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(54) Electrical connector and cable with electrical connector

(57) An electrical connector (100) includes a contact (1) for electrical connection with a contact (201) of a counterpart connector (200), a main body (21) having a contact housing part (24) for housing the contact (1), and a coupling member (22) which can be coupled to the main body (21), and can latch a cable (40) that is connected to a contact (1) housed in the contact housing part (24) in conjunction with the main body (21) by being coupled to the main body (21). The electrical connector (100) further includes a retainer (35) which is attached in a displaceable manner to the main body (21), and is displaced from an initial position to a latching position at which the retainer can latch a contact (1) housed in the contact housing part (24) by receiving an external force from the couplingmember (22) when the coupling-member (22) is coupled to the main body (21).

FIG. 1 (a)

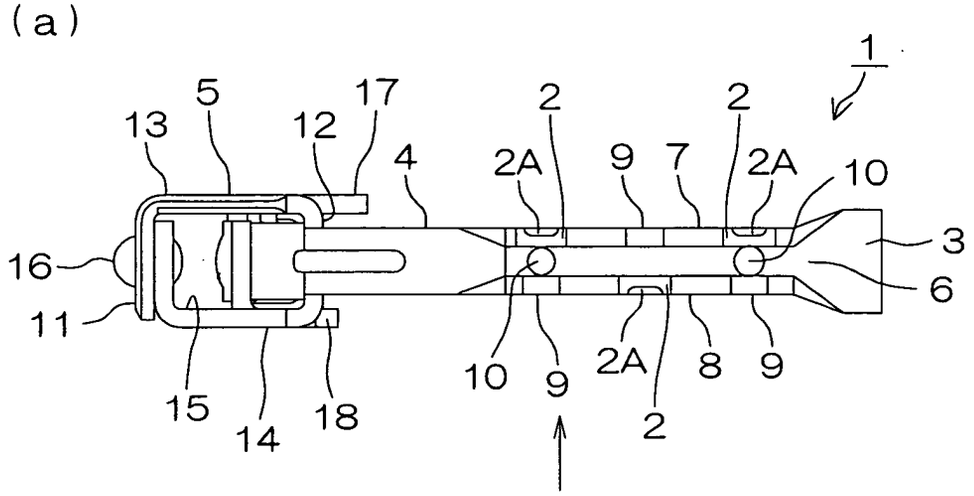

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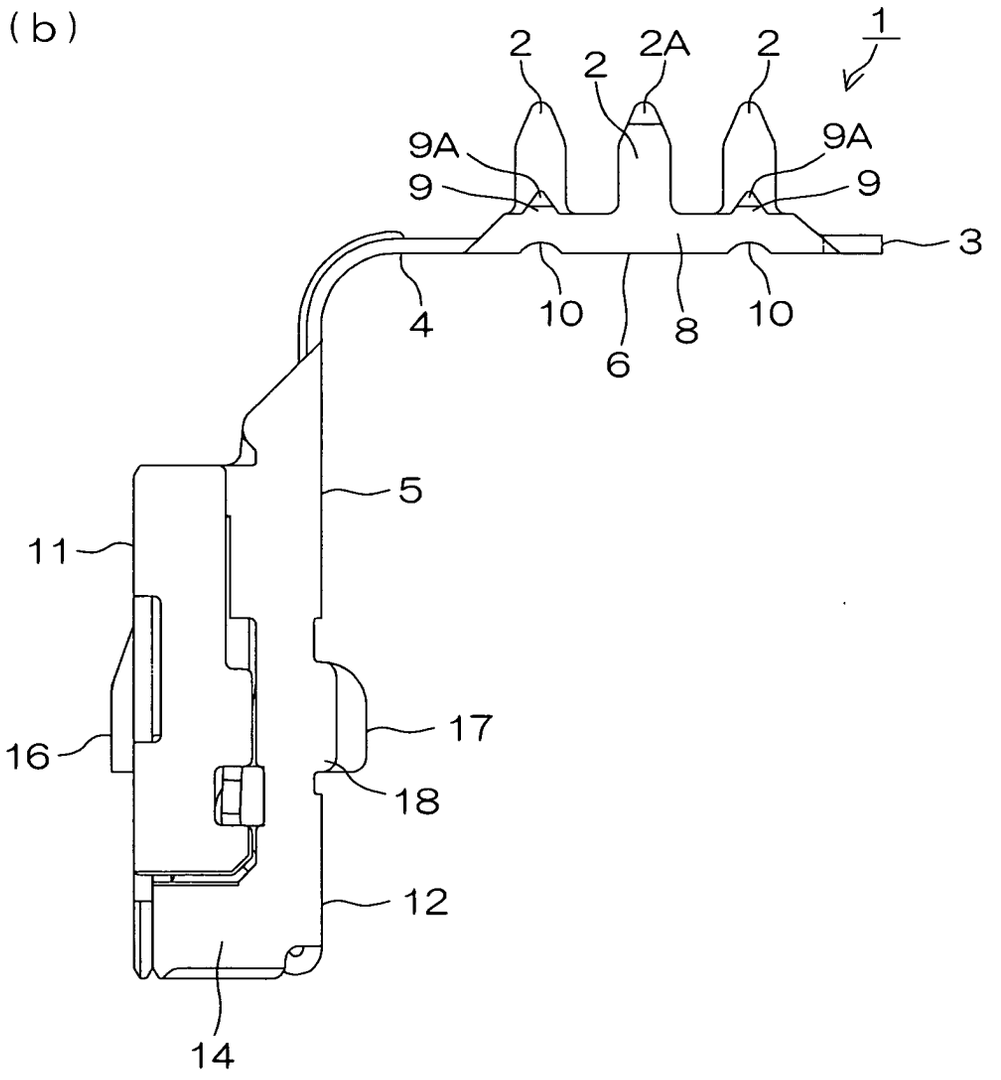
FIG. 1 (b)



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention concerns an electrical connector and a cable with an electrical connector, used for electrically connecting a cable such as an FFC (Flexible Flat Cable) with a contact of a counterpart connector.

2. Description of Related Art

[0002] An electrical connector includes a contact for electrical connection with a contact of a counterpart connector, and a housing which houses and holds the contact. In the housing, for example, a cable passage is formed for passing a cable attached to the contact housed in the housing (for example, a flat cable such as an FFC) . However, when the housing is twisted with respect to the cable or vibration is transmitted from the cable to the contact, there is a possibility that an external force is applied to the contact and cable coupling part. Therefore, for example, it is considered that the cable is fixed by attaching a fixing member to the housing (main body) and fixing the cable inserted through the cable passage by pressing the cable against the housing to restrain an external force from being applied to the contact and cable coupling part.

[0003] On the other hand, in some electrical connectors, a contact housed in the housing canbe fixed inside the housingby a retainer (for example, refer to Japanese Unexamined Patent Publication No. H11-354185) .

[0004] However, as described above, when both the arrangement wherein the cable is fixed inside the cable passage by attaching a fixing member to the housing and the arrangement wherein the contact is fixed inside the housing by a retainer are employed, it is required that the work of fixing the cable and the work of fixing the contact must be performed separately, so that the assembling of the electrical connector becomes complicated.

SUMMARY OF THE INVENTION

[0005] The present invention has been made in view of the above-mentioned circumstances, and an object thereof is to provide an electrical connector and a cable with an electrical connector, which are assembled readily.

[0006] The electrical connector of the invention includes a contact for electrical connectionwith a contact of a counterpart connector, a main body having a contact housing part for housing this contact, a coupling member which can be coupled to the main body and can latch a cable that is connected to the contact housed in a contact housing part in conjunction with this main body by being coupled to the main body, and a retainer which is attached in a displaceable manner to the main body and displaces from its initial position to a latching position at which the retainer can latch the contact housed in the contact housing part by receiving an external force from this coupling member when the coupling member is coupled to the main body.

[0007] With this arrangement, only by coupling the coupling member to the main body, a cable connected to the contact that is housed inside the contact housing part can be latched, and furthermore, the contact can be latched inside the contact housing part by displacing the retainer from its initial position to the latching position.

[0008] Therefore, the assembling of the cable and the contact with the electrical connector is easy.

[0009] In an embodiment of this invention, in the main body, a contact insertion passage for inserting the contact inside the contact housing part is formed, and the retainer allows insertion of the contact via the contact insertion passage when the retainer is at the initial position, and when the retainer is at the latching position, it extends to the contact insertion passage to restrict the falling off of the contact housed in the contact housing part.

[0010] With this arrangement, the contact can be housed readily inside the contact housingpart via the contact insertionpassage when the retainer is at its initial position. Thereafter, only by coupling the coupling member to the main body, the cable and the contact can be latched, so that the assembling becomes easier.

[0011] It is preferable that the coupling member and the main body form and define the cable passage for piercing the cable connected to the contact housed in the contact housing part in a state with practically no bends.

[0012] With this arrangement, in the electrical connector through which a cable connected to the contact can be pierced in a state with practically no bends (almost straight), the assembling can be made easier.

[0013] It is preferable that, near the openings at both ends of the cable passage, first and second clamping parts for clamping the cable are provided, respectively.

[0014] With this arrangement, the cable is clamped in the vicinity of openings at both ends of the cable passage across the coupling part between the contact and the cable, so that it canbe prevented that the electrical connector is twisted with respect to the cable and vibration is transmitted from the cable to the contact. Therefore, application of an external force to the part at which the contact and the cable are coupled to each other can be effectively restrained.

