC), or the like, but may be circuit boards of any other types.

[0030] In the illustrated embodiment, the aforementioned first connector 10 has a first housing 11, which is an integrally formed housing made from a material with insulating properties, *e.g.*, a

synthetic resin. As shown in Figs. 1 to 3, the first housing 11 is a thick-walled plate of a substantially rectangular shape that has, on the side mated with the second connector 101 (*i.e.*, on the upper side in the view of Fig. 1), a substantially rectangular recess 12 whose bottom surface is defined by an upper surface 16a of a bottom plate 16 and whose periphery is surrounded by a side wall 14.

[0031] Typically, the first connector 10 is a multipole connector having a flat, elongated shape and anywhere from 100 or more to 1,000 or more poles. Therefore, for ease of illustration, the central parts of the connector are cut out in the direction connecting the upper right to the lower left side in Fig. 1, in the vertical direction in Fig. 2(a), and in the transverse direction in Fig. 3(b).

[0032] The recess 12 has a plurality of projections 13 that are formed integrally with the first housing 11. In the illustrated case, the projections 13 project upward from the upper surface 16a of the bottom plate 16 and extend in the longitudinal direction of the first housing 11. As a result, thin longitudinal grooves 12a that extend in the longitudinal direction of the housing 11 are formed on both sides of the aforementioned projections 13. In the example shown in the drawings, five projections 13 are provided, but it is understood that this number may be any number from one to a plurality.

[0033] First-terminal receiving cavities 15 as cavities for receiving first terminals 61 as terminals are formed on both sides of the aforementioned projections 13. A plurality of cavities 15 spaced at a pitch, for example, of approximately 1 mm, are formed on both sides of the projections 13, and each such cavity accommodates a respective first terminal 61. The pitch and number of the first-terminal receiving cavities 15 and the number of the terminals 61 can be appropriately set.

[0034] Furthermore, first protuberances 14a for use as first mating guides are formed on both sides of the housing 11 in the longitudinal direction. These first protuberances 14a are formed by a part of the side wall 14 bulging outward. In the illustrated example, one such protuberance is formed on one longitudinal side of the housing, and two are formed on the other side, but the number and positions of the first protuberances 14a can be appropriately set. When the first connector 1 is in a mated state with the second connector 101, second protuberances 14a of the second connector 101, which are described below, are inserted into the aforementioned first protuberances 14a.

[0035] The housing 11 has first housing legs 17 that project downward and are formed at a plurality of locations on the periphery of a lower side 16b of the bottom plate 16. The lower

surfaces of these first housing legs 17 contact the surface of the first circuit board, thereby functioning as spacers that maintain a predetermined distance between the surface of the first circuit board and the lower side 16b of the bottom plate 16.

[0036] The first-terminal receiving cavities 15 are formed extending from the upper surface of the projections 13 to the lower surface 16b of the bottom plate 16, and, as shown in Figs. 2-3, the tail portions 62 of the first terminals 61 extend in the downward direction from the lower surface 16b of the bottom plate 16. The tail portion 62 of each first terminal 61 is the so-called “solder tail,” and is connected by soldering to a terminal connection pad coupled to a conductive trace on the first circuit board.

[0037] As shown in the drawings, the first terminal 61 has a tail portion 62, a body portion 63, a held portion 64, and a contact portion 65, and is formed as a single piece by stamping, bending, or otherwise machining an electrically conductive metal plate. The body portion 63 is a flat part with a substantially square shape. The contact portion 65 is a part for contacting a second terminal 161 described below constituting the mating terminal, has approximately the same width as the body portion 63, and includes a curved portion 65a that is connected to the upper end of the body portion 63, a base portion 65b that is connected to the upper end of the curved portion 65a, a contact arm 65d that is connected to the upper end of the base portion 65b and divided into left and right portions by a separating slit 65c, a contact projection 65e formed by bending the aforementioned contact arm 65d in the middle, and tip portions 65f constituting the upper end of the contact arm 65s that are located further towards the tip side than the contact projection 65e.

[0038] The aforementioned curved portion 65a has a side surface shaped as a gentle “S” and extending obliquely forward at a moderate angle upward from the body portion 63. The base portion 65b is a flat portion having a width somewhat greater than that of the curved portion 65a, extends upward and forward at a slight angle relative to the body portion 63, is flexibly deformable, and functions as a spring. Furthermore, the contact arm 65d also extends upward and forward at a slight angle relative to the body portion 63, is flexibly deformable, and functions as a spring. The contact arm 65d is a thin elongated plate-like portion having the same width as the base portion, but is bifurcated by the separating slit 65c formed extending in the longitudinal direction from the tip. As a result, the left and right parts of the contact arm 65d are independently flexibly deformable and, even if their positions relative to the second terminal 161

vary, capable of maintaining reliable contact with the terminal 161. Because the tip portions 65f extend obliquely upward to the rear from the contact projection 65e, the tips thereof are positioned further to the rear than the contact projection 65e. Therefore, when the first connector 1 is mated with the second connector 101, smooth contact with the second terminal 161 is performed.

[0039] Furthermore, the aforementioned tail portion 62 includes a stress alleviating portion 62a connected to the lower end of the body portion 63 and a connecting part 62b connected to the lower end of the stress alleviating portion 62a. The stress alleviating portion 62a is a thin elongated part narrower than the body portion 63. In a side view, the stress alleviating portion 62a has a substantially U-shaped or J-shaped configuration, bends from a connection point with the lower end of the body portion 63, and extends forward roughly perpendicular to the body portion 63 before bending roughly 180° so that its tip is turned backward. The aforementioned connecting portion 62b is flat and circular in shape, is connected to the lower end, *i.e.*, to the tip of the stress-alleviation portion 62a, and extends almost perpendicularly to the body portion 63.

[0040] The connecting part 62b is soldered to the aforementioned terminal connection pad in a condition in which its lower surface faces the upper surface of the terminal connection pad on the first circuit board. Because the connecting part 62b is circular in shape and the stress alleviating portion 62a is flexibly deformable, it is possible to prevent concentration of stress in the solder, formation of cracks in the solder, and separation from the terminal connection pad even if the positions of the body portion 63 of the first terminal 61 and terminal connection pad are changed relative to each other. Also, because the distance from the connecting part 62b through the stress-alleviating portion 62a to the body portion 63 becomes longer, occurrence of the phenomena of solder rising, flux rising, or the like is prevented.

[0041] The held portion 64 is a flat-plate part that is shaped so as to be coplanar with the body portion 63, and extends outward in the width direction from the side edges on both sides of the body portion 63. The held portion 64 has upward projections 64a that extend upward from the upper end of the held portion and downward projections 64b that extend downward from the lower end of the held portion. The upper ends of the upward projections 64a are positioned higher than the upper end of the body portion 63, and the lower ends of the downward projections 64b are positioned lower than the lower end of the body portion. Thus, the distance from the upper end of the upward projections 64a to the lower end of the downward projections

64b, *i.e.*, the vertical dimension of the held portion 64, is greater than the distance from the upper end to the lower end of the body portion 63, *i.e.*, the vertical dimension of the body portion 63.

[0042] Formed on the side edges of the held portion 64 are anchor portions 64c that project outward and smooth stabilizing portions 64d that extend vertically. More specifically, the

5 anchor portions 64c are formed on the upper parts of the side edges of the held portion 64, and the stabilizing portions 64d are formed on the lower parts of the side edges of the held portion

64. In the present embodiment, the first terminal 61 is inserted into and received by the first-terminal receiving cavity 15, the aforementioned anchor portion 64c is a part that locks into a

below-described support side wall 15d of the first-terminal receiving cavity 15, and the

10 stabilizing portion 64d contacts the support side wall 15d. In the present embodiment, because

the held portion 64 has a large vertical dimension, at least greater than the vertical dimension of the body portion 63, it becomes possible to increase the distance between the anchor portions 64c

and the stabilizing portions 64d, in turn stabilizing the position of the first terminal 61 in the

first-terminal receiving cavity 15. Furthermore, the positions of the anchor portion 64c and the

15 stabilizing portion 64d can be appropriately changed. For example, the anchor portions 64c can be formed higher than the positions shown in the drawing, and the stabilizing portions 64d can

be formed lower than the positions shown in the drawings.

[0043] For ease of illustration, only one first-terminal receiving cavity 15 of the first housing 11 and the surrounding periphery of the cavity shown in the above drawings is depicted. Illustration

20 of other parts is omitted.

