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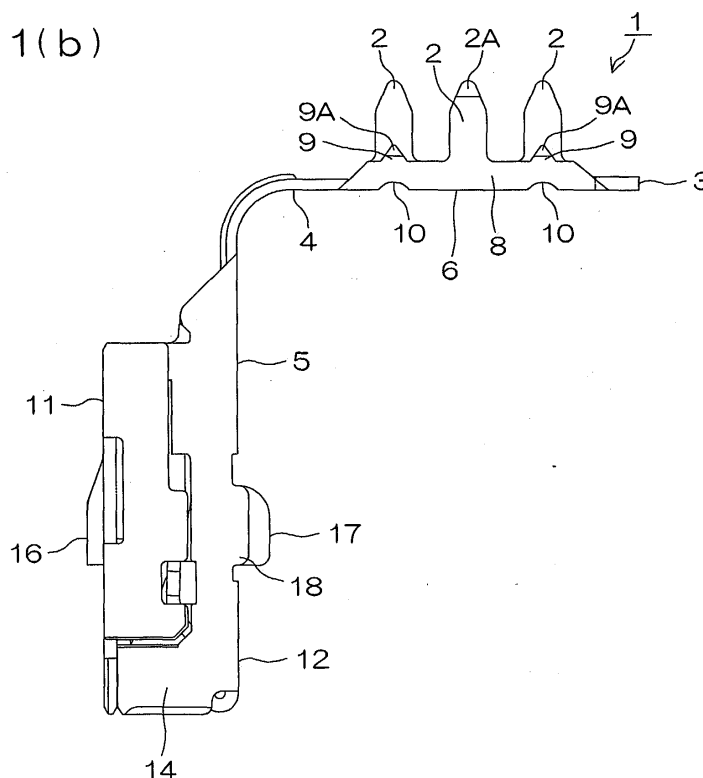
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(54) **Flat cable contact, electrical connector, and flat cable with electrical connector**

(57) A contact (1), which is for a flat cable electrical connector used for electrically connecting a flat cable (40) to a contact of a counterpart connector, is disclosed. The contact (1) includes: a piercing part (3), equipped with protrusions (2) to be pierced through a conductor (41) of the flat cable (40); a linking part (4), having one

end linked to the piercing part (3) and extending towards the opposite side of the direction in which the protrusions (2) protrude; and a connection part (5), being connected to the other end of the linking part (4) and being for electrical connection with the contact of the counterpart connector.

FIG. 1 (b)



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

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

Description of the Related Art

[0002] As a contact to be attached to a flat cable, a piercing contact, equipped with piercing protrusions that are pierced through a conductor of the flat cable, has been known conventionally (see, for example, Japanese Unexamined Patent Publication No. 2001-210408). A piercing contact is conductively attached to a flat cable by piercing the piercing protrusions through a conductor of the flat cable and thereafter bending the tip parts of the piercing protrusions. A piercing contact normally has a piercing part, equipped with piercing protrusions, a linking part, having one end linked to the piercing part and extending in a direction substantially orthogonal to the direction in which the piercing protrusions protrude, and a connection part, to which the other end of the linking part is linked and being for electrical connection with a contact of a counterpart connector, and this piercing contact has the shape of a substantially straight line as a whole.

[0003] There are cases where it is desired to attach such piercing contacts to intermediate parts of a flat cable to branch the intermediate parts of the flat cable and electrically connect other cables, wiring boards, etc., and thereby connect various electrical parts in a chain-like manner (in the manner of a so-called daisy chain connection). However, when performing piercing on a flat cable by the piercing protrusions of the piercing part upon positioning the flat cable so as to oppose the piercing protrusions, the flat cable interferes with the connection part. Thus for making a daisy chain connection using a piercing contact, a method of folding back a flat cable immediately in front of the connection part so that the flat cable will not interfere with the connection part, may be considered.

[0004] However, when a flat cable is folded back in such a manner, an excessive stress is applied to the conductor at the folded-back part and the conductor may break.

[0005] Also, an FFC is normally formed by positioning a plurality of conductors in a manner whereby the conductors are mutually spaced apart by a fixed interval and then sandwiching these plurality of conductors with holding films, and when such a flat cable is folded back, the adhesive agent, which adheres the holding films that sandwich the conductors, become peeled at the folded-

back part.

SUMMARY OF THE INVENTION

[0006] An object of this invention is to provide a flat cable contact, an electrical connector, and a flat cable with electrical connector with which a daisy chain connection can be made without folding back a flat cable.

[0007] Another object of this invention is to provide a flat cable contact, an electrical connector, and a flat cable with electrical connector with which the external force that is applied to the part at which a piercing part and a flat cable are coupled can be restrained.

[0008] Yet another object of this invention is to provide a flat cable contact, an electrical connector, and a flat cable with electrical connector with which attachment to a flat cable can be performed readily.

[0009] This invention concerns a contact, which is for a flat cable electrical connector used for electrically connecting a flat cable to a contact of a counterpart connector. This contact comprises: a piercing part, equipped with protrusions to be pierced through a conductor of the flat cable, a linking part, having one end linked to the piercing part and extending towards the opposite side of the direction in which the protrusions protrude; and a connection part, being connected to the other end of the linking part and being for electrical connection with the contact of the counterpart connector.

[0010] In making a daisy chain connection using a flat cable contact, the flat cable is positioned so as to oppose the protrusions of the piercing part and the protrusions are pierced through a conductor of the flat cable. In this process, since the piercing part and the connection part are connected via the linking part that extends towards the opposite side of the protrusions, the interference of the flat cable with the connection part can be prevented.

[0011] A flat cable contact, with which a daisy chain connection can be made without having to fold back a flat cable, can thus be provided.

[0012] The linking part may have a substantially L-like shape, which extends in a direction substantially orthogonal to the direction in which the protrusions protrude and then extends towards the opposite side of the direction in which the protrusions protrude.