[0015] The respective first and second clamping parts may include convex portions formed on the coupling member or the main body for pressing the cable.

[0016] In this case, the first and second clamping parts may include concave portions opposing the convex portions formed on the coupling member or the main body.

[0017] The contact may preferably comprise a piercing part equipped with protrusions to be pierced through a conductor of a cable, a linking part linked on one end to the piercing part and extending toward the opposite side of the direction in which the protrusions protrude, and a connection part for electrical connection with a contact of a counterpart connector and linked to the other end of the linking part, and it is preferable that the coupling member and the main body form in a partitioning manner, when they are coupled, the cable passage at a position opposing the protrusions of the contact housed in the contact housing part.

[0018] With this arrangement, the assembling in an electrical contact using a contact equipped with protrusions to be pierced through a conductor of a cable (that is, a piercing contact) becomes easier.

[0019] Normally, a piercing contact comprises a piercing part equipped with protrusions, a linking part which is linked on its one end to the piercing part and extends in the direction substantially orthogonal to the direction in which the protrusions protrude, and a connection part for electrical connection with a contact of a counterpart connector and linked to the other end of the linking part, and the piercing contact has the shape of a substantially straight line as a whole. In cases where such piercing contacts are attached to intermediate parts of a cable (for example, a flat cable) to branch the intermediate parts of the cable and electrically connect it to other cables, wiringboards, etc., and thereby connect various electrical parts in a chain-like manner (in the manner of a so-called daisy chain connection), when performing piercing on a flat cable by the piercing protrusions of the piercing part upon positioning the cable so as to oppose the piercing part protrusions, the flat cable interferes with the connection part.

[0020] By using the contact of the present invention, the piercing part and the connection part are linked via a linking part extending toward the opposite side of the direction in which the protrusions protrude, so that, when making a daisy chain connection by attaching the contacts to intermediate parts of a cable to be pierced through the cable passage, the cable can be prevented from interfering with the connection part. Since the cable can be pierced through the cable passage in a state with practically no bends (almost straight), harmful effects in that an excessive stress is applied to the conductor at a bend and the conductor breaks can be prevented.

[0021] Namely, with the arrangement of the present invention, the assembling becomes easier in the electrical connector with which a daisy chain connection can be made without folding back a cable.

[0022] The linking part may have a substantially L-like form, which extends in a direction substantially orthogonal to the direction in which the protrusions protrude and then extends toward the opposite side of the direction in which the protrusions protrude.

[0023] The connection part may be one with which a contact of a counterpart connector can be attached along the direction in which the protrusions protrude.

[0024] The protrusions of the piercing part may be pierced into a conductor of a cable, having connectors connected at both ends thereof, at a predetermined position between the connectors.

[0025] The cable with an electrical connector of the present invention comprises an electrical connector having the above-mentioned characteristics, and a cable that is connected to a contact housed in the contact housing part and latched with respect to the electrical connector by coupling the coupling member to the main body.

[0026] The above and other obj ects, characteristics, and effects of the present invention shall be made clear by the following description of the embodiments with referring to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1 (a) and Fig. 1 (b) are diagrams showing the arrangement of a piercing contact that is used as a flat cable contact in an electrical connector of an embodiment of the present invention.

Fig. 2 (a) , Fig. 2 (b) , and Fig. 2 (c) are diagrams showing the arrangement of a housing for holding the piercing contact.

Fig. 3 is a plan view for explaining the manner in which a piercing connector is attached to a flat cable.

Fig. 4A(a), Fig. 4A(b), Fig. 4A(c), Fig. 4B (a) , and Fig. 4B (b) are diagrams showing the flow of the process of attaching the piercing connector to a flat cable, and shows sections along the arrows A-A of Fig. 3 as viewed from the left side.

Fig. 5 is a plan view of a retainer.

Fig. 6(a) and Fig. 6(b) are plan views showing a state wherein the retainer is inserted inside a main body of the housing.

Fig. 7 (a) , Fig. 7 (b) , and Fig. 7 (c) are front views showing themanner of displacement of the retainer when a cover is closed.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0028] Fig. 1 (a) and Fig. 1 (b) are diagrams showing the arrangement of a piercing contact 1 that is used as a flat cable contact in an electrical connector of an embodiment of the invention. Fig. 1(a) shows a plan view of piercing contact 1 and Fig. 1 (b) shows a side view of piercing contact 1 as viewed in the direction of the arrow shown in Fig. 1(a). The left side in Figs. 1 (a) and 1 (b) shall be referred to as the front side and the right side shall be referred to as the rear side.

[0029] Referring to Figs. 1 (a) and 1 (b) , this piercing contact 1 is used for electrically connecting a flat cable,

such as an FFC (Flexible Flat Cable), to a contact of a counterpart connector (not shown) and has a plurality (for example, three) of piercing protrusions 2 for conductively connecting the piercing contact to a flat cable upon being pierced through a conductor of the flat cable.

[0030] Piercing contact 1 is formed by bending a single metal plate that has been cut to a predetermined shape in advance and is equipped with a piercing part 3, equipped with piercing protrusions 2, a substantially L-shaped linking part 4, one end of which is linked to the front end of piercing part 3 and which, after extending in a direction (front direction) substantially orthogonal to the direction in which the piercing protrusions 2 protrude, is bent (downward) towards the opposite side of the direction in which the piercing protrusions 2 protrude, and a connection part 5, which is linked to the other end of linking part 4 and is for electrical connection with the contact of the counterpart connector.

[0031] Piercing part 3 has both its left and right side parts bent upward and is thereby formed to a substantially U-like shape as viewed from the front. That is, piercingpart 3 includes a lower plate part 6, which extends longitudinally in the front/rear direction, and two side plate parts (left side plate part 7 and right side plate part 8), which rise upward from the respective left and right side parts of lower plate part 6. Piercing protrusions 2 are respectively protruded from a front end part and a rear end part of the upper end of left side plate part 7. Meanwhile, a piercing protrusion 2 is protruded from a central part in the front/rear direction of the upper end of right side plate part 8. Three piercing protrusions 2 are thus positioned on the two side plate parts 7 and 8 in a staggered manner along the front/end direction.

[0032] The tip part of each piercing protrusion 2 is formed to a substantially triangular shape, and by a tapered surface 2A being formed on the outer side surface (the left surface of each piercing protrusion 2 equipped on left side plate part 7 and the right surface of piercing protrusion 2 equipped on right side plate part 8) of the tipmost part, the tip part of each piercing protrusion 2 is formed to a sharp edge.

[0033] In attaching this piercing contact 1 to a flat cable, piercing contact 1 is set on a punch base of a press machine, for example, in an orientation such that the direction in which piercing part 3 of piercing contact 1 extends will be horizontal and the direction in which piercing protrusions 2 protrude will be the upward direction. The flat cable is then positioned so as to extend in a horizontal direction above piercing contact 1, and after piercing the respective piercing protrusions 2 through parts at which a conductor of the flat cable is positioned, the piercing protrusions 2 are pressed from above to bend their tip parts downwards. Piercing contact 1 can thus be attached conductively to the flat cable with the flat cable being pressingly held from above by the tip parts of the respective piercing protrusions 2. The tip part of each piercing protrusion 2 may be made to pierce (the conductor) of the flat cable from above by being pressed and bent from above.

[0034] At the upper ends of left side plate part 7 and right side plate part 8 of piercing part 3, small protrusions 9, which are of substantially triangular shape and are shorter than piercing protrusions 2, are protruded at positions opposing the respective piercing protrusions 2 in the left/right direction. A tapered surface 9A is formed on the outer side surface (the left surface of small protrusion 9 equipped on left side plate part 7 and the right surface of small protrusion 9 equipped on right side plate part 8) of the tipmost part of each small protrusion 9 and the tip part of each small protrusion 9 is thereby formed to a sharp edge.

[0035] When the respective piercing protrusions 2 are pressed from above, the flat cable is also pressed downwards. In this process, the respective small protrusions 9 that are formed on the upper ends of left side plate part 7 and right side plate part 8 of piercing part 3 pierce the flat cable from below and reach the conductor of the flat cable. Since not just piercing protrusions 2 but small protrusions 9 are thus also connected to the conductor of the flat cable, the area of contact of piercing contact 1 with respect to the conductor of the flat cable can be made large and the electrical connection of the flat cable with piercing contact 1 can be made definite.

[0036] On lower plate part 6 of piercing part 3, positioning insertion holes 10, each of substantially circular shape, are formed respectively between the front side piercing protrusion 2 and the opposing small protrusion 9 and between the rear side piercing protrusion 2 and the opposing small protrusion 9. In performing the piercing of piercing contact 1 on a flat cable, piercing part 3 of piercing contact 1 is held from below by a punch base (not shown). The punch base is equipped with a plurality of guide pins for the positioning of piercing part 3, and in the piercing process, positioning is performed by the guide pins of the punch base being inserted respectively through the corresponding respective positioning insertion holes 10. However, the number of positioning insertion holes 10 that are formed in the lower plate part 6 of piercing part 3 of piercing contact 1 is not restricted to two and may be one or may be three or more.

[0037] Connection part 5 is formed by a metal plate being bent to a substantially rectangular shape in plan view. That is, connection part 5 comprises a front plate part 11, a rear plate part 12, a left plate part 13, and a right plate part 14, and a through hole 15, which extends in the up/down direction, is formed in the interior thereof. This through hole 15 is for inserting a rod-like contact, equipped on a counterpart connector, from below, and in the state where the contact of the counterpart connector is inserted in through hole 15, the surface of the contact of the counterpart connector contacts the inner surfaces of connection part 5 and piercing contact 1 is thereby conductively connected to the contact of the counterpart connector.