[0044] The first-terminal receiving cavity 15 includes a narrow portion 15a that is a narrow groove-shaped space extending in the vertical direction; a wide portion 15b that is a groove-

shaped space connected to the lower end of the narrow portion 15a, extending in the vertical

direction, and wider than the narrow portion 15a; and a bottom plate-penetrating portion 15c that

25 has almost the same width as the wide portion 15b and passes through the bottom plate 16 from its upper surface 16a to its back surface 16b. Furthermore, the portions on the upper side of the

wide portion 15b and the narrow portion 15a are formed as recesses in the side wall of the

projection 13, are integral with the bottom plate-penetrating portion 15c and a portion on the

lower side of the wide portion, and are formed so as to penetrate vertically through the bottom

30 plate 16.

[0045] The first terminal 61 is inserted into the first-terminal receiving cavity 15 from the lower side of the first housing 11, *i.e.*, from the lower surface 16b of the bottom plate 16. More specifically, as shown in Figs. 5(c)-(d), the back surface of the body portion 63 (*i.e.*, the surface on the side opposite to the direction of extension of the tail 62) is positioned so that it abuts the back surface 15e of the first-terminal receiving cavity 15, and the first terminal 61 is inserted into and received by the first-terminal receiving cavity 15. Since in this case the distance between the tips of the left and right anchor portions 64c of the first terminal 61 is set wider than the distance between the support side walls 15d formed on both sides of the first terminal 61, the anchor portions 64c lock into the support side walls 15c and become secured. As a result, the held portion is held by the support side walls 15d of the wide portion 15b, and the first terminal 61 is received by and held in the first-terminal receiving cavity 15.

[0046] Since the distance between the left and right stabilizing portions 64d is set almost the same as the distance between the tips of the anchor portions 64c, the stabilizing portions 64d contact and are pressed against the support side walls 15d. As a result, the held portion 64 is squeezed and held by the support side walls 15d of the wide portion 15d over a wide range in the vertical direction, the first terminal 61 is reliably held in the first-terminal receiving cavity 15, and the first terminal 61 is prevented from falling out of the first-terminal receiving cavity 15. Furthermore, because the anchor portions 64c are formed on the upper parts of the held portion 64 and the stabilizing portions 64d are formed on the lower parts of the held portion 64, the distance between the anchor portions 64c and the stabilizing portions 64d is increased with respect to the vertical direction, and, therefore, the held portion 64 is held in a stable state by the support side walls 15d of the wide portion 15b over a very wide range in the vertical direction. For this reason, the terminal 61 is restricted from tilting to the left or right relative to the first-terminal receiving cavity 15 as seen in Fig. 5(c).

[0047] With the first terminal 61 completely received by the first-terminal receiving cavity 15, the base portion 65b and the contact arm 65d of the contact portion 65, *i.e.*, at least the upper part of the contact portion 65, is received by the narrow portion 15a, while the curved portion 65a of the contact portion 65, the body portion 63, and the held portion 64 are received by the wide portion 15b. However, as mentioned above, the curved portion 65a and the base portion 65b extend obliquely upward and forward at a slight angle with respect to the body portion 63 of the first-terminal receiving cavity 15, they are separated from the back wall 15e of the first-terminal

receiving cavity 15 and adjacent to the projection 13, as shown in the side view in Fig. 5(d).

Furthermore, because the contact arms 65d extend obliquely upward and forward at a slight angle with respect to the body portion 63 from the upper end of the base portion 65b, the peripheral portion of the contact projection 65e is separated from the back surface 15e and

5 projects outward from the narrow portion 15a, *i.e.*, projects outside the side wall of the projection 13. Furthermore, the width of the base portion 65b and the contact arm 65d is less than the width of the narrow portion 15a. Therefore, when the first connector 1 is mated with the second connector 101, the narrow portion 15a is flexibly shifted even when in contact with and pressed by the second terminal 161b, and contact with the second terminal 161 is reliably maintained.

10 [0048] The end of the tip portion 65f is positioned closer to the back surface 15e than the contact projection 65e is, and remains inside the narrow portion 15a so as not to project outside the side wall of the projection 13. Therefore, when the first connector 1 is mated with the second connector 101, the material of the second connector 101 is not caught upon the end of the tip 65f. Moreover, even if a width-direction force (*e.g.*, a force acting in the transverse direction as
15 shown in Fig. 5(c)) caused, for example, by contact with foreign matter is applied to the contact projection 65e, the contact arm 65d will not shift in the width direction and contact the contact arm 65d of the neighboring first terminal 61 or the neighboring second terminal 161 adjacent to the corresponding second terminal 161, thereby causing short-circuiting.

[0049] The connecting part 62b of the tail portion 62 is positioned below the bottom plate-
20 penetrating portion 15c, and projects downward from the lower surface 16b of the bottom plate 16. In other words, the connecting part 62b projects downward from the lower end of the first-terminal receiving cavity 15. In addition, the stress alleviating portion 62a extends forward from the lower end of the body portion 63. However, the front end part thereof is located inside the bottom plate-penetrating portion 15c and does not contact the surface on the side opposite the
25 back surface 15e in the bottom plate-penetrating portion 15c. Furthermore, because the width of the stress alleviating portion 62a is sufficiently less than the width of the wide portion 15c and the bottom plate-penetrating portion 15c, the stress alleviating portion 62a does not contact the side surfaces of the bottom plate-penetrating portion 15c or the wide portion 15b. Thus, even if
30 there is a change in the relative positions of the body portion 63 of the first terminal 61 and the terminal connection pad on the first circuit board to which the connecting part 62b is connected by soldering, the stress alleviating portion 62a does not interfere with the surface of the wide

portion 15b or the bottom plate-penetrating portion 15c; and because it is flexibly deformable, cracks in or separation of the solder from the terminal connecting pad does not occur.

[0050] 6]

5 **[0051]** The second connector 101 has a second housing 111 integrally formed from an insulating material such as synthetic resin, or the like. As shown in Figs. 6-8, the second housing 111 has a substantially rectangular, thick plate-like shape, and a plurality of recesses 113 on the side (*i.e.*, the upper side in Fig. 6) to which the first connector 10 is mated. In the illustrated case, the recesses 113 penetrate down from the front surface, have bottom surfaces defined by the upper surface 116a of the bottom plate 116, and extend in the longitudinal direction of the second
10 housing 111. Thin longitudinal ridges 112 extending in the longitudinal direction of the second housing 111 are thereby formed on both sides of the recesses 113. The ridges 112 have a plurality of recesses 112a, which, however, can be omitted as appropriate. Although five recesses 113 are shown in the illustrated example, their number may be any number, from one to a plurality.

15 **[0052]** Like the aforementioned first connector 10, the second connector 101 typically is a multipole connector in the form of a flat, elongated body that may have anywhere from 100 or more to 1,000 or more poles. Therefore, for ease of illustration, in Figs. 6-8 the central parts of the connector are cut out in the direction connecting the upper right to the lower left in Fig. 6, in the vertical direction in Fig. 7(a), and in the transverse direction in Fig. 8(b).

20 **[0053]** Formed on the side walls on both sides of the recesses 113, *i.e.*, on the side walls of the ridges 112, are second-terminal cavities 115 acting as terminal receiving cavities for second terminals 161. On each side wall of each cavity 113, *i.e.*, on each side wall of the ridge 112, a plurality of second-terminal receiving cavities 115 are formed with a pitch of, for example, approximately 1 mm. Each second-terminal receiving cavity 115 receives one respective second
25 terminal 161. The pitch and the number of the second-terminal receiving cavities 115 and the second terminals 161 can be appropriately set.

[0054] Furthermore, second protuberances 114a acting as second insertion guides are formed on both sides of the second housing 111 in the longitudinal direction thereof. These second protuberances 114a are formed by a part of the side wall 114 bulging outward. In the illustrated
30 example, one such protuberance is formed on end of the second housing 111 in the longitudinal direction, and two are formed on the other side, but the number and positions of the second

protuberances 114a can be appropriately set. When the first connector 1 and the second connector 101 are in a mated state, the second protuberances 114a are inserted into the first protuberances 14a of the first connector 10.

[0055] The second housing 111 has downward projecting second housing legs 117 formed at a plurality of locations on the periphery of the lower side 116b of the bottom plate 116. The lower surfaces of these second housing legs 117 contact the front side of the second circuit board and function as spacers that provide a predetermined distance between the front side of the second circuit board and the back side 116b of the bottom plate 116.

[0056] The second-terminal receiving cavities 115 are formed so as to extend from the side surfaces of the recesses 113 through to the lower surface 116b of the bottom plate 116, and, as shown in Figs. 7-8, the tail portions 162 of the second terminals 161 project downward from the lower surface 116b of the bottom plate 116. The tail portion 162 of each second terminal 161 constitutes a so-called "solder tail" and is connected by soldering or the like to a terminal connection pad linked to a conductive trace on the second circuit board.