[0013] 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.

[0014] The protrusions of the piercing part may be pierced into a conductor of a flat cable, having connectors connected at both ends thereof, at a predetermined position between the connectors.

[0015] The protrusions may be fixed onto a flat cable by being pierced through a conductor of the flat cable and thereafter pressing and bending the tip parts thereof. In this case, the piercing part preferably has formed therein positioning insertion holes for insertion of guide pins equipped on a punch base for receiving the piercing

part when the protrusions are pressed.

[0016] With this arrangement, since piercing can be performed after performing positioning by insertion of the guide pins of the punch base into the positioning insertion holes, the positioning of the piercing contact can be performed more accurately.

[0017] This inventive electrical connector is used to electrically connect a flat cable to a contact of a counterpart connector. This electrical connector comprises a flat cable contact and a housing that holds the contact. The contact comprises: a piercing part, equipped with protrusions to be pierced through a conductor of the flat cable, a linking part, having one end linked to the piercing part and extending towards the opposite side of the direction in which the protrusions protrude; and a connection part, being connected to the other end of the linking part and being for electrical connection with the contact of the counterpart connector. The housing comprises: a contact housing part, for housing the flat cable contact; and a cable passage, which is partitioned at a position opposing the protrusions of the flat cable contact that is housed in the contact housing part and is for passing the flat cable in a state wherein there are practically no bends (straightly).

[0018] With this arrangement, since the piercing part and the connection part are linked via the linking part that extends towards the opposite side of the direction in which the protrusions protrude, the flat cable can be prevented from interfering with the connection part when the flat cable is positioned so as to oppose the protrusions of the piercing part and the protrusions are pierced through a conductor of the flat cable in making a daisy chain connection using the flat cable contact.

[0019] An electrical connector, with which a daisy chain connection can be made without folding back the flat cable, can thus be provided.

[0020] The housing preferably has formed thereon a plurality of piercing protrusions, which are formed in plurality along the direction in which the flat cable passes through the cable passage and, in the state in which the flat cable is passed through the cable passage, are pierced through a plurality of through holes formed in the flat cable.

[0021] With this arrangement, by passing piercing protrusions respectively through thorough holes, which are formed in plurality along the direction in which the flat cable passes through the cable passage, the twisting of the housing with respect the flat cable can be prevented. An external force, due to the twisting of the flat cable contact, which is housed in the contact housing part equipped in the housing, with respect to the flat cable, can thus be restrained from being applied to the part at which the piercing part and the flat cable are coupled.

[0022] The piercing protrusions may be wall-like or rod-like.

[0023] The flat cable is preferably equipped with a plurality of conductors and a holding member for holding these plurality of conductors in parallel with the conduc-

tors being mutually spaced by a fixed interval. In this case, the plurality of through holes are preferably formed in the holding member at predetermined positions between adjacent conductors and aligned along the direction in which the conductors extend.

[0024] The housing preferably has a pair of clamping parts, which are respectively for clamping the flat cable near the openings at the respective ends of the cable passage.

[0025] With this arrangement, since the flat cable is clamped near the openings at the respective ends of the cable passage with the piercing part in between, the twisting of the housing with respect to the flat cable and transmission of vibration from the flat cable to the flat cable contact can be prevented. An external force can thus be restrained from being applied to the part at which the flat cable is coupled to the piercing part of the flat cable contact, which is housed in the contact housing part equipped in the housing.

[0026] The clamping parts may include protrusions for pressing the flat cable.

[0027] The housing may comprise: a main body, equipping the contact housing part; and a cover, which is detachable to (can be coupled to) the main body; and be arranged so that by the attachment (coupling) of the cover to the main body, the cable passage is formed in a demarcated manner between the cover and the main body.

[0028] In this case, it is preferable for there to be provided furthermore a retainer, which is attached in a replaceable manner to the main body and is for fixing the flat cable contact, housed in the contact housing part, inside the contacting housing part. More preferably, arrangements are made so that in a state wherein the retainer is set at a predetermined initial position, the flat cable contact can be housed in the contact housing part, and by the attachment of the cover in this state, the retainer can be displaced from the initial position and the flat cable contact can be fixed inside the contact housing part. With this arrangement, since by simply attaching the cover to the main body, the retainer can be displaced and the flat cable contact that is housed in the contact housing part can be fixed, working processes can be reduced and the electrical connector can be assembled readily.

[0029] Preferably, the protrusions of the piercing part are fixed onto the flat cable by being pierced through the conductors of the flat cable and then pressing and bending the tip parts thereof in the state in which the flat cable contact is housed in the contact housing part. In this case, the housing preferably has formed therein a punch base insertion hole for passing through a punch base for receiving the piercing part when the protrusions are pressed.

[0030] With this arrangement, since after performing positioning by housing the flat cable contact in the contact housing part, a receiving surface of the punch base can be put in contact with the lower surface of the pierc-

ing part simply by inserting the punch base through the punch base insertion hole, the attachment of the electrical connector to the flat cable can be performed readily.

[0031] Also, in a case where a plurality of flat cable contacts are to be attached to a flat cable, by performing positioning by housing all the flat cable contacts in corresponding contact housing parts and then inserting punch bases through punch base insertion holes to put their receiving surfaces in contact with the lower surfaces of all of the flat cable contacts, the protrusions of all of the flat cable contacts can be bent at once using a punch. Since a plurality of flat cable contacts can thus be attached to a flat cable at once, in comparison to the case where flat cable contacts are attached one by one to a flat cable, the working processes can be reduced and the attachment of an electrical connector to the flat cable can be performed more readily.

[0032] Further convenience is provided in that whether or not (the piercing parts of) the flat cable contacts are housed in the contact housing part can be checked visually via the punch base insertion holes.