[0038] Also, at the central part of front plate part 11 and the left and right side parts of rear plate part 12 of

connection part 5 are respectively formed latching protrusions 16, 17, and 18 for latching this piercing contact 1 onto the interior of a housing (not shown) for holding piercing contact 1.

[0039] Figs. 2 (a) , 2 (b) and 2 (c) show diagrams of the arrangement of a housing 20 for holding piercing contacts 1.

[0040] This housing 20 comprises an integral, resin-molded article equipped with a main body 21, for holding piercing contacts 1, and a cover 22, which is attached to this main body 21 in an openable and closable manner. Cover 22 has one end part thereof attached to an upper part of main body 21 by a pair of linking parts 23 having one end thereof elastically deformable and cover 22 is openable and closable by elastically deforming linking parts 22 by rotating cover 22 about linking parts 23. Fig. 2 (a) is a plan view of housing 20 in the state where cover 22 is opened, Fig. 2 (b) is a front view of housing 20 in the state where cover 22 is opened, and Fig. 2(c) is a front view of housing 20 in the state where cover 22 is closed.

[0041] Housing 20 is formed, for example, of a synthetic resin with an insulating property. Main body 21 is formed to a substantially rectangular parallelepiped shape and on its upper surface, a plurality (for example, five) contact housing recesses 24, for housing piercing contacts 1, are formed and aligned in the left/right direction. More specifically, each contact housing recess 24 comprises a piercing part housing part 25, which is comparatively shallow (approximately equivalent to the thickness of piercingpart 3) and is for housing piercing part 3 of a piercing contact 1 and receiving the lower surface of lower plate part 6 of this piercing part 3, and a connection part housing part 26, which extends downwards and longitudinally from the front end of piercing part housing part 25 and is for housing connection part 5 of piercing contact 1. By a piercing contact 1 being housed in each contact housing recess 24 of housing 20, a piercing connector is arranged.

[0042] At the bottom surface of piercing part housing part 25 of each contact housing recess 24, a punch base insertion hole 27, of substantially rectangular shape, is formed at a position that will lie below the vicinity of piercing protrusions 2 and small protrusions 9 when piercing part 3 of a piercing contact 1 is housed in this piercing part housing part 25. After housing a piercing contact 1 in each contact housing recess 24, by inserting punch bases through the respective punch base insertion holes 27 from below main body 21 and making the receiving surfaces of the punch bases contact the lower surfaces of lower plate parts 6, piercing parts 3 can be received by the punch bases from below in the subsequent process of pressing piercing protrusions 2 of the respective piercing contacts 1 from above.

[0043] With such an arrangement, since, after positioning a piercing contact 1 by housing it in a contact housing recess 24, the receiving surface of a punch base can be put in contact with the lower surface of lower plate part 6 of piercing part 3 simply by inserting the punch base through punch base insertion hole 27, a piercing connector can be attached readily to a flat cable.

[0044] Also, in the case where a plurality of piercing contacts 1 are to be attached to a flat cable, after positioning all piercing contacts 1 by housing them in corresponding contact housing recesses 24, punch bases are inserted through all punch base insertion holes 27 to put their receiving surfaces in contact with the lower surfaces of lower plate parts 6 of the respective piercing contacts 1. Piercing protrusions 2 of all piercing contacts 1 can then be bent at once using a punch. Since a plurality of piercing contacts 1 can thus be attached at once to a flat cable, the working processes can be reduced and the attachment of a piercing connector to the flat cable can be performed more readily in comparison to the case where piercing contacts 1 are attached one by one to a flat cable.

[0045] Furthermore, whether or not (piercing parts 3 of) piercing contacts 1 are housed in (piercing part housing parts 25 of) the respective contact housing recess 24 can be conveniently checked visually from below via the respective punch base insertion holes 27.

[0046] At the bottom surface of connection part housing part 26 of each contact housing recess 24, a substantially square-shaped contact insertion hole 28 is formed at a position that opposes through hole 15 of connection part 5 when connection part 5 of a piercing contact 1 is housed in this connection part housing part 26. By fitting housing 20 (main body 21) of the present piercing connector to the housing of a counterpart connector from above, rod-like contacts of the counterpart connector can be inserted in through holes 15 of connection parts 5 of piercing contacts 1 via contact insertion holes 28 and this piercing connector can thus be conductively connected to the counterpart connector.

[0047] At the bottom surface (the surface that opposes main body 21 in the state where cover 22 is closed) of cover 22, a recess 29, of a shape that corresponds to the cross-sectional shape of the flat cable that is to be electrically connected to the piercing contacts 1 that are housed in the present housing 20, is formed so as to extend from the front end to the rear end of the lower surface of this cover 22. When cover 22 is closed, a cable passage 30, for passing through a flat cable in the front/rear direction is formed in a demarcated manner between recess 29 of this cover 22 and the upper surface of main body 21 (see Fig. 2(c)). Cable passage 30 has its length in the left/right direction substantially matched to the width of a flat cable and has its length in the up/down direction (height) substantially matched to the thickness of the flat cable. By passing a flat cable straightly (with practically no bends) through cable passage 30 with a piercing contact 1 being attached to an intermediate part of the flat cable, a daisy chain connection can be made without having to bend the flat cable.

[0048] Thus with the present embodiment, since

piercing part 3 and connection part 5 are linked via linking part 4, which is bent to a substantially L-like shape, when a daisy chain connection is made using piercing contact 1, the flat cable can be prevented from interfering with connection part 5. A daisy chain connection can thus be made without having to fold back the flat cable.

[0049] On the upper surface of main body 21, two piercing walls 31 and 32, each of which extends in the front/rear direction, are protruded so as to be aligned in the front/rear direction respectively at the left side of the leftmost contact housing recess 24, the right side of the rightmost contact housing recess 24, and at each interval between adjacent contact housing recesses 24. Meanwhile, on the lower surface of cover 22, piercing wall housing recesses 33 and 34 are formed at positions that oppose the respective piercing walls 31 and 32 in the state in which cover 22 is closed, and in the state in which cover 22 is closed, the respective piercing walls 31 and 32 are arranged to be inserted inside the corresponding piercing wall housing recesses 33 and 34. The respective piercing walls 31 and 32 are used to position a flat cable by being pierced through a plurality of through holes, which are formed in advance in the flat cable that is to be passed through cablepassage 30. However, the piercing protrusions for positioning the flat cable that is passed through cable passage 30 are not limited to those of wall-like form (piercingwalls 31 and 32) andmay, for example, have a rod-like form instead.

[0050] At an upper part of main body 21, a retainer 35 is inserted towards the left direction from the right side surface. This retainer 35 is for restricting (latching) (connection parts 5 of) piercing contacts 1 that are housed in the respective contact housing recesses 24 so that they will not become displaced upward, and from the right end part of the retainer, an engaging part 37 for engagement with a cover 22 when the cover 22 is closed extends upward outside the main body 21.

[0051] On the right end surface (the surface positioned at the right side in the state in which cover 22 is closed) of cover 22 is formed a protruding engaging part 38 for engagement of engaging part 37 of retainer 35. When cover 22 is closed, engaging part 37 of retainer 35 is inserted into and engages with protruding engaging part 38 of cover 22, and cover 22 is thereby kept in the closed state.

[0052] Fig. 3 shows plan views for explaining the manner in which a piercing connector 100 is attached to a flat cable 40.

[0053] Flat cable 40, which is to be electrically connected to this piercing connector 100, is an FFC equipped with a plurality (for example, five) of conductors 41 and holding films 42, for holding these conductors 41 in parallel in a manner in which conductors 41 are mutually spaced apart by a fixed interval. Each conductor 41 is formed to thin, plate-like form, and flat cable 40 is formed by sandwiching these conductors 41 by holding films 42 and adhering the opposing holding films 42 by an adhesive agent.

[0054] In each holding film 42 of flat cable 40, two through holes 43 and 44, each of which extends in the front/rear direction, are formed in advance so as to be aligned at the front and rear, respectively, in each interval between adjacent conductors 41. The respective through holes 43 and 44 correspond to piercing walls 31 and 32 between the respective contact housing recesses 24 equipped in main body 21 of housing 20. Through holes 43 and 44 of each row are formed to tapering shapes with which the end parts at the opposing sides in the front/rear direction become gradually narrower.

[0055] Also at each of the left and right edge parts of holding film 42 are formed in advance two notches 45 and 46, which respectively correspond to the two piercing walls 31 and 32 equipped at the left side of the leftmost contact housing recess 24 of main body 21 and the right side of the rightmost contact housing recess 24. The two notches 45 and 46 that are formed at the left edge part of holding film 42 have the same shapes as the right halves of the two front and rear through holes 43 and 44 that are formed between adjacent conductors 41, and the two notches 45 and 46 that are formed at the right edge part of holding film 42 have the same shapes as the left halves of the two front and rear through holes 43 and 44 that are formed between adjacent conductors 41.

[0056] In attaching piercing connector 100 to flat cable 40, flat cable 40 is positioned so as to extend in the front/rear direction above main body 21 of housing 20 with piercing contacts 1 being housed in the respective contact housing recesses 24 of main body 21 as shown in Fig. 3, and by making the respective through holes 43 and 44 and notches 45 and 46 of flat cable 40 be pierced by the corresponding piercing walls 31 and 32 that are formed on main body 21, flat cable 40 is positioned with respect to piercing connector 100.