[0057] As shown in the drawings, the second terminal 161 has a tail portion 162, a body portion 163, a held portion 164, and a contact portion 165. The second terminal 161 is formed as a single piece by stamping, bending, or otherwise machining an electrically conductive metal plate. The body portion 163 is a flat part shaped substantially as a square. Furthermore, the contact portion 165 is a part intended for contact with the first terminal 61. This portion has the same width as the body portion 163 and includes a curved portion 165a connected to the upper end of the body portion 163 and a contact arm 165b wider than the curved portion 165a and connected to the upper end of the curved portion 165a.

[0058] The aforementioned curved portion 165a has a side surface that is shaped as a crank or the letter S, is curved and connected to the upper end of the body portion 163, and extends roughly perpendicularly to the body portion 163 before bending and being connected to the lower end of the contact arm 165b. The contact arm 165b is a plate-like portion substantially rectangular in shape and extending vertically parallel to the body portion 163.

[0059] Furthermore, the aforementioned tail portion 162 includes a stress alleviating portion 162a connected to the lower end of the body portion 163 and a connecting part 162b connected to the lower end of the stress alleviating portion 162a. The tail portion 162, along with the stress alleviating portion 162a and connecting part 162b included in the tail portion 162, have the same

configuration as the above-described tail portion 62 with the stress alleviating portion 62a that contains the tail portion 62 as well as the connecting part 62b of the first contact 61. Therefore, descriptions of these parts are omitted.

[0060] The held portion 164 is a flat-plate part that is shaped so as to be coplanar with the body portion 163 and extending outward in the width direction from the side edges on both sides of the body portion 163. Each held portion 164 has projections 164a that extend upward from the upper ends of the held portion and projections 164b that extend downward from the lower ends of the held portion. Formed on the side edges of the held portion 164 are anchor portions 164c that project outward and smoothed stabilizing portions 164d that extend in the vertical direction. The held portion 164, as well as the vertically extending projections 164a, downward projections 164b, anchor portions 164c, and stabilizing portions 164d included in the held portion 164, have the same configuration as the held portion 64 and the vertically extending projections 64a, downward projections 64b, anchor portions 64c, and stabilizing portions 64d included in the held portion 64 of the first terminal 61. Therefore, their descriptions are omitted.

[0061] For ease of illustration, only one second-terminal receiving cavity 115 of the second housing 111 and the vicinity thereof is shown in the above drawing. Illustration of other parts is omitted.

[0062] As shown in the drawings, the second-terminal receiving cavity 115 includes a narrow portion 115a that is a narrow groove-shaped space extending in the vertical direction; a wide portion 115b that is a groove-shaped space connected to the lower end of the narrow portion 115a, extending in the vertical direction, and wider than the narrow portion 115a; and a bottom plate-penetrating portion 115c that has almost the same width as the wide portion 115b and passes through the bottom portion 116 from its upper surface 116a to the back surface 116b.

Furthermore, the portions on the upper side of the wide portion 115b and the narrow portion 115a are formed as recesses in the side wall of the ridges 112, are integral with the bottom plate-penetrating portion 115c and a portion on the lower side of the wide portion, and extend vertically through the bottom portion 116.

[0063] Whereas the first-terminal receiving cavity 15 is formed so as to extend from the lower surface 16b of the bottom plate 16 through to the upper surface of the projections 13, the second-terminal receiving cavity 115 does not reach the upper surface of the ridges 112. Therefore, the upper end of the second-terminal receiving cavity 115, *i.e.*, the upper end of the narrow portion

115a, is defined by the side-wall upper end 112b of the ridge 112. Furthermore, whereas the back surface 15e of the first-terminal receiving cavity is roughly flat, the back surface 115e of the second-terminal receiving cavity 115 is gradated, and is divided into an upper back surface 115e1 forming the back surface of the narrow portion 115a and a lower back surface 115e2 forming the back surface of the wide portion 115b. The upper back surface 115e1 and the lower back surface 115e2 are parallel to each other, but because the narrow portion 115 is shallower than the wide portion 115b, the upper back surface 115e1 is positioned more forward (the left as seen in Fig. 10(b)) than the lower back surface 115e2; *i.e.*, closer to the side wall surface of the ridge 112.

[0064] The second terminal 161 is inserted into the second-terminal receiving cavity 115 from the lower side of the second housing 111, *i.e.*, from the lower surface 116b of the bottom portion 116. More specifically, as shown in Figs. 10(c)-10(d), the second terminal 161 is inserted into and received by the second-terminal receiving cavity 115 so that the back surface of the body portion 163 (*i.e.*, the surface on the side opposite the direction of extension of the tail 162) contacts the lower back surface 115e2 of the second-terminal receiving cavity 115. Because the distance between the tips of the left and right anchor portions 164c of the second terminal 161 is set so as to be greater than the distance between the support side walls 115d formed on both sides of the second terminal 161 in this case, the anchor portions 164c lock into the support side walls 115c and are secured. As a result, the held portion is held by the support side walls 115d of the wide portion 115b, and the second terminal 161 is received by and held in the second-terminal receiving cavity 115.

[0065] Because the distance between the left and right stabilizing portions 164d is set almost the same as the distance between the tips of the anchor portions 164c, the stabilizing portions contact and are pressed against the support side walls 115d. As a result, the held portion 164 is squeezed and held by the support side walls 115d of the wide portion 115d over a wide range in the vertical direction, the second terminal 161 is reliably held in the second-terminal receiving cavity 115, and the second terminal 161 is prevented from falling out from the second-terminal receiving cavity 115. Furthermore, because the anchor portions 164c are formed on the upper parts of the held portion 164 and the stabilizing portions 64d are formed on the lower parts of the held portion 164, the distance between the anchor portions 164c and the stabilizing portions 164d is increased with respect to the vertical direction, and, therefore, the held portion 164 is held in a

stable state by the support side walls 115d of the wide portion 115b over a very wide range in the vertical direction. For this reason, the second terminal 161 is restricted from tilting to the left or right relative to the second-terminal receiving cavity 115 as seen in Fig. 10(c).

[0066] With the second terminal 161 completely received by the second-terminal receiving cavity 115, the contact arm 165b of the contact portion 165, *i.e.*, at least the upper part of the contact portion 165, is received by the narrow portion 115a, while the curved portion 165a of the contact portion 165, the body portion 163, and the held portion 164 are received by the wide portion 115b. Because the curved portion 165a extends forward from the body portion 163, the body portion 163 and the contact arm 165b extending parallel to the body portion 163 approaches or contacts the upper-side back surface 115e1, as shown in Fig. 10(d). The front surface of the contact arm 165b is either roughly coplanar with the side wall upper end 112b of the ridge 112 or positioned slightly more forward than the side wall upper end 112b.

[0067] Therefore, when the first connector 10 and the second connector 101 are mated, the first terminal 61 will not catch on the upper end, *i.e.*, the tip, of the contact arm 165b. Even if it comes into contact with the first terminal 61 and is pressed upon by the first terminal, the contact arm 165b will not shift backward, and therefore contact with the first terminal can be reliably maintained.

[0068] The connecting part 162b of the tail portion 162 is positioned below the bottom plate-penetrating portion 115c and projects downward from the lower surface 116b of the bottom plate 116. In other words, the connecting part 162b projects downward from the lower end of the second-terminal receiving cavity 115. In addition, the stress alleviating portion 162a extends forward from the lower end of the body portion 163. However, the front end part thereof is located inside the bottom plate-penetrating portion 115c and does not contact the surface on the side opposite the lower back surface 115e2 in the bottom plate-penetrating portion 115c.

Furthermore, because the width of the stress alleviating portion 162a is sufficiently narrower than the width of the wide portion 115c and the bottom plate-penetrating portion 115c, the stress alleviating portion 162a does not contact the side surfaces of the bottom plate-penetrating portion 115c or the wide portion 115b. Thus, even if there is a change in the relative positions of the body portion 163 of the second terminal 161 and the terminal connection pad on the second circuit board to which the connecting part 162b is connected by soldering, the stress alleviating portion 162a does not interfere with the surface of the wide portion 115b or the bottom plate-

penetrating portion 115c; and because it is flexibly deformable, cracks in or separation of the solder from the terminal connecting pad does not occur.

[0069] In operation, the first connector 10 is surface-mounted to the first circuit board (not shown) by connecting the connecting part 62b of the tail portion 62 of the first terminal 61 by
5 soldering or the like to the terminal connection pad attached to the conductive trace on the first circuit board. Likewise, the second connector 101 is surface-mounted to the second circuit board (not shown) by connecting the connecting part 162b of the tail portion 162 of the second terminal 161 by soldering or the like to the terminal connection pad attached to the conductive trace on the second circuit board.

10 **[0070]** Next, an operator puts the mating side of the first connector 10 into a position facing the mating side of the second connector 101, as shown in Fig. 11(a). After the positions of the projections 13 of the first connector 10 are aligned with the recesses 113 of the second connector 101 and the projections are inserted into the recesses, the operation of aligning the positions of the first connector 10 and the second connector 101 is completed.