[0033] Preferably, the piercing part of the flat cable contact has formed therein positioning insertion holes for insertion of guide pins, equipped on the punch base that is passed through the punch base insertion hole. Since piercing can thereby be performed after performing positioning by inserting the guide pins of the punch base into the positioning insertion holes of the flat cable contact, the positioning of the piercing contact can be performed more accurately.

[0034] This inventive flat cable comprises: an electrical connector of the arrangement described above; and a flat cable, passed through the cable passage. The flat cable has the protrusions of the piercing part pierced through the conductor thereof at an intermediate part and the flat cable contact is fixed thereto by the bending of the tip parts of the protrusions.

[0035] With this arrangement, since the piercing part and the connection part are linked via the linking part that extends towards the opposite side of the direction in which the protrusions protrude, the flat cable can be prevented from interfering with the connection part in the state in which the protrusions are pierced through the intermediate part of the flat cable and their tip parts are bent.

[0036] A flat cable with electrical connector, with which a daisy connection can be made without folding back the flat cable, can thus be provided.

[0037] The above and other objects, characteristics, and effects of this invention shall be made clear by the following description of the embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

Figs. 1(a) and 1(b) show diagrams of the arrange-

ment of a piercing contact that is a flat cable contact of an embodiment of this invention.

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

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

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

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

Fig. 5 is a plan view of a retainer.

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

Figs. 7(a), 7(b) and 7(c) show front views of the manner of displacement of the retainer when a cover is closed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Figs. 1(a), 1(b) and 1(c) show diagrams of the arrangement of a piercing contact 1 that is a flat cable contact of an embodiment of this 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), 1(b) and 1(c) shall be referred to as the front side and the right side shall be referred to as the rear side.

[0040] Referring to Figs. 1(a), 1(b) and 1(c), 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) piercing protrusions 2 for conductively connecting the piercing contact to a flat cable upon being pierced through a conductor of the flat cable.

[0041] 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.

[0042] Piercing part 3 has both its left and right side parts bent upward and is thereby formed to a substan-

tially U-like shape as viewed from the front. That is, piercing part 3 comprises 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] Figs. 2(a), 2(b) and 2(c) show diagrams of the arrangement of a housing 20 for holding piercing contacts 1.

[0051] 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.

[0052] 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 piercing part 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.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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 cable passage 30. However, the piercing protrusions for positioning the flat

[0061] 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 (connection parts 5 of) piercing contacts 1 that are housed in the respective contact housing recesses 24 so that they do not become displaced upwards, and from the right end part of retainer 35, an engaging part 37, for engagement with cover 22 when this cover 22 is closed, extends upward outside main body 21.

[0062] 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.

[0063] Fig. 3 shows plan views for explaining the manner in which a piercing connector 100 is attached to a flat cable 40.

[0064] Flat cable 40, which is to be electrically connected to this piercing connector 100, is an FFC equipped with a plurality (for example, five) 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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 can be 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 more of these may be formed in the front/rear direction instead.

[0069] 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.

[0070] In attaching piercing connector 100 to flat cable 40, first, punch bases 50 are inserted from below 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.

[0071] 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)).

[0072] 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)).

[0073] 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. 2A 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.

[0074] 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.

[0075] Connectors 300 and 400, each for achieving electrical contact with another electrical part, are attached to the respective end parts 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.

[0076] 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 from 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.

[0077] Fig. 5 is a plan view of retainer 35. Also, Figs. 6(a) and 6(b) show plan 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.

[0078] 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.

[0079] 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 respective 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, 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).

[0080] As shown in Fig. 6(a), in the present embodiment, after positioning piercing contacts 1 inside contact housing recesses 24 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 attach-

ment 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.

[0081] Figs. 7(a) and 7(b) show front views of the manner of displacement of retainer 35 in the process of closing cover 22.

[0082] 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.

[0083] 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 displaced towards the left by its inclined surface 371 being pressed by sliding surface 381 of protruding engaging part 38.

[0084] 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 end of 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.

[0085] Referring again to Figs. 6(a) and 6(b), in the state in which retainer 35 is pushed into the leftmost side, the respective intermediate protrusions 39 of retainer 35, 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, 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 connection part housing part 26) (see Fig. 6(b)). In this state, the upper end surfaces of connection parts 5 of piercing contacts 1 (not shown in Figs. 6(a) or 6(b)), which are housed in the respective contact housing recesses 24, contact the lower surfaces of intermediate protrusions 39 (restricting part) of retainer 35 (see Fig. 4B(b)) and piercing contacts 1 are thereby restricted from moving 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.

[0086] With this embodiment, since retainer 35 can be displaced to the left and piercing contacts 1, which are housed in contact housing recesses 24, can be fixed simply by closing cover 22, the working processes can be reduced and piercing connector 100 can be assembled readily.

[0087] 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.

[0088] 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.

[0089] Piercing contact 1 is not restricted to that of a substantially L-like form, with 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 downwards (towards the opposite side of the direction in which piercing protrusions 2 protrude), and may instead have a shape, wherein linking part 4 extends downwards (towards 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 the direction in which the protrusions protrude.

[0090] 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, and may instead be, for example, a male 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.

[0091] Though an FFC was used as an example of a flat cable with the embodiment described above, this invention is also applicable to other flat cables, such as an FPC (Flexible Printed Circuit).

[0092] Though embodiments of this invention have been described in detail, these are merely specific examples used for clarifying 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.

[0093] The present Application corresponds to Japanese Patent Application No. 2003-355434, submitted to the Japan Patent Office on October 15, 2003, and the full disclosure of this Application is incorporated herein by reference.