[0057] By thus making the respective through holes 43 and 44 and notches 45 and 46 of flat cable 40 be pierced by the corresponding piercing walls 31 and 32 that are formed on main body 21, the twisting of housing 20 with respect to flat cable 40 canbe prevented. The twisting of piercing contacts 1, housed in contact housing recesses 24 of housing 20, with respect to flat cable 40, and the resulting application of external force to the parts at which piercing parts 3 and flat cable 40 are coupled can thus be restrained. However, the arrangement is not restricted to that in which through holes 43 and 44 and notches 45 and 46 are formed in twos in the front/rear direction, and three and more of these may be formed in the front/rear direction instead.

[0058] Figs. 4A(a), 4A(b), 4A(c), 4B (a) and 4B (b) show diagrams of the flow of the process of attaching piercing connector 100 to flat cable 40 and show sections along arrows A-A of Fig. 3 as viewed from the left side.

[0059] In attaching piercing connector 100 to flat cable 40, first, punchbases 50 are inserted frombelow into

the respective punch base insertion holes 27, and by inserting guide pins 52, which protrude from receiving surfaces 51 of the respective punch bases 50, through positioning insertion holes 10 of piercing parts 3 of the respective piercing contacts 1, piercing parts 3 are positioned (see Fig. 4A(a) and Fig. 4A(b)). By thus inserting guide pins 52 of punch bases 50 into the respective positioning insertion holes 10, the positioning of piercing contacts 1 can be performed more accurately.

[0060] By moving punch bases 50 further upward from this state, the receiving surfaces 51 of punch bases 50 are put in contact with the lower surfaces of piercing parts 3 of piercing contacts 1 (see Fig. 4A(c)) . Thereafter, flat cable 40 is set on the upper part of main body 21 of housing 20 and after making the respective through holes 43 and 44 and notches 45 and 46 of this flat cable 40 be pierced by the corresponding piercing walls 31 and 32, flat cable 40 is pressed downwards and piercing protrusions 2 are pierced into conductors 41 of flat cable 40 (see Fig. 4A(c)).

[0061] Thereafter, by pressing and thereby bending piercing protrusions 2 from above by punch 53, piercing protrusion 2 and small protrusions 9 are conductively connected to conductors 41 of flat cable 40 and the attachment of piercing contacts 1 to flat cable 40 is thereby achieved (see Fig. 4B (a)) . Then by closing cover 22, the respective piercing walls 31 and 32 enter into the corresponding piercing wall housing recesses 33 and 34, flat cable 40 is put in the state in which it passes through cable passage 30 in the front/rear direction, and the attachment of piercing connector 100 to flat cable 40 is thereby completed (see Fig. 4B(b)).

[0062] With this embodiment, protruding strips 54, each extending in the left/right direction, are respectively formed at a front end part and a rear end part of the lower surface of cover 22, and recessed grooves 55, each extending in the left/right direction, are respectively formed at a front end part and a rear end part of the upper surface of main body 21 of housing 20 (see Figs. 2 (a) and 4B (b)) . When cover 22 is closed after attaching flat cable 40 to piercing contacts 1, the upper surface of flat cable 40, which extends in the front/rear direction inside cable passage 30, is pressed downwards by the respective protruding strips 54 and the parts of flat cable 40 that are pressed are clamped in a curved state inside the recessed grooves 55.

[0063] By thus clamping flat cable 40 near the openings at both ends (front end and rear end) of cable passage 30, the twisting of housing 20 with respect to flat cable 40 and the transmission of vibration from flat cable 40 to piercing contacts 1 can be prevented. The application of external force to the parts coupling flat cable 40 to piercing parts 3 of piercing contacts 1, which are housed in contact housing recesses 24 of housing 20, can thus be restrained. However, the arrangement of clamping flat cable 40 near the openings at both ends of cable passage 30 is not restricted to the above-described arrangement and, for example, an arrangement wherein protruding strips are formed on the upper surface of main body 21 of housing 20 and recessed grooves are formed on the lower surface of cover 22 is also possible.

[0064] Connectors 300 and 400, each for achieving electrical contact with another electrical part, are attached to the respective endparts of flat cable 40 (see Fig. 4B(b)) . Piercing connector 100, which is attached to an intermediate part of flat cable 40 (between the two connectors 300 and 400), is attached to a counterpart connector 200 that is fixed, for example, to a wiring substrate S and is thereby electrically connected to wiring substrate S. However, counterpart connector 200 is not restricted to that which is mounted to a wiring substrate S and may, for example, be attached to another cable instead.

[0065] Counterpart connector 200 is a female type connector, comprising a housing 220, in which is formed a fitting recess 220A for the fitting of piercing connector 100, and rod-like contacts 201 which is protruded inside the fitting recess 220A of the housing 220. Fitting recess 220A of housing 220 has a shape corresponding to the shape of the lower part of housing 20 (main body 21) of piercing connector 100, and by fitting housing 20 of the male type piercing connector 100 into fitting recess 220A of counterpart connector 200 form above and thereby making contacts 201 of counterpart connector 200 be inserted in through holes 15 of connection parts 5 of piercing contacts 1 via contact insertion holes 28, this piercing connector 100 and counterpart connector 200 can be connected conductively.

[0066] Fig. 5 is a plan view of retainer 35. Also, Figs. 6(a) and 6 (b) showplan views of a state wherein retainer 35 is inserted inside main body 21 of housing 20 with cover 22 being omitted. Fig. 6(a) shows a state wherein retainer 35 is inserted to an intermediate position with respect to main body 21 and Fig. 6(b) shows the state wherein retainer 35 is inserted to the leftmost side with respect to main body 21.

[0067] Referring to Fig. 5 and Figs. 6(a) and 6(b), retainer 35 is formed to a substantially U-like shape in plan view and comprises a restricting part 351, which is for restricting (connection parts 5 of) piercing contacts 1 that are housed in the respective contact housing recesses 24 so that they will not become displaced upwards, an auxiliary part 352, which extends parallel to and is spaced by a fixed interval from restricting part 351 and is for preventing the falling off of this retainer 35 from main body 21 of housing 20, and a linking part 353, which links the right end part of restricting part 351 and the right end part of auxiliary part 352. Auxiliary part 352 of retainer 35 has a tapered shape, with which the end part thereof narrows gradually, and an engaging protrusion 352A, which protrudes towards the rear, is formed on a front end part thereof.

[0068] At the rear end edge of restricting part 351 of retainer 35, five notches 36, corresponding to the planar shapes of connection part housing parts 26 of the re-

spective contact housing recesses 24 formed in housing 20, are formed and aligned in the left/right direction. Thus in the state in which this retainer 35 is inserted to the position shown in Fig. 6 (a) with respect to main body 21 of housing 20 (a state in which linking part 353 protrudes slightly from main body 21), the respective notches 36 are positioned above connection part housing parts 26 but retainer 35 is not positioned above connection part housing parts 26. In this state, above the connection part housing parts 26, insertionpassages 241 are formed for inserting the connection parts 5 of the piercing contacts 1 into the connection part housing parts 26 when the piercing contacts 1 are housed inside the contact housing recesses 24. Furthermore, in this state, the portions (intermediate protrusions 39) between the respective notches 36 of retainer 35 are positioned between the respective contact housing recesses 24 (and below the respective piercing walls 31 that are formed at the front side) .

[0069] As shown in Fig. 6(a), in the present embodiment, after positioning piercing contacts 1 inside contact housing recesses 24 via the insertion passages 241 in a state (initial state) in which retainer 35 is not positioned above connection part housing parts 26 and attaching these piercing contacts 1 to flat cable 40, cover 22 is closed to complete the attachment of piercing connector 100 to flat cable 40. In the process in which protruding engaging part 38 of cover 22 engages with engaging part 37 of retainer 35 when cover 22 is closed, retainer 35 is pushed to the leftmost side with respect to main body 21 as shown in Fig. 6 (b) and engaging protrusion 352A of auxiliary part 352 engages with main body 21.

[0070] Figs. 7 (a) , 7 (b) , and 7 (c) show front views of the manner of displacement of retainer 35 in the process of closing cover 22.

[0071] At the right end surface of engaging part 37, an inclined surface 371 is formed so that this engaging part 37 narrows gradually towards the tip, and the lower end of this inclined surface 371 is connected to the right end surface of engaging part 37 via a step surface 372. By this inclined surface 371 and step surface 372, a latching claw 373, for latching engaging part 37 inside protruding engaging part 38 of cover 22, is formed.

[0072] Protruding engaging part 38 of cover 22 is hollow in its interior, and as cover 22 is closed, engaging part 37 of retainer 35 enters from its tip into protruding engaging part 38 and inclined surface 371 of engaging part 37 slides against a sliding surface 381 formed inside protruding engaging part 38 (see Fig. 7 (a) and Fig. 7(b)). In this process, retainer 35 is sliding-displaced towards the left by its inclined surface 371 being pressed by sliding surface 381 of protruding engaging part 38.

[0073] When cover 22 is closed further and inclined surface 371 of engaging part 37 moves upward beyond sliding surface 381 of protruding engaging part 38, latching claw 373 rides over the upper endof sliding surface 381 and step surface 372 contacts a latching surface 382, which is formed inside protruding engaging part 38 (see Fig. 7(c)). Thus in the state in which retainer 35 is displaced to the leftmost side, engaging part 37 of retainer 35 is latched with respect to protruding engaging part 38, and the cover 22 is coupled to the main body 21.