15 **[0071]** In this state, the first connector 10 and/or the second connector 101 are/is moved toward each other, and both connectors are mated, as shown in Fig. 11(b). When the first connector 10 and the second connector 101 are in a mated state, each projection 13 of the first connector 10 is inserted into the corresponding recess 113 of the second connector 101, the contact arm 65d of each first terminal 61 contacts the corresponding contact arm 165d of the second terminal 161,
20 and each first terminal 61 electrically connects with the corresponding second terminal 161.

[0072] Thus, according to the present embodiment, the first connector 10 and the second connector 101 constituting the multipole connector pair have, respectively, the first integral housing 11 and the second integral housing 111, and the plurality of first terminals 61 and second terminals 161 attached to the first housing 11 and the second housing 111; the first
25 terminals 61 and the second terminals 161 include the body portions 63 and 163 received by the first-terminal receiving cavity 15 and the second-terminal receiving cavity 115 of the first housing 11 and the second housing 111, the tail portions 62 and 162 connected to the lower ends of the body portions 63 and 163 and surface-mounted to the first circuit board and the second circuit board, the contact portions 65 and 165 connected to the upper ends of the body portions
30 63 and 163 and contacting the counterpart terminals, and the held portions 64 and 164 connected to both side edges of the body portions 63 and 163 and held by the holding side walls 15d and

115d formed on both sides of the first-terminal receiving cavity 15 and the second-terminal receiving cavity 115; the held portions 64 and 164 extend in the vertical direction, and have a vertical dimension greater than the vertical dimension of the body portions 63 and 163; the anchor portions 64c and 164c locking into the holding side walls 15d and 115d are formed on the side edges on the upper parts of the held portions 64 and 164; and the stabilizing portions 64d and 164d contacting the holding side walls 15d and 115d are formed on the lower parts of the held portions 64 and 164.

[0073] It is thereby possible to increase the vertical dimension of the held portions 64 and 164, and to increase the distance between the anchor portions 64c and 164c and the stabilizing portions 64d and 164d even if the height as a whole of the first connector 10 and the second connector 101 is reduced, with the result that the stability of the first terminal 61 and the second terminal 161 can be maintained. Therefore, the positions of the first terminal 61 and the second terminal 161 are maintained even when the first housing 11 and the second housing 11 thermally expand with respect to the first circuit board and the second circuit board, especially in the longitudinal direction, and the tail portions 62 and 162 surface-mounted to the first circuit board and the second circuit board are subjected to force. This allows highly reliable first connectors 10 and second connectors 101 capable of having a multipolar construction and easily manufacturable and mountable to the first circuit board and the second circuit board to be obtained.

[0074] The first-terminal receiving cavity 15 and the second-terminal receiving cavity 115 include the narrow portions 15a and 115a extending in the vertical direction and the wide portions 15b and 115b connected to the lower ends of the narrow portions 15a and 115a that extend in the vertical direction and are wider than the narrow portions 15a and 115a; the narrow portions 15a and 115a receive at least the upper parts of the contact portions 65 and 165; the wide portions 15b and 115b receive the body portions 63 and 163 and the held portions 64 and 164; the rear surfaces of the body portions 63 and 163 contact the back surfaces 15e and 115e of the first-terminal receiving cavity 15 and the second-terminal receiving cavity 115 in the wide portions 15b and 115b; and the held portions 64 and 164 are held in the wide portions 15b and 115b by the support side walls 15d and 115d of the first-terminal receiving cavity 15 and the second-terminal receiving cavity 115.

[0075] It is thereby possible to increase the distances between the left and right anchor portions 64c and 164c as well as between the stabilizing portions 64d and 164d, thus further improving the stability of the first terminal 61 and the second terminal 161.

[0076] Furthermore, the tail portions 62 and 162 include the stress alleviating portions 62a and 162a connected to the lower end of the body portions 63 and 163, and the connecting parts 62b and 162b connected to the lower ends of the stress alleviating portions 62a and 162a; and the connecting parts 62b and 162b protrude downward from the lower ends of the first-terminal receiving cavity 15 and the second-terminal receiving cavity 115 and are connected to the terminal connection pads on the surfaces of the first and second circuit boards. The connecting parts 62b and 162b are thus capable of flexibly shifting position, and even if there is a change in the relative positions of the first terminal 61 and second terminal 161 to the terminal connection pads on the surfaces of the first and second circuit boards, the connection of the connecting parts 62b and 162b to the terminal connection pads is maintained.

[0077] Furthermore, the connecting parts 62b and 162b are circular in shape, and are positioned further forward than the front surfaces of the body portions 63 and 163. Thus, stress does not concentrate in the connecting material such as, for example, solder bonding the connecting parts 62b and 162b to the terminal connection pads, and cracks do not form in the connecting material.

[0078] Furthermore, the stress alleviating portions 62a and 162a are narrower than the body portions 63 and 163, and extend forward roughly perpendicularly to the body portions 63 and 163 before curving so that their tips are turned back. The stress alleviating portions 62a and 162a are thereby capable of flexibly deforming, and if a change occurs in the positions of the first terminals 61 and the second terminals 161 relative to the terminal connection pads on the surfaces of the first circuit board and the second circuit board, no force is placed upon the body parts 63 and 163. Furthermore, the distance along the stress alleviating portions 62a and 162a from the connecting parts 62b and 162b to the body portions 63 and 163 is increased, preventing the occurrence of phenomena such as solder rising or flux rising.

[0079] 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:**

- 5 1. A multipole connector comprising:
 an integrally formed housing; and
 a plurality of terminals attached to the housing so as to form multiple pairs of
rows;
 wherein:
10 the terminal comprises a body portion received by a terminal receiving cavity
 of the housing, a solder tail connected to a lower end of the body portion
 and surface-mounted on a circuit board, a contact portion connected to an
 upper end of the body portion for contacting a counterpart terminal, and
 held portions connected to both side edges of the body portion and held by
15 holding side walls formed on both sides of the terminal receiving cavity;
 the held portions extend in a vertical direction and have a vertical dimension
 greater than a vertical dimension of the body portion; and
 anchor portions locking into the holding side walls are formed on side edges
20 of an upper part of the held portions, and stabilizing portions contacting
 the holding side walls are formed on side edges of a lower part of the held
 portions.
2. The multipole connector according to Claim 1, wherein the terminal receiving
cavity comprises a narrow portion extending in the vertical direction and a wide portion
25 extending in the vertical direction, the wide portion being connected to the lower end of said
narrow portion and wider than the narrow portion.
3. The multipole connector according to Claim 2, wherein at least an upper part of
the contact portion is received by the narrow portion, and the body portion and held portion are
30 received by the wide portion.

4. The multipole connector according to Claim 3, wherein a rear surface of the body portion contacts a back surface of the terminal receiving cavity in the wide portion, and the held portion is held by the holding side walls of the terminal receiving cavity in the wide portion.

5 5. The multipole connector according to Claim 4, wherein the solder tail comprises a stress alleviating portion connected to the lower end of the body portion and a connecting portion connected to a lower end of the stress alleviating portion.

10 6. The multipole connector according to Claim 5, wherein the connecting portion extends downward from a lower end of the terminal receiving cavity and is connected to a terminal connection pad on a surface of the circuit board.

15 7. The multipole connector according to Claim 6, wherein the connection portion has a circular shape and is positioned in front of a front surface of the body portion.

8. The multipole connector according to Claim 7, wherein the stress alleviating portion is narrower than the said body portion, extends forward roughly perpendicularly to the body portion before curving, and has a tip turned in a backward direction.

20 9. The multipole connector according to Claim 1, wherein the solder tail comprises a stress alleviating portion connected to the lower end of the body portion and a connecting portion connected to a lower end of the stress alleviating portion.

25 10. The multipole connector according to Claim 9, wherein the connecting portion extends downward from a lower end of the terminal receiving cavity and is connected to a terminal connection pad on a surface of the circuit board.