Claims

1. A contact (1), which is for a flat cable electrical connector used for electrically connecting a flat cable (40) to a contact (201) of a counterpart connector (200), said contact for flat cable comprising:

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

2. The flat cable contact according to Claim 1, wherein said protrusions (2) are fixed onto a flat cable (40) by being pierced through a conductor (41) of the flat cable (40) and then pressing and bending tip parts thereof, and

said piercing part (3) has formed therein positioning insertion holes (10) for insertion of guide pins (52) equipped in a punch base (50) for receiving said piercing part (3) when said protrusions (2) are pressed.

3. An electrical connector (100), used to electrically connect a flat cable (40) to a contact (201) of a counterpart connector (200), said electrical connector comprising:

the flat cable contact (1) according to Claim 1; and
a housing (20) for holding said flat cable contact (1), said housing (20) having formed therein: a contact housing part (24), for housing said flat cable contact (1); and a cable passage (30), being partitioned at a position opposing said protrusions (2) of said flat cable contact (1) that is housed in said contact housing part (24) and being for passing the flat cable (40) in a state wherein there is substantially no bend.

4. The electrical connector according to Claim 3, wherein said housing (20) has formed thereon a plurality of piercing protrusions (31, 32), which are formed in plurality along a direction in which the flat

cable (40) passes through said cable passage (30), the plurality of piercing protrusions (31, 32) being to be pierced through a plurality of through holes (43, 44) formed in said flat cable (40) in the state in which said flat cable (40) is passed through said cable passage (30).

5. The electrical connector according to Claim 3 or 4, wherein said housing (20) has a pair of clamping parts (54, 55), formed near openings at respective ends of said cable passage (30), the pair of clamping parts (54, 55) respectively for clamping the flat cable (40).

6. The electrical connector according to any of Claims 3 through 5, wherein said housing (20) comprises: a main body (21), equipping said contact housing part (24); and a cover (22), which is detachable to the main body;

the electrical connector being arranged so that by the attachment of said cover (22) to said main body (21), said cable passage (30) is defined between said cover and said main body.

7. The electrical connector (100) according to any of Claims 3 through 6, wherein said protrusions (2) of said piercing part (3) are fixed onto the flat cable (40) by being pierced through the conductor (41) of the flat cable (40) and then pressing and bending tip parts thereof in a state in which said flat cable contact (1) is housed in said contact housing part (24) and

said housing (20) has formed therein a punch base insertion hole (27) for passing through a punch base (50) for receiving said piercing part (3) when said protrusions (2) are pressed.

8. The electrical connector according to Claim 7, wherein said piercing part (3) of said flat cable contact (1) has formed therein positioning insertion holes (10) for insertion of guide pins (52), equipped on the punch base (50) that is passed through said punch base insertion hole (27).

9. A flat cable with electrical connector comprising:

the electrical connector (100) according to any of Claims 3 through 8; and
a flat cable (40), passed through said cable passage (30); said flat cable having the protrusions (2) of said piercing part (3) pierced through an intermediate part of the conductor (41) thereof and having said flat cable contact (1) fixed thereto by bending the tip parts of said protrusions.

FIG. 1(a)

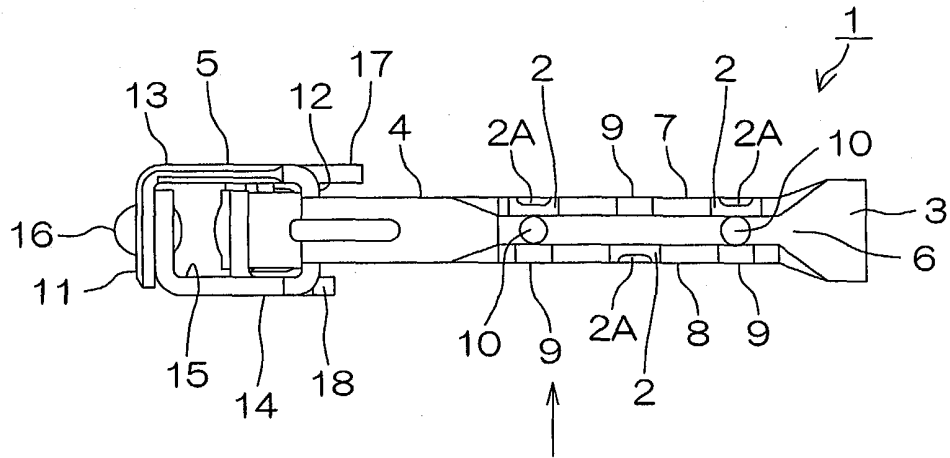


FIG. 1(b)