[0074] Referring again to Fig. 6 (a) and Fig. 6 (b) , in the state in which retainer 35 is pushed into the leftmost side (latching position), the respective intermediate protrusions 39, which in the initial state were positioned between the respective contact housing recesses 24 (see Fig. 6 (a)) , extend above the connection part housing parts 26 to the immediate left sides (the inserting passages 241), and a right edge part 361 of the rightmost notch 36 of retainer 35 extends above connection part housing part 26 to the immediate left side thereof (the rightmost inserting passage 241) (see Fig. 6(b)). In this state, the upper end surfaces of connection parts 5 of piercing contacts 1 (not shown in Fig. 6 (a) and Fig. 6 (b)), which are housed in the respective contact housing recesses 24, contact the lower surfaces of restricting parts 36 of retainer 35 (see Fig. 4B (b)) andpiercing contacts 1 are thereby restricted frommoving upward. Since connection parts 5 of piercing contacts 1 can thus be fixed securely inside contact housing recesses 24 (inside connection part housing part 26), the removal of piercing contacts 1 from housing 20 can be prevented.

[0075] In this embodiment, only by closing the cover 22 and coupling it to the mainbody 21, the flat cable 40 canbe sandwiched and latched (fixed) by the protruding strips 54 and the recessed grooves 55, and the piercing contact 1 housed in the contact housing recess 24 can be latched (fixed) by displacing the retainer 35 from the initial position to the latching position.

[0076] Therefore, since the flat cable 40 and the piercing contact 1 can be latched with respect to the piercing connector 100 by one action, the assembling becomes, easy.

[0077] Particularly, in a state in which the retainer 35 is at the initial position, the piercing contact 1 can be housed readily into the contact housing recess 24 through the insertion passage 241. Thereafter, only by closing the cover 22 upon connecting the flat cable 40 to the piercing contact 1, the flat cable 40 and the piercing contact 1 can be latched, so that the assembling becomes easier.

[0078] Though embodiments of this invention have been described above, this invention may also be practiced in other modes. For example, the housing is not restricted to an arrangement comprising main body 21 and cover 22 and wherein cable passage 30 is formed in a demarcated manner between main body 21 and cover 22, and an arrangement, wherein the main body and the cover are formed integrally, that is, an arrangement, wherein a cable passage for passing flat cable 40 straightly (in a state with practically no bends), is opened in the housing, may be used instead. In this case, by coupling the coupling member (different from the cover 22) to the housing, the flat cable 40 piercing through the cable passage may be latched, and the piercing contact

1 may be latched by displacing the retainer attached to the housing from the initial position to the latching position.

[0079] Furthermore, the cable passage is not restricted to one piercing through the housing 20, and may instead extend to the intermediate part inside the housing from one end surface of the housing. In this case, the piercing contact 1 housed inside the housing is not restricted to that connected to the intermediate part of the flat cable 40, and may instead be connected to the end part of the flat cable 40.

[0080] Cover 22 is not restricted to one that is linked to main body 21 via linking part 23 and may instead be separated from main body 21.

[0081] The cover 22 is not restricted to one coupled to the main body 21 by being engaged with the retainer 35, and may instead be engaged with the main body 21. In this case, for example, the retainer 35 may be displaced from the initial position to the latching position by pressing the retainer 35 in the process of engaging the cover 22 with the main body 21.

[0082] The retainer 35 is not restricted to one that latches the piercing contact 1 by contact with the piercing contact 1 housed inside the housing 20, andmay latch the piercing contact 1 by being inserted through the piercing contact 1.

[0083] The piercing contact 1 is not restricted to that of a substantially L-like form, in which linking part 4 extends forward (in the direction substantially orthogonal to the direction in which piercing protrusions 2 protrude) from the front end of piercing part 3 and thereafter extends downward (toward the opposite side of the direction in which piercing protrusions 2 protrude), and may instead have a shape, wherein linking part 4 extends downward (toward the opposite side of the direction in which piercing protrusions 2 protrude) from an arbitrary position of piercing part 3, or a shape, wherein linking part 4 extends in a direction that is inclined by a predetermined angle (for example, less than 90°) with respect to the direction opposite to the direction in which the piercing protrusions 2 protrude. The piercing contact may have the shape of a substantially straight line as a whole wherein the linking part 4 extends in the direction substantially orthogonal to the direction in which the piercing protrusions 2 protrude.

[0084] The piercing contact is not restricted to a female type arrangement, which receives the insertion of a contact 201 of counterpart connector 200 as in the above-described arrangement, andmay insteadbe, for example, amale type arrangement, wherein a piercing contact is inserted into a contact of a counterpart connector. Also, the piercing connector is not restricted to a male type arrangement, which is fitted inside fitting recess 220A of counterpart connector 200 as in the above-described embodiment, and may instead be, for example, a female type arrangement equipped with a fitting recess for fitting in of a counterpart connector.

[0085] In the above-mentioned embodiment described above, though an FFC was used as an example of a cable, this invention is also applicable to other flat cables such as an FPC (Flexible Printed Circuit) and other cables such as a coaxial cable.

[0086] Furthermore, in the embodiment described above, though the piercing contact 1 is used as an example of a contact, this invention is also applicable to other contacts such as a coaxial cable contact equipped with a bullet connecting part.

[0087] Though embodiments of this invention have been described in detail, thesearemerelyspecificexamplesusedforclarifying the technical details of this invention, and this invention should not be interpreted in restriction to these specific examples and the spirit and scope of this invention are restricted only by the attached Claims.

[0088] The present Application corresponds to Japanese Patent Application No. 2003-391094, submitted to the Japan Patent Office on November 20, 2003, and the full disclosure of this application is incorporated herein by reference.

Claims

1. An electrical connector (100) **characterized by** comprising:

   a contact (1) for electrical connection with a contact (201) of a counterpart connector (200);
   a main body (21) having a contact housing part (24) for housing the contact (1);
   a coupling member (22) which can be coupled to the main body (21), and can latch a cable (40) that is connected to the contact (1) housed in the contact housing part (24) in conjunction with the main body (21) by being coupled to the main body (21); and
   a retainer (35) which is attached in a displaceable manner to the main body (21), and is displaced from an initial position to a latchingposition at which the retainer can latch the contact (1) housed in the contact housing part (24) by receiving an external force of the coupling member (22) when the coupling member (22) is coupled to the main body (21).

2. The electrical connector (100) according to Claim 1 **characterized in that**,

   the main body (21) thereof is formed with a contact insertion passage (241) for inserting the contact (1) into the contact housing part (24), and

   the retainer (35) allows insertion of the contact (1) via the contact insertion passage (241) when the retainer is at the initial position, and extends to the contact insertion passage (241) to restrict falling off of the contact (1) housed in the contact housing part (24) when the retainer is at the latching position.

3. The electrical connector (100) according to Claim 1 or 2 **characterized in that** the coupling member (22) and the main body (21) thereof form and define a cable passage (30) for piercing a cable (40) connected to the contact (1) housed in the contact housing part (24) in a state with practically no bends by being coupled to each other.

4. The electrical connector according to Claim 3 **characterized by** further comprising first and second clamping parts (54, 55) which are provided near openings at respective ends of the cable passage (30) and are for clamping the cable (40).

5. The electrical connector (100) according to Claim 3 or 4 **characterized by**,

the contact (1) comprising a piercing part (3) equipped with protrusions (2) to be pierced through a conductor (41) of a cable (40), a linking part (4) having one end linked to the piercing part (3) and extending towards the opposite side of a direction in which the protrusions (2) protrude, and a connection part (5), being connected to the other end of the linking part (4) and for electrical connection with a contact (201) of a counterpart connector (200), and

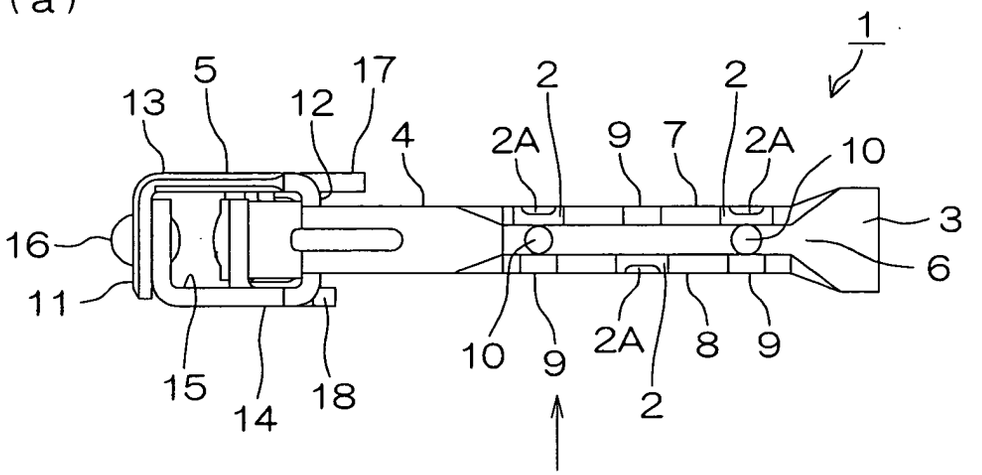
the coupling member (22) and the main body (21) forming and defining the cable passage (30) at a position opposing the protrusions (2) of the contact (1) housed in the contact housing part (24) in a state where the coupling member and the main body are coupled to each other.