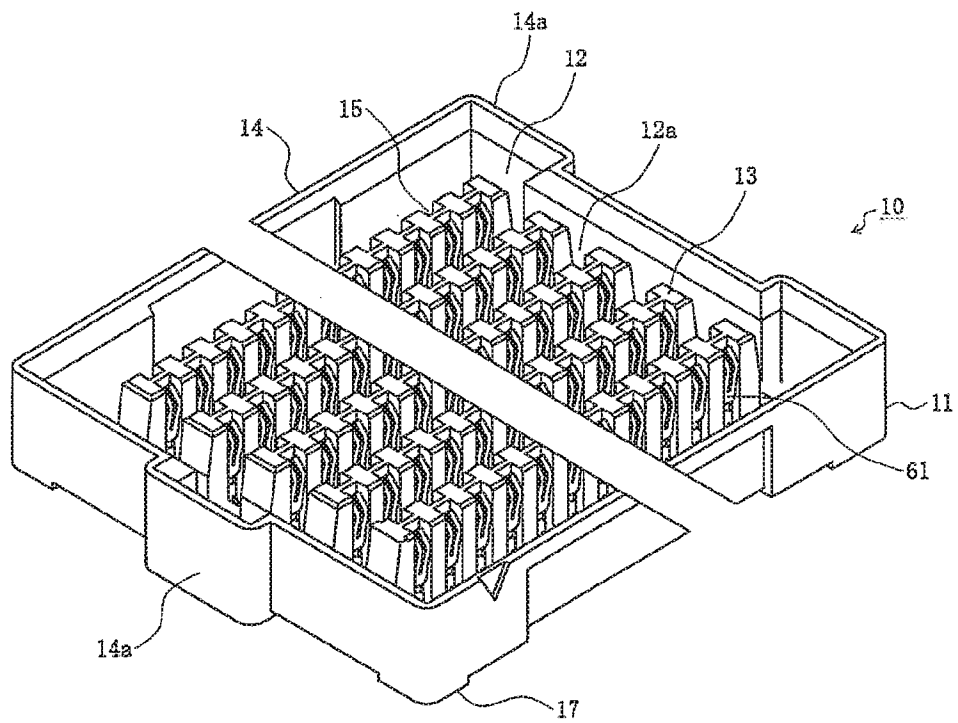


FIG. 1

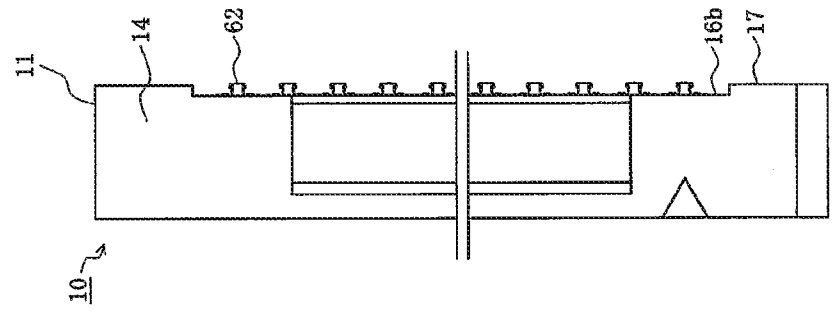


FIG. 2B

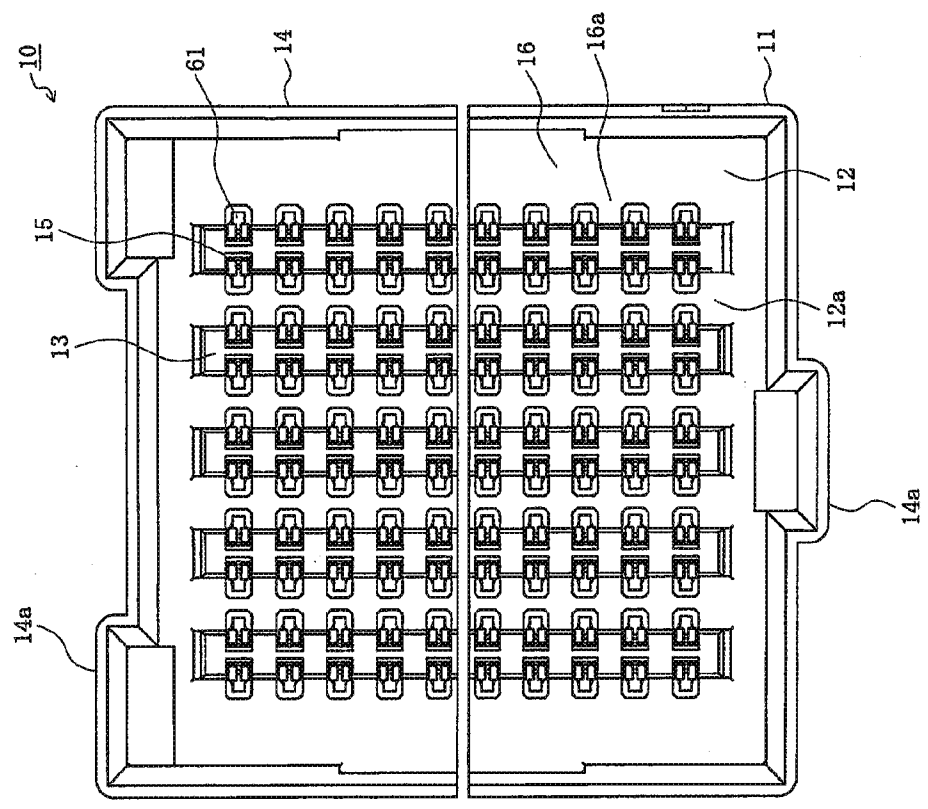


FIG. 2A

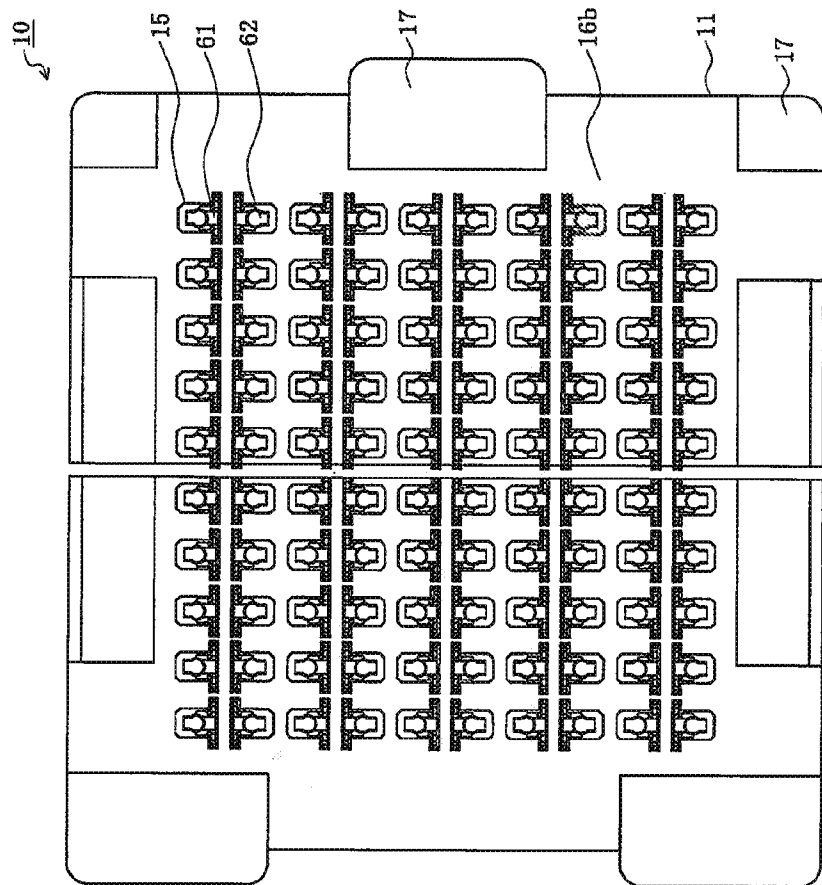


FIG. 3B.