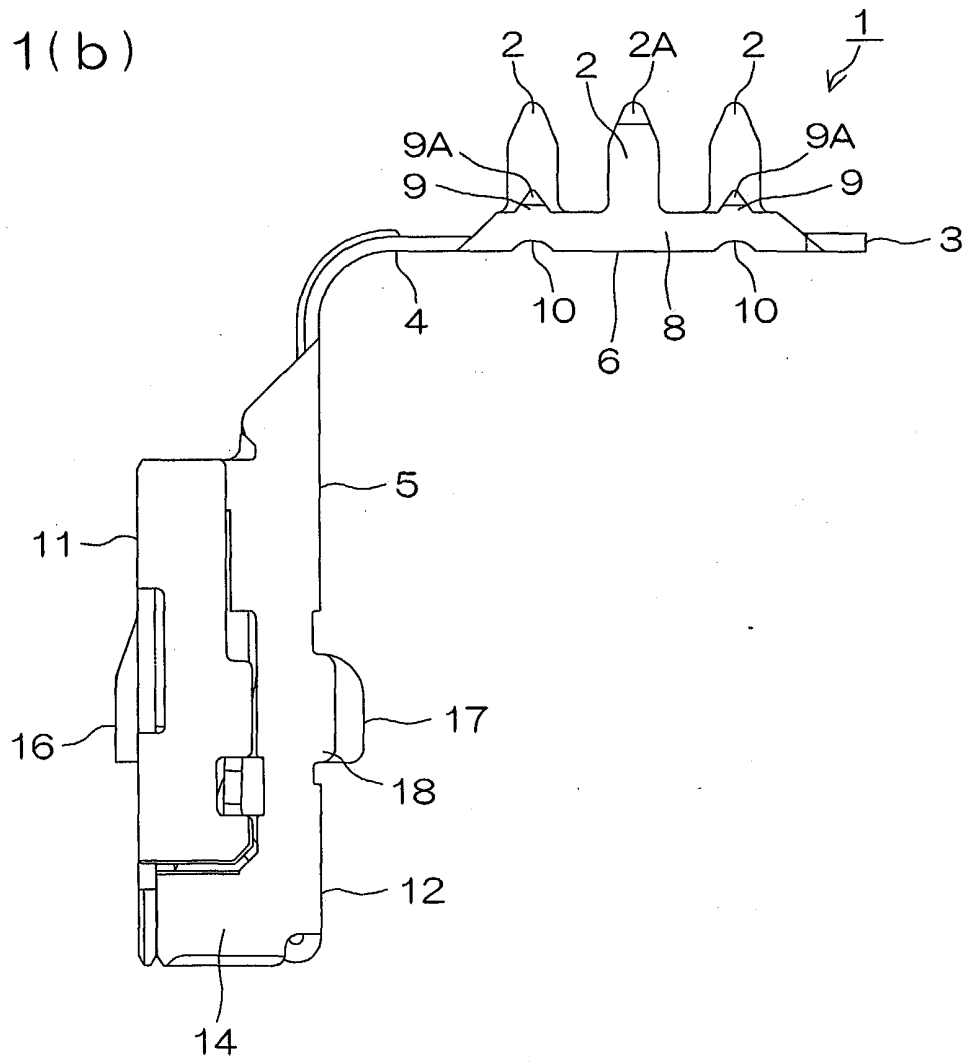


FIG. 2(a)

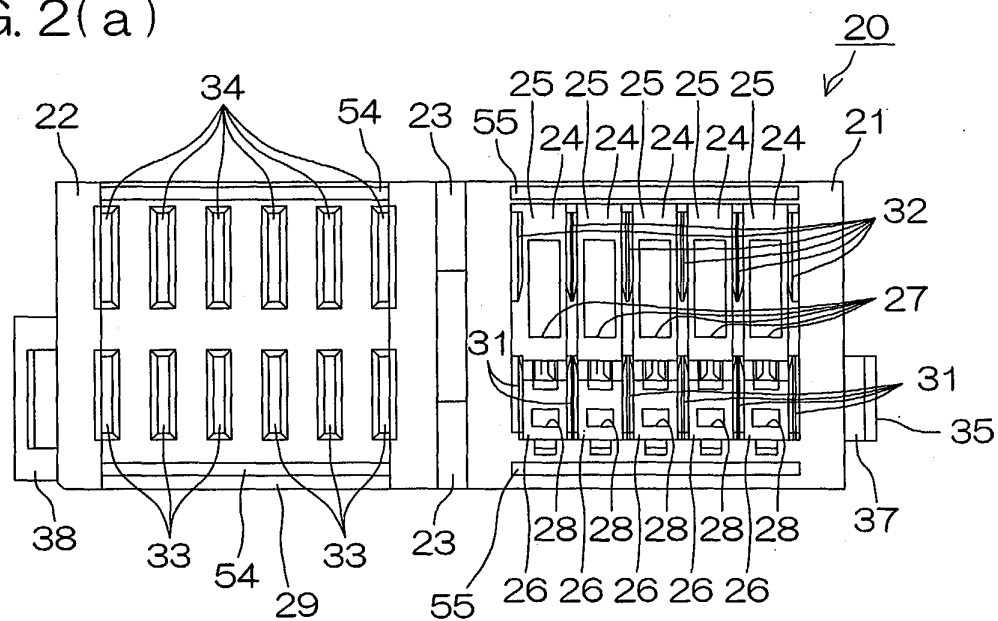


FIG. 2(b)

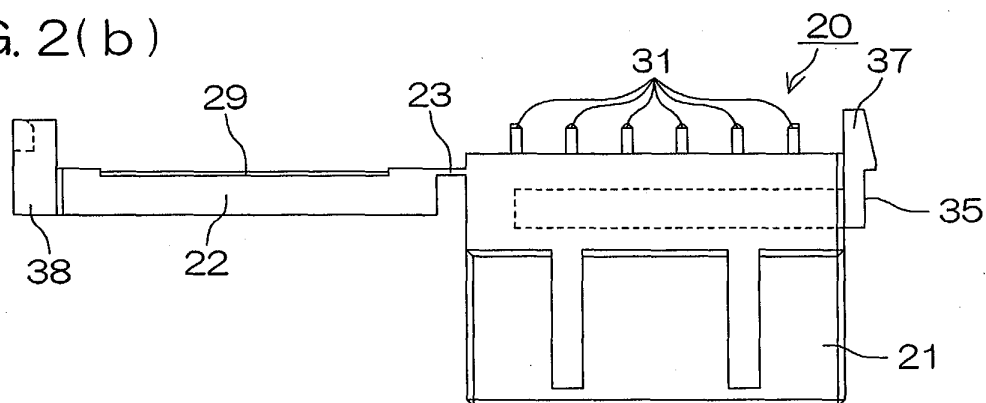


FIG. 2(c)