6. A cable with an electrical connector **characterized by** comprising:

the electrical connector according to any of Claims 1 through 5, and

a cable (40), connected to the contact (1) housed in the contact housing part (24) and latched with respect to the electrical connector (100) by coupling the coupling member (22) to the main body (21).

FIG. 1 (a)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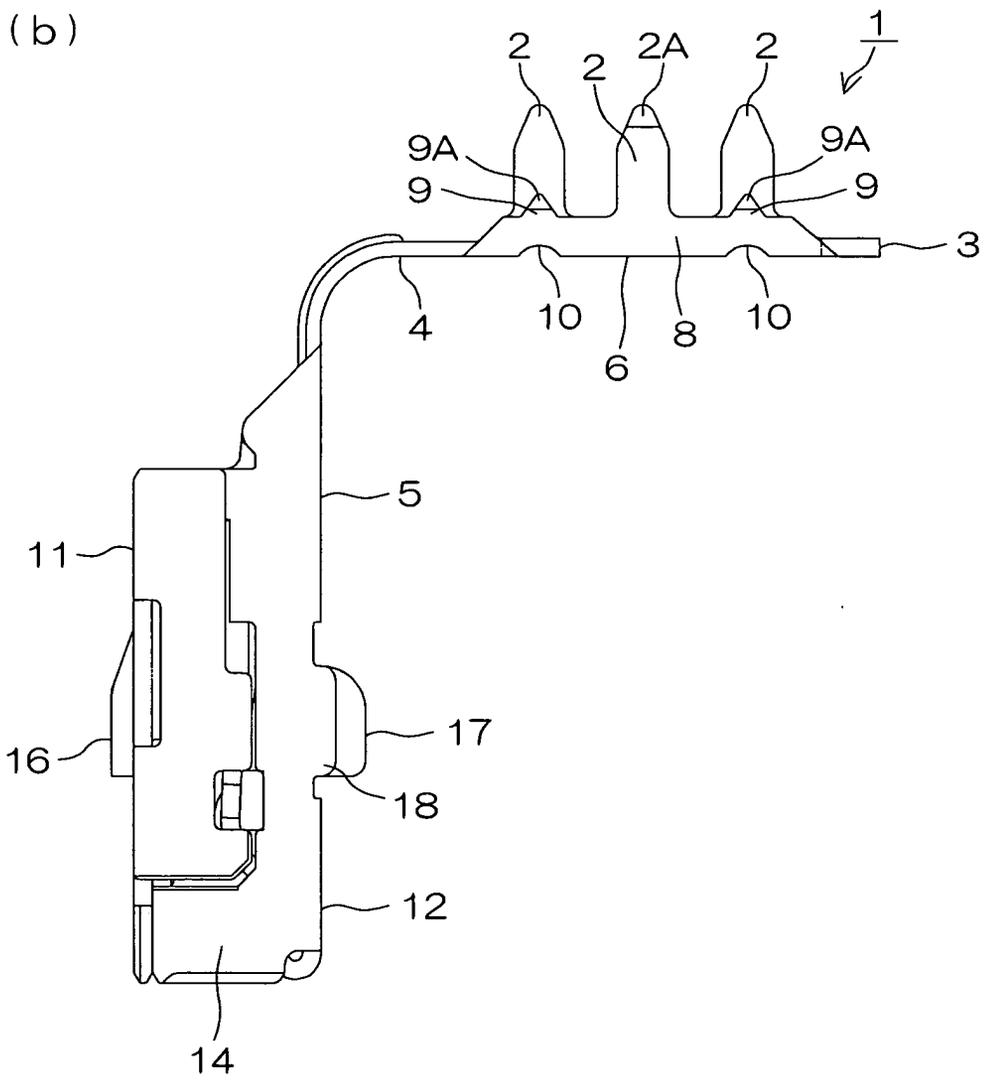
13
12
4
2A
9
7
2A
10
3
16
6
11
10
9
2A
8
9
15
14
18
2

FIG. 1 (b)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2
2A
2
9A
9A
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10
5
11
17
16
18
12
14

FIG. 2(a)

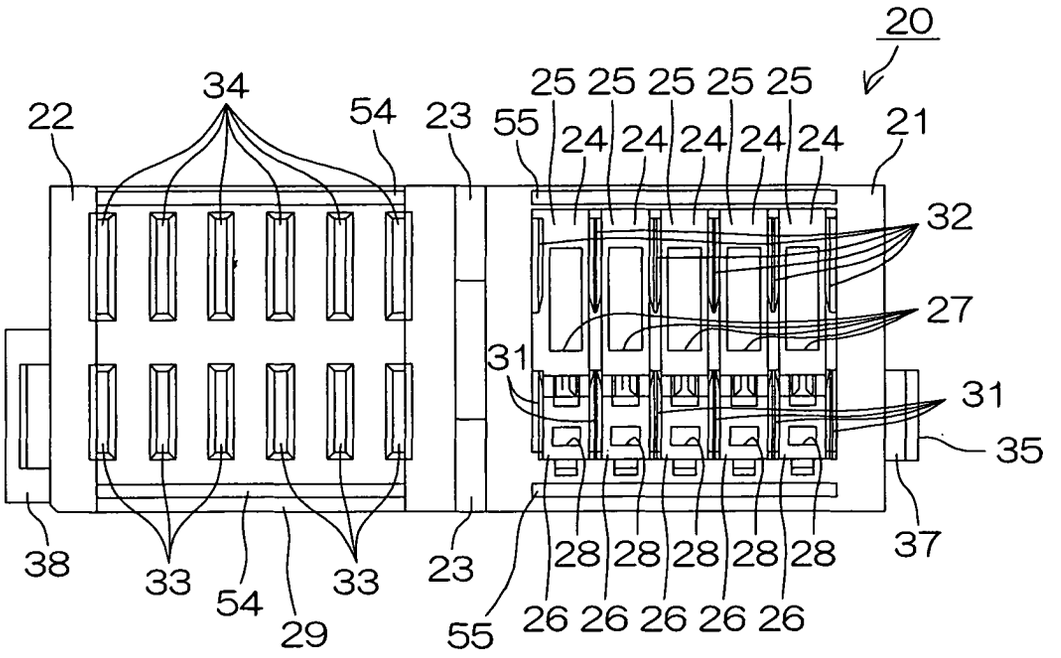

FIG. 2(b)

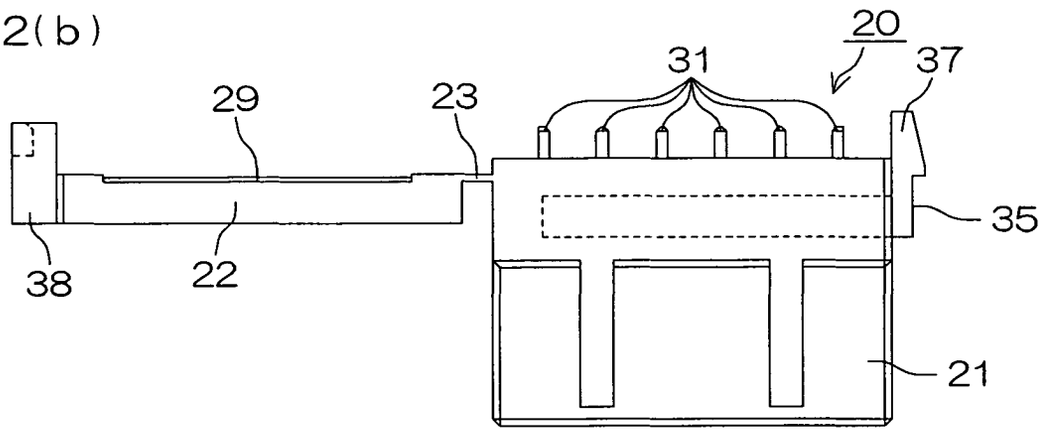

FIG. 2(c)