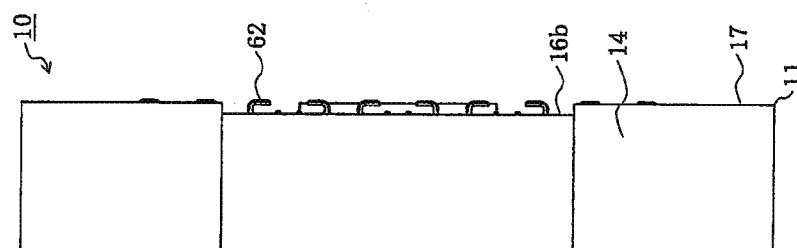


FIG. 3A

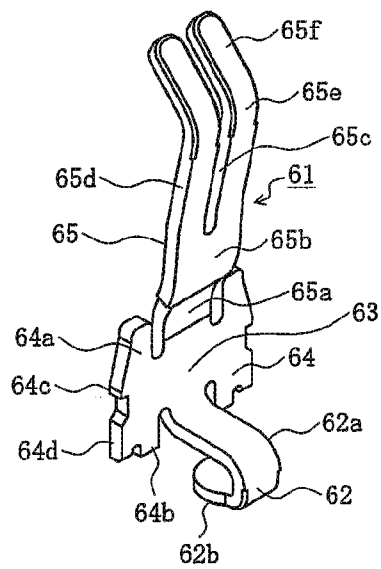


FIG. 4A

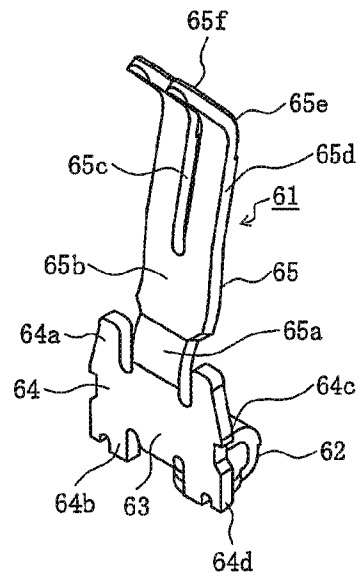


FIG. 4B

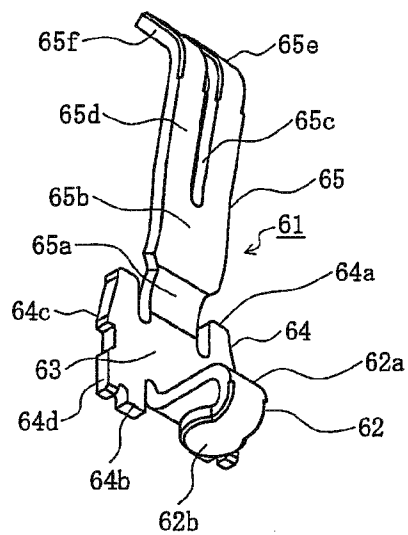


FIG. 4C

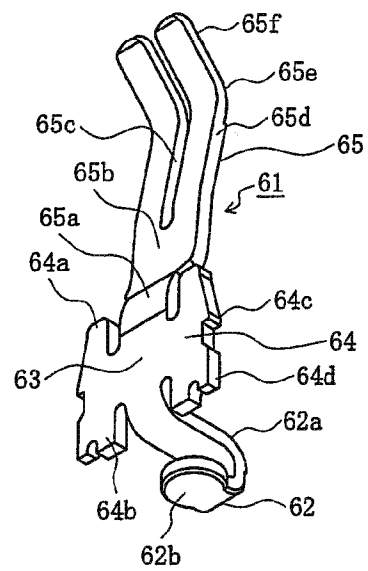


FIG. 4D

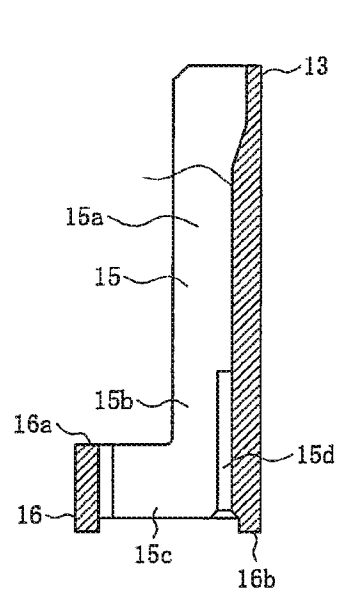


FIG. 5B

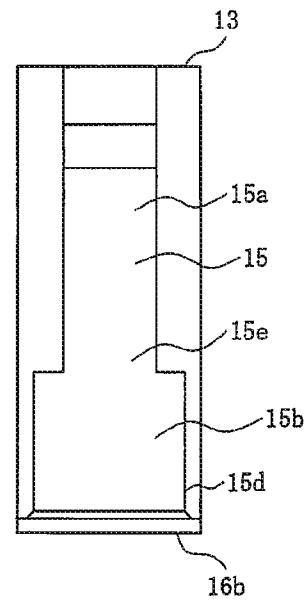


FIG. 5A

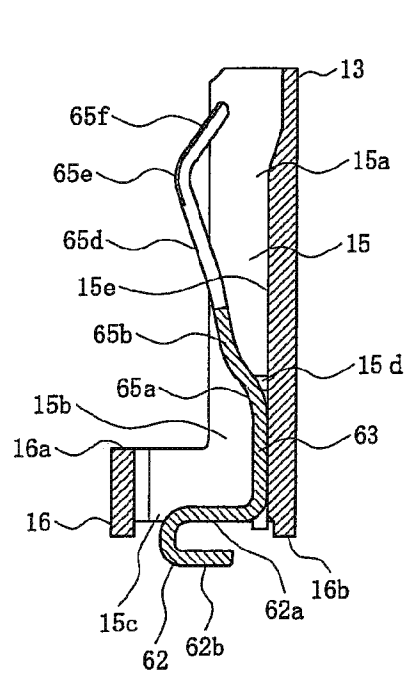


FIG. 5D