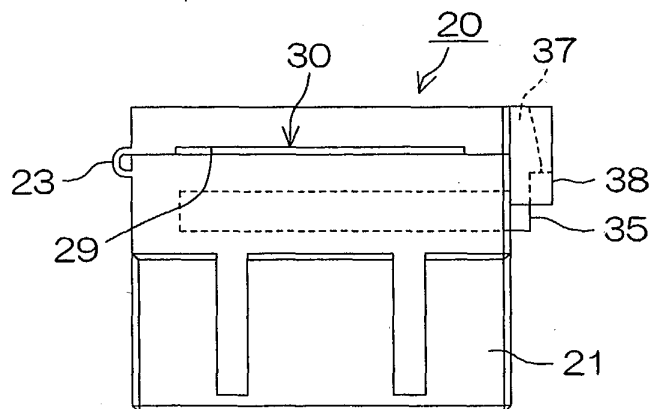


FIG. 3

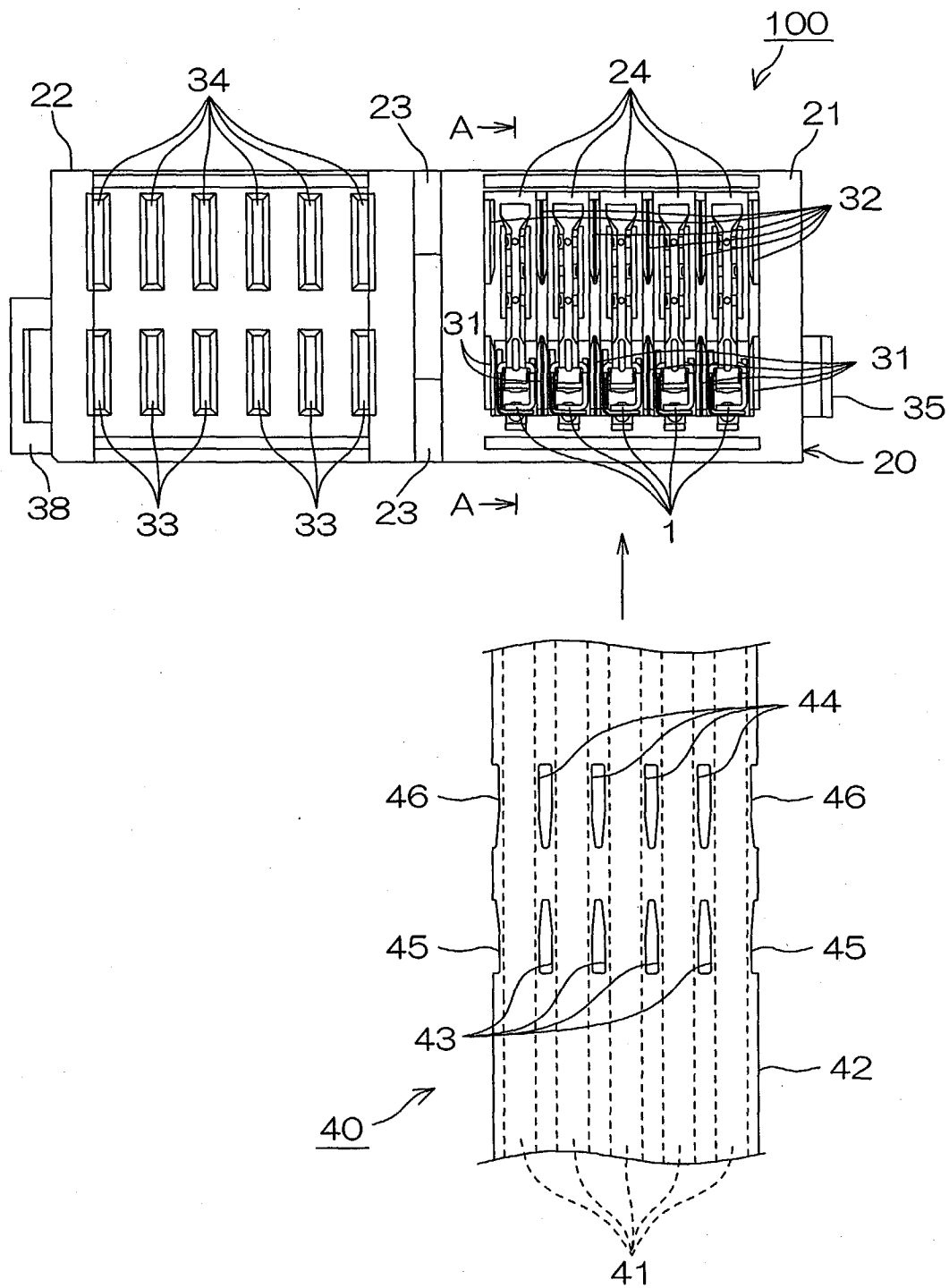


FIG. 4A(a)

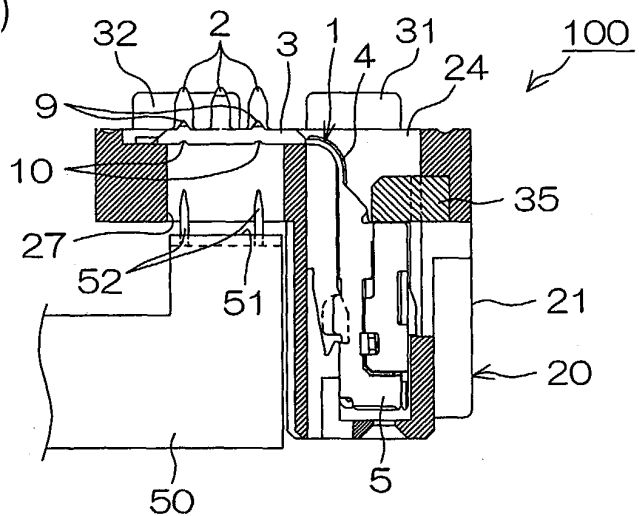


FIG. 4A(b)