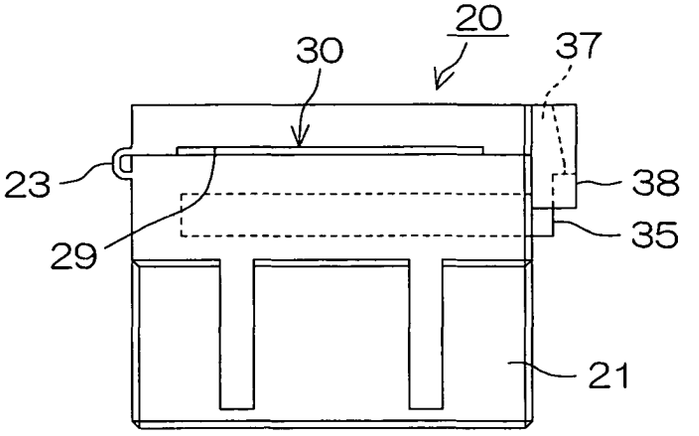

FIG. 3

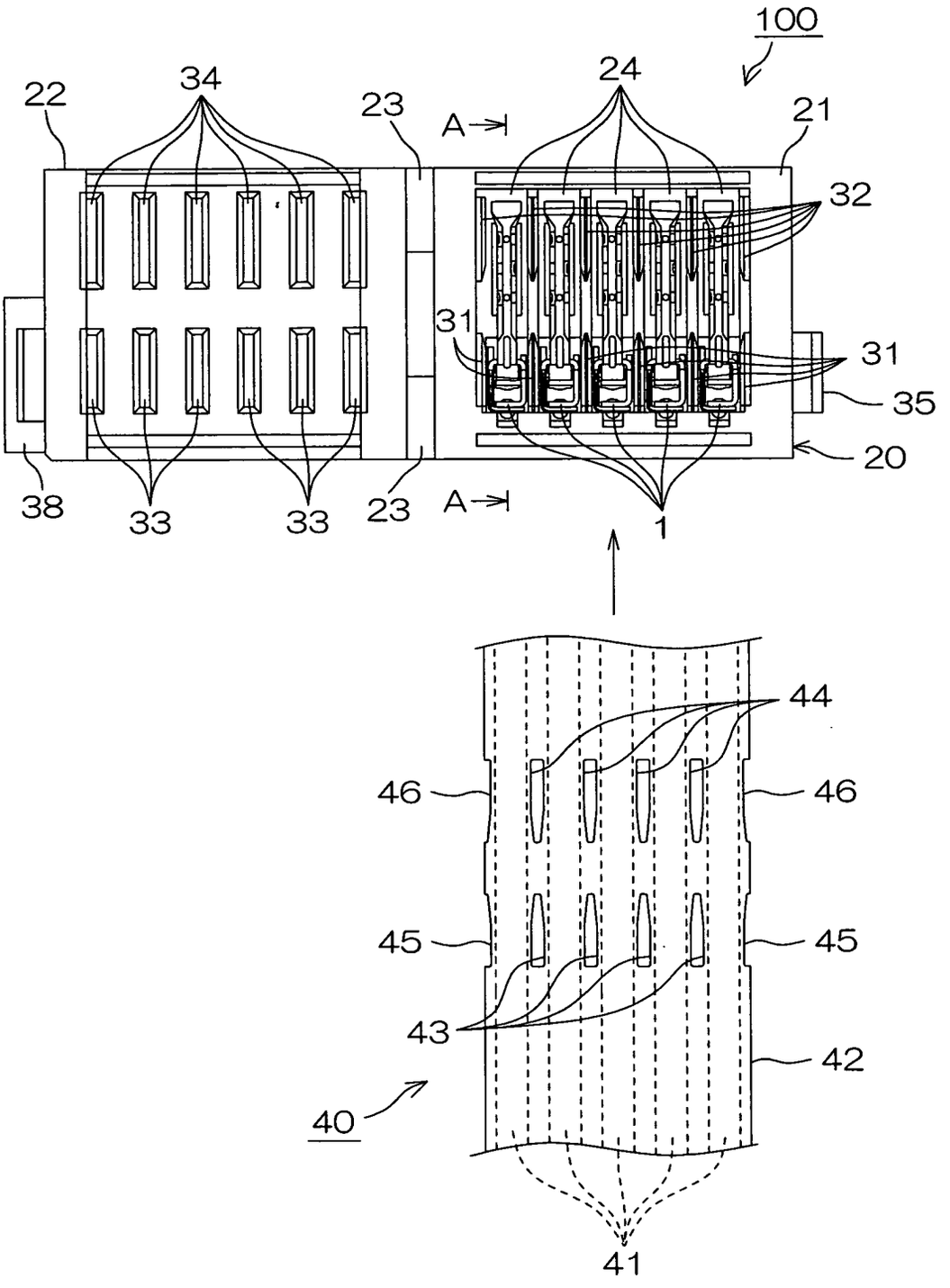
100
22
34
23
A
24
21
32
31
31
35
20
38
33
33
23
A
1
44
46
46
45
45
43
42
40
41

FIG. 4A(a)

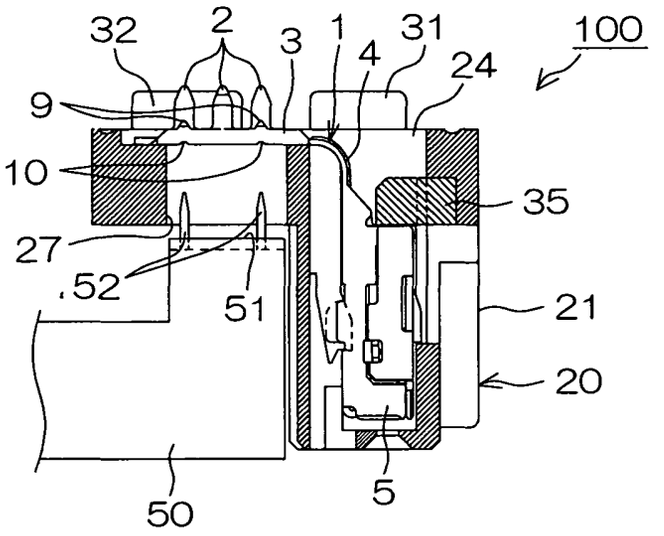

FIG. 4A(b)

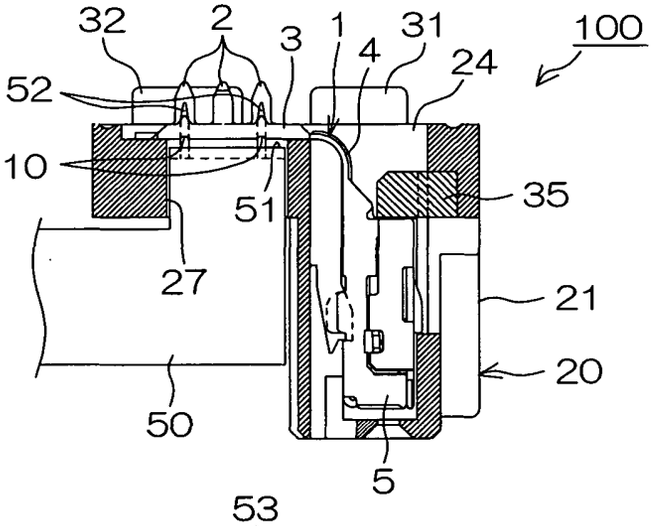

FIG. 4A(c)

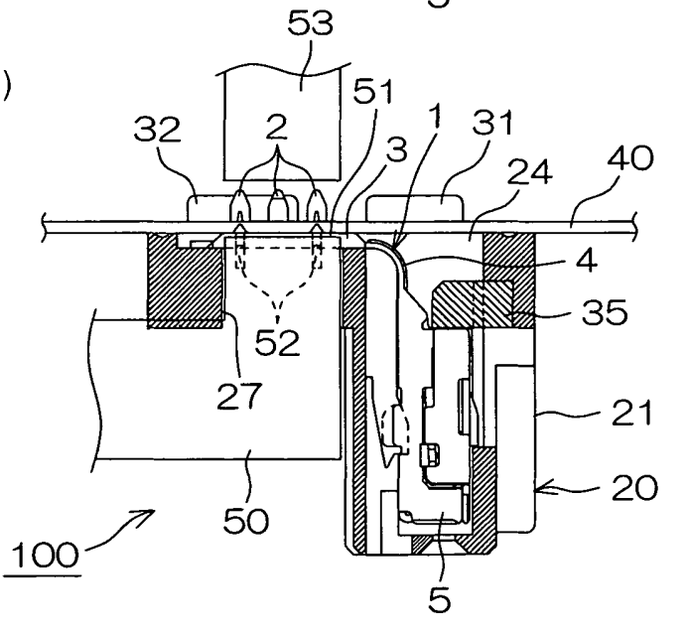

FIG. 4B(a)

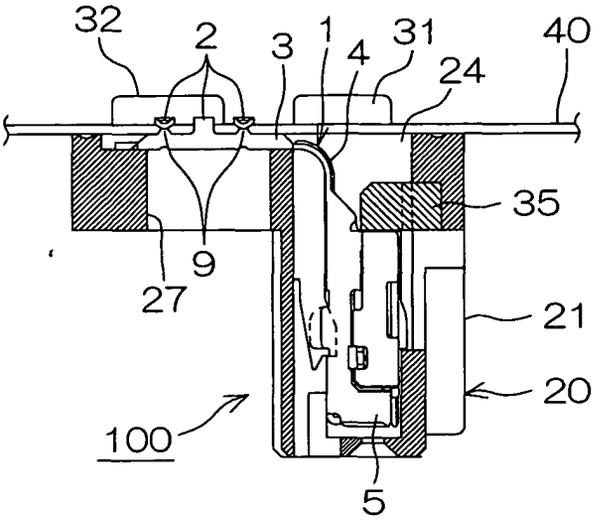

FIG. 4B(b)