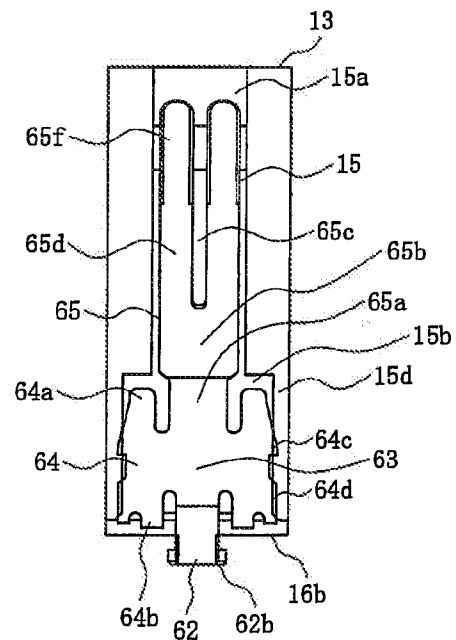


FIG. 5C

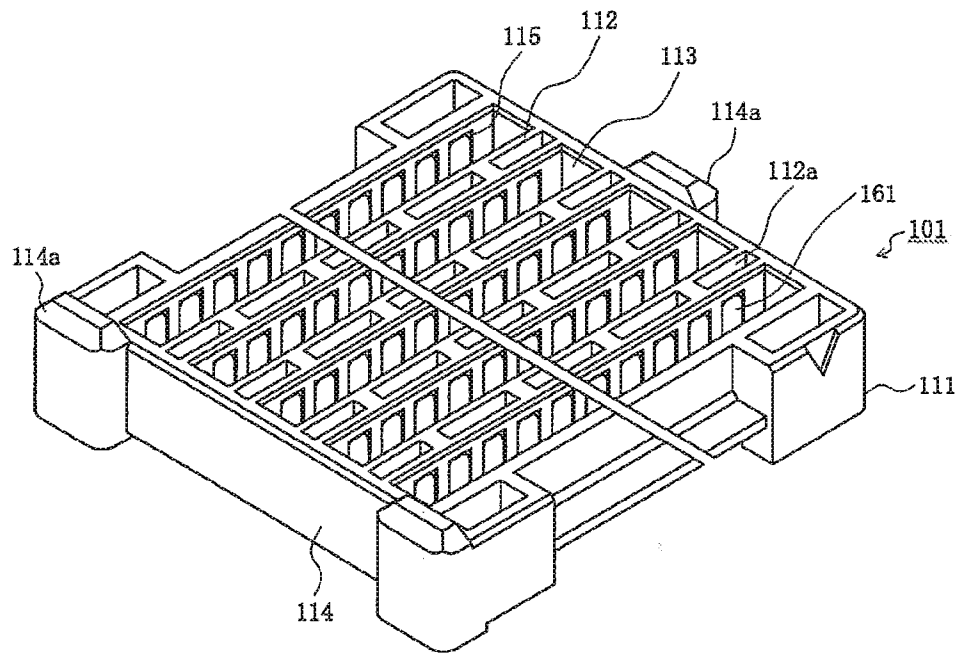


FIG. 6

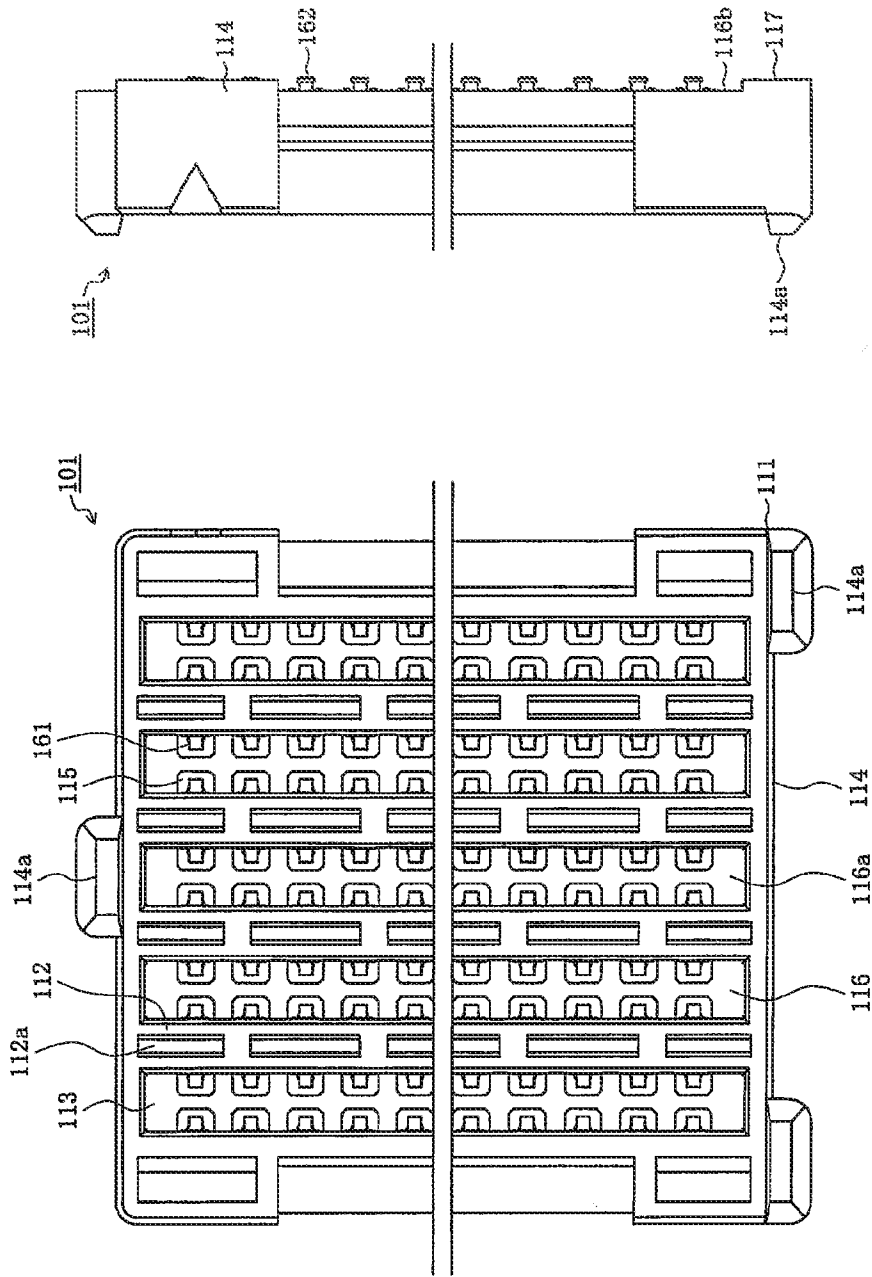


FIG. 7B

FIG. 7A

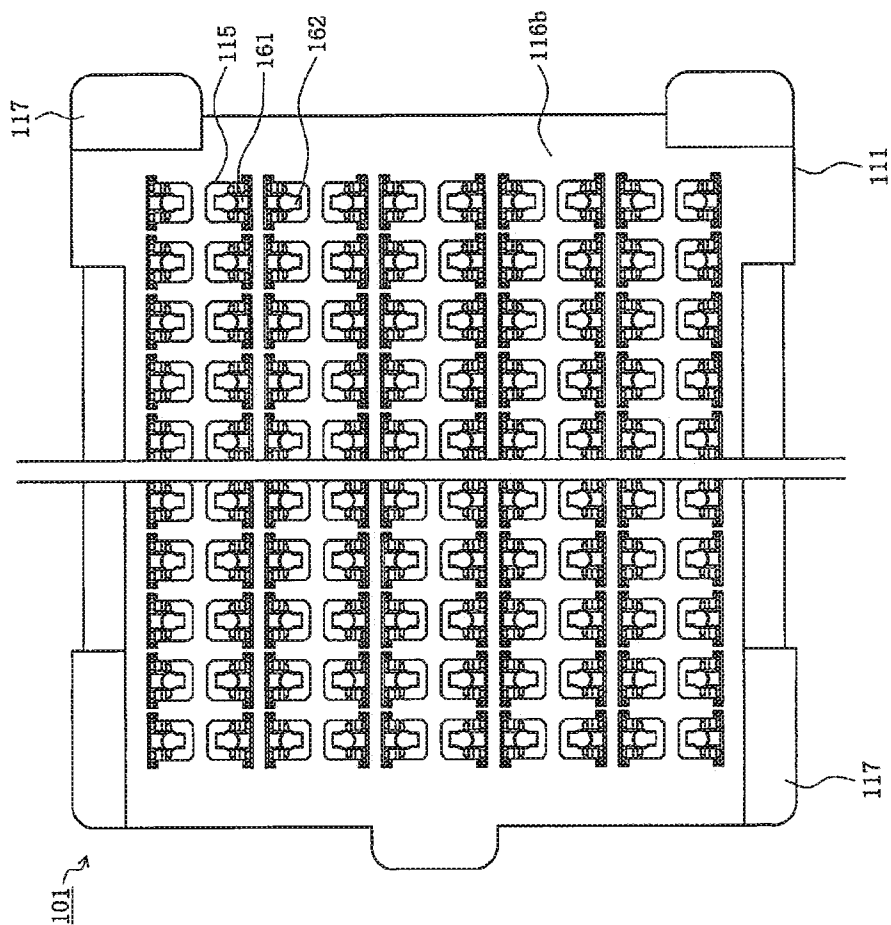


FIG. 8B

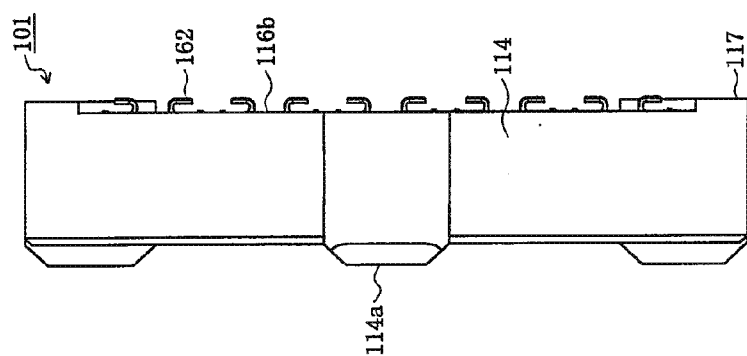


FIG. 8A

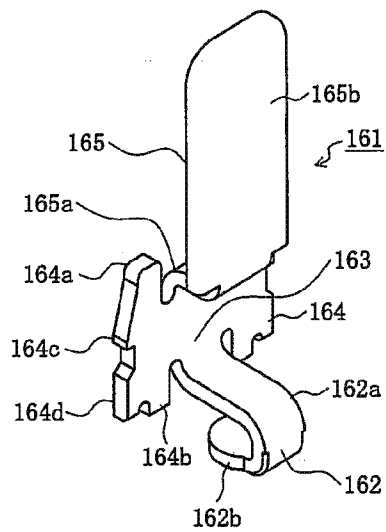


FIG. 9A

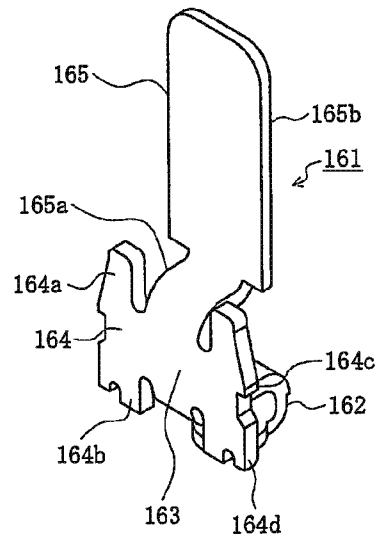


FIG. 9B

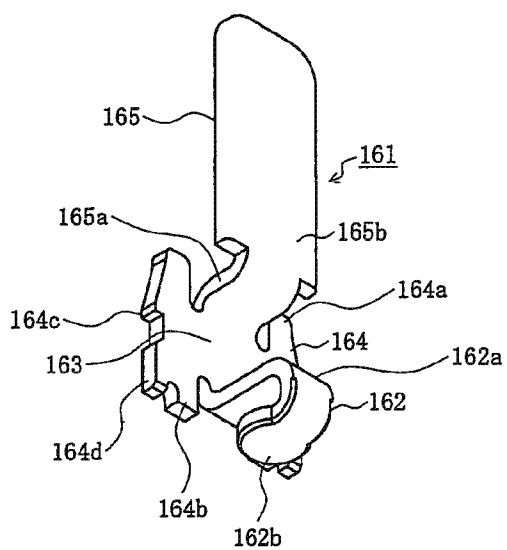


FIG. 9C