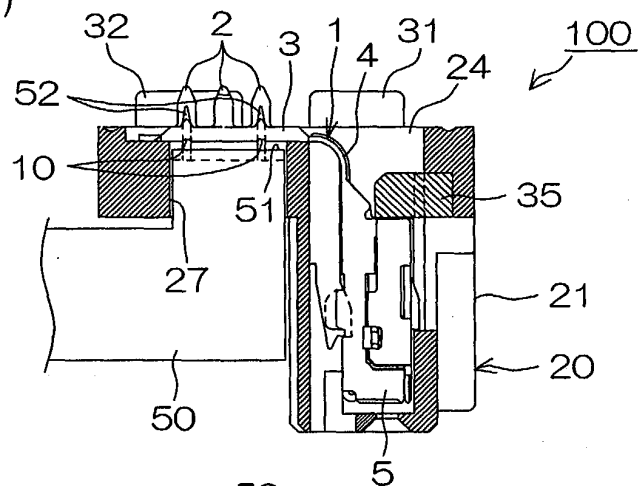


FIG. 4A(c)

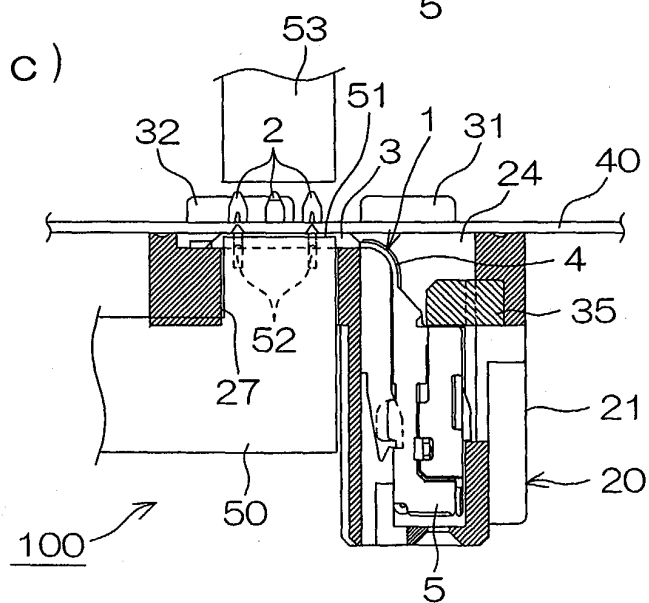


FIG. 4B(a)

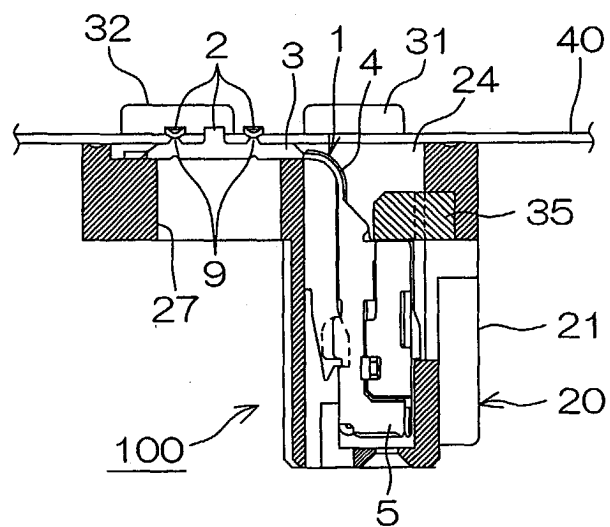


FIG. 4B(b)