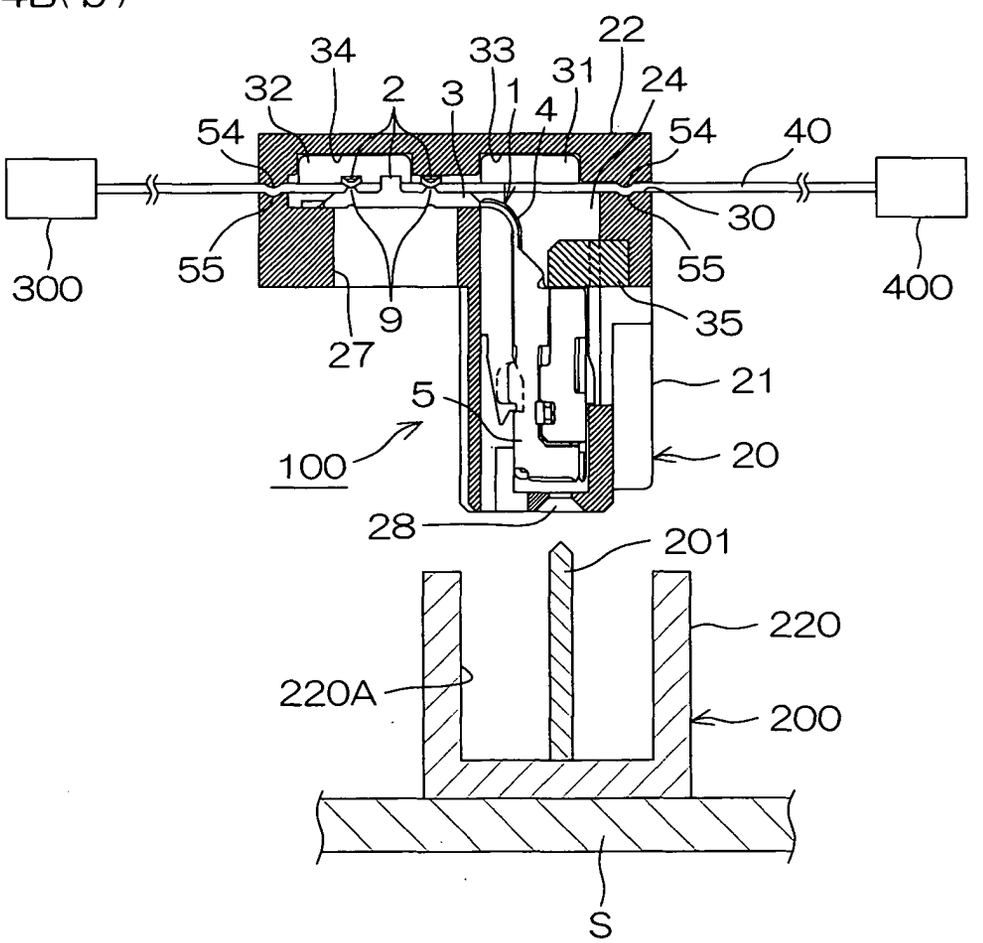

FIG. 5

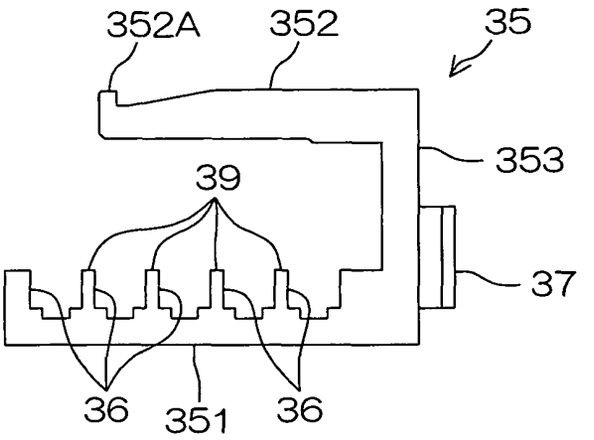

FIG. 6(a)

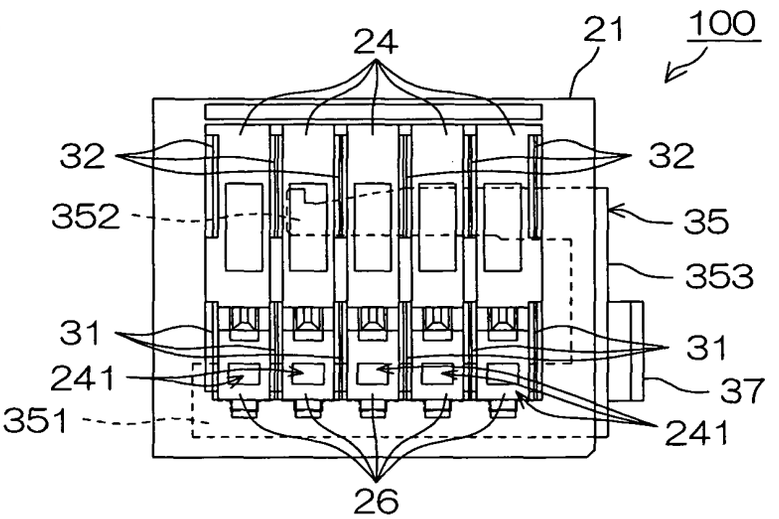

FIG. 6(b)

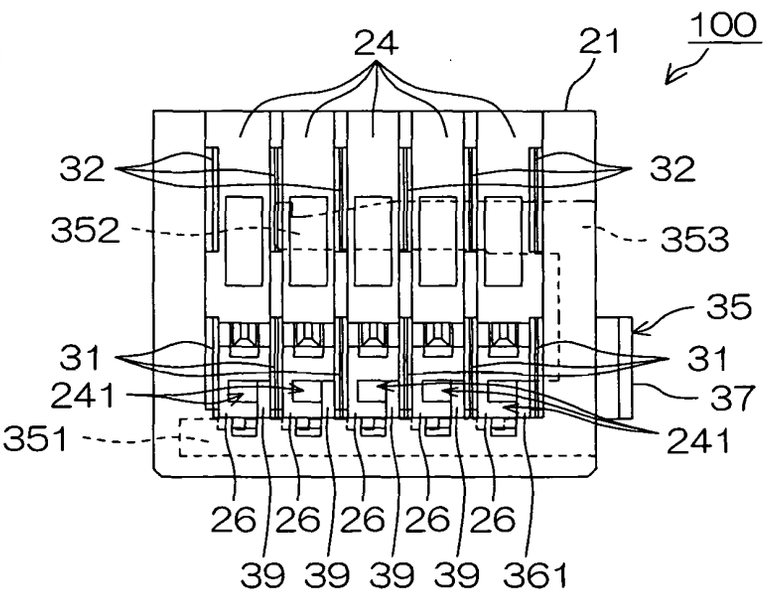

FIG. 7(a)

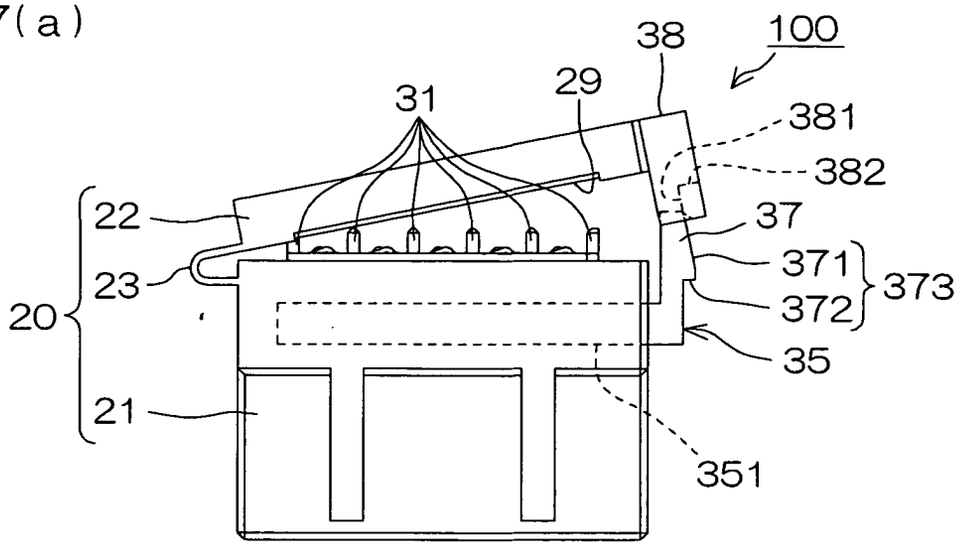

FIG. 7(b)

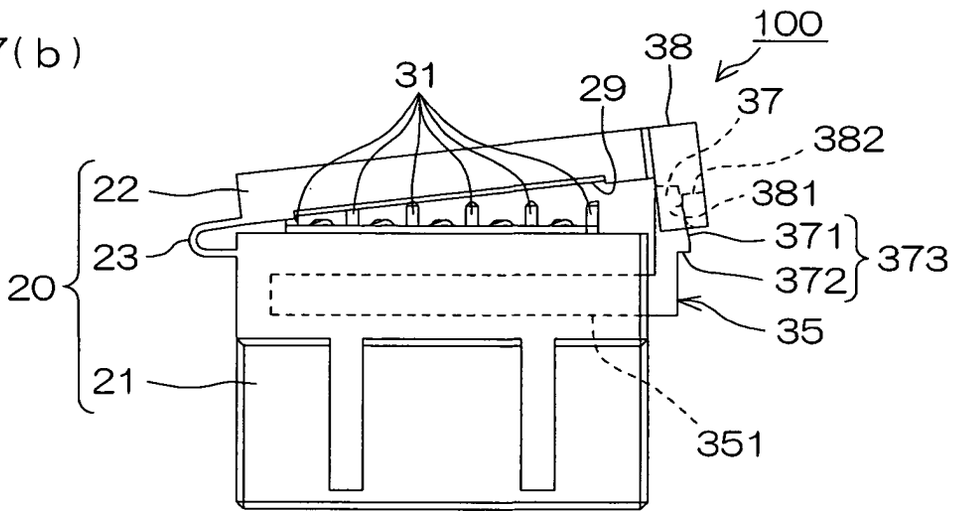

FIG. 7(c)