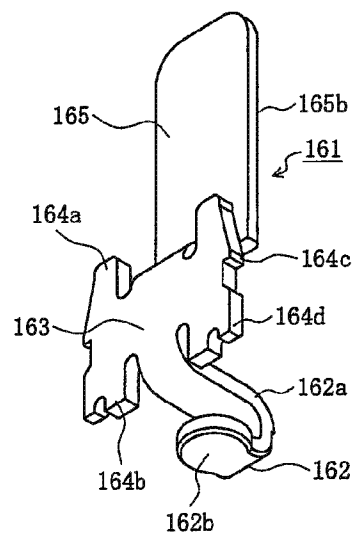


FIG. 9D

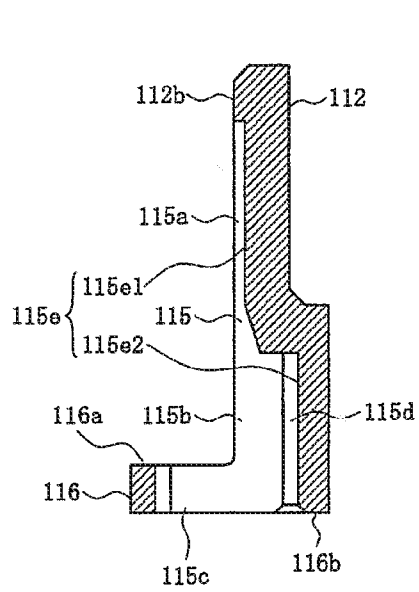


FIG. 10B

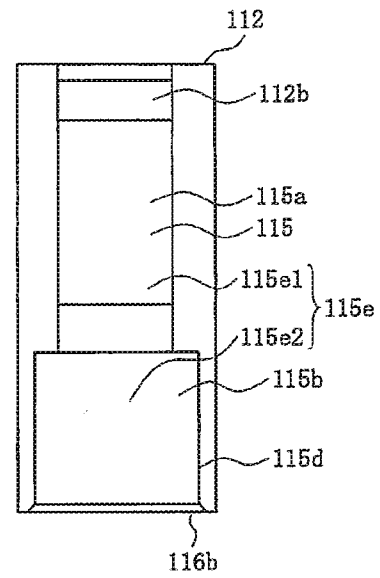


FIG. 10A

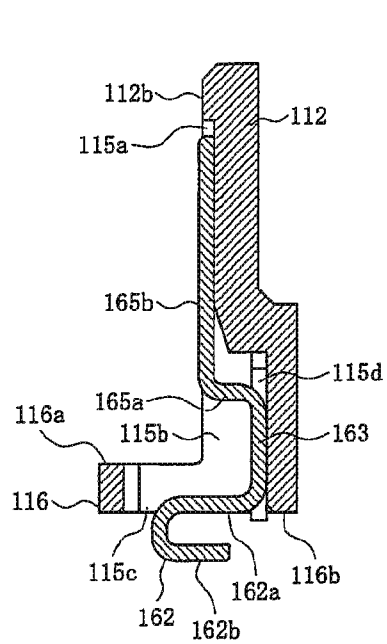


FIG. 10D

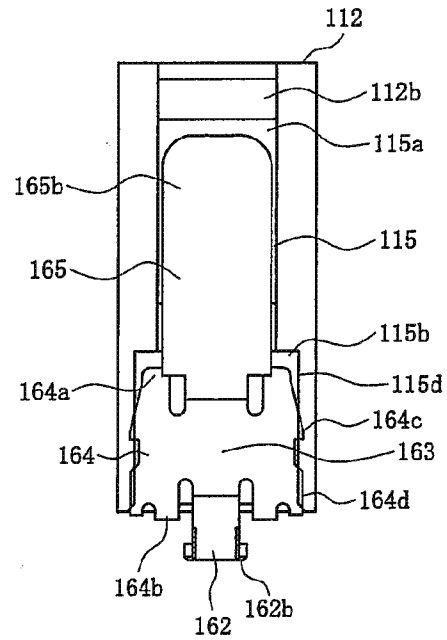


FIG. 10C

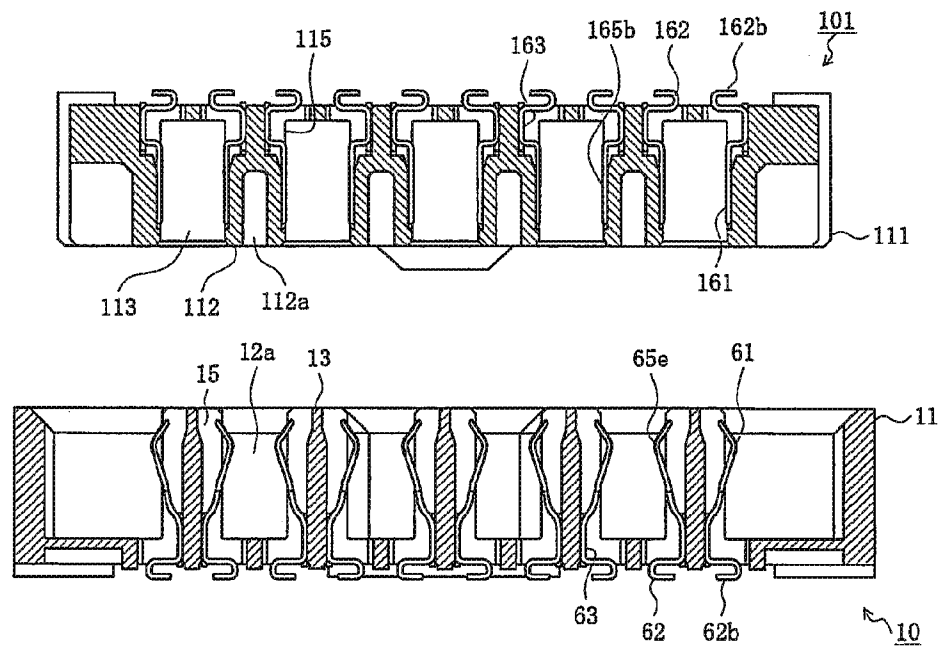


FIG. 11A

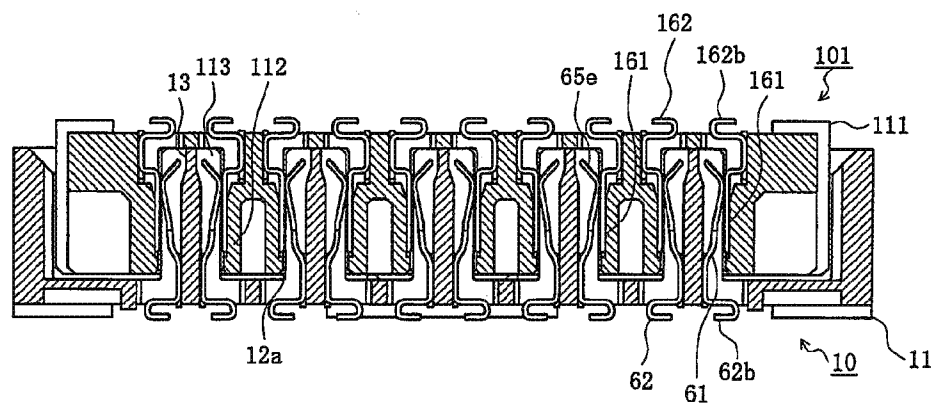
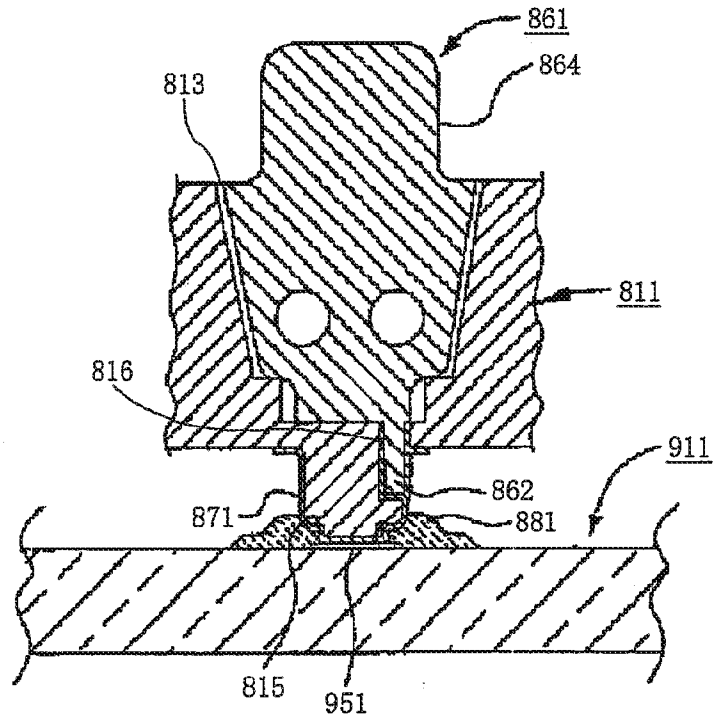


FIG. 11B



Prior art

FIG. 12