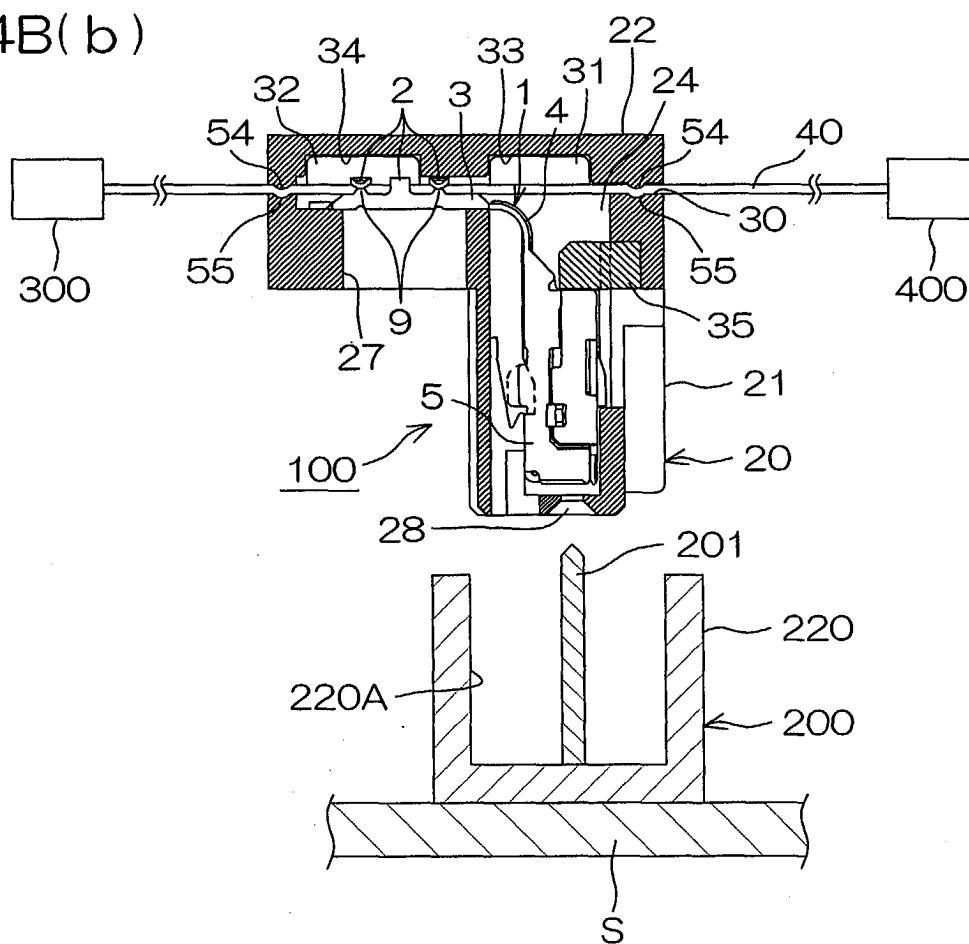


FIG. 5

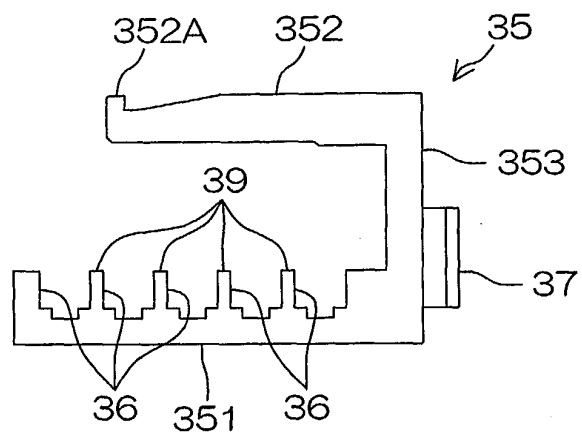


FIG. 6(a)

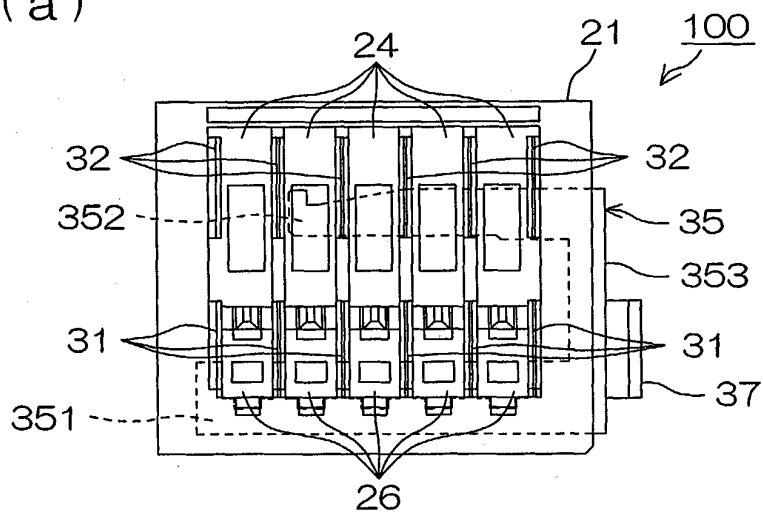


FIG. 6(b)

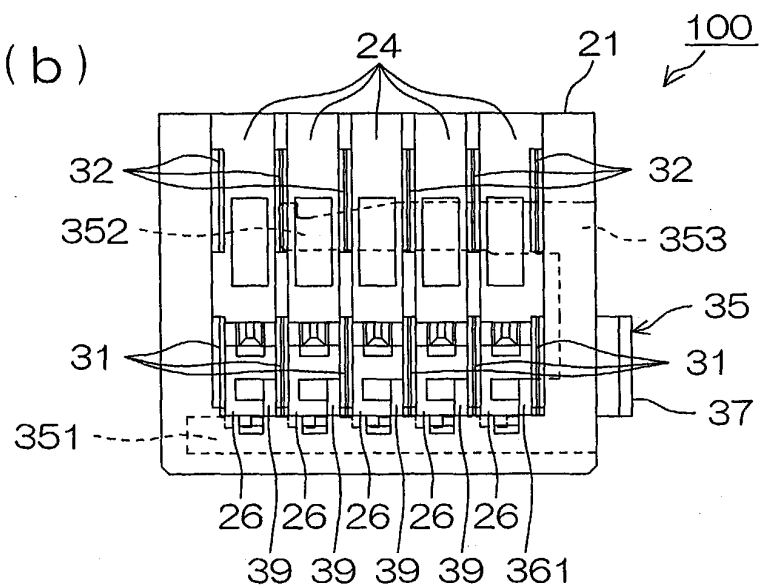


FIG. 7(a)

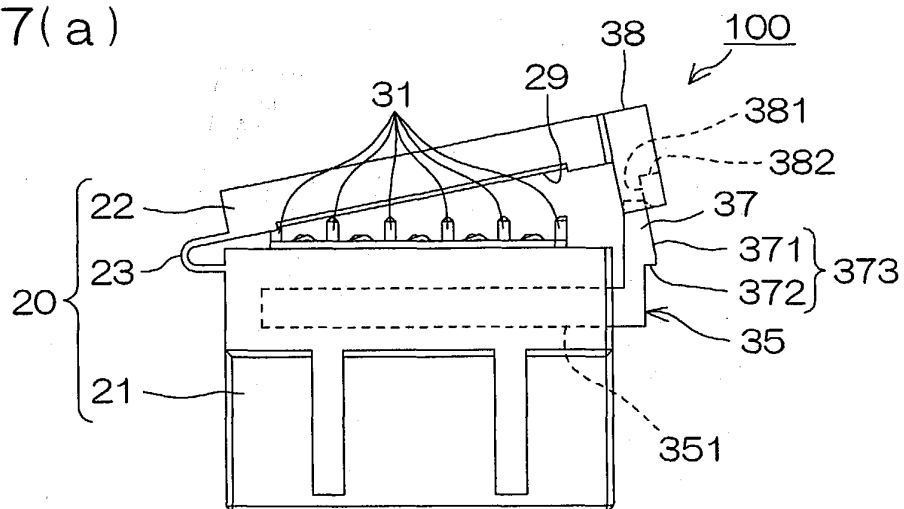


FIG. 7(b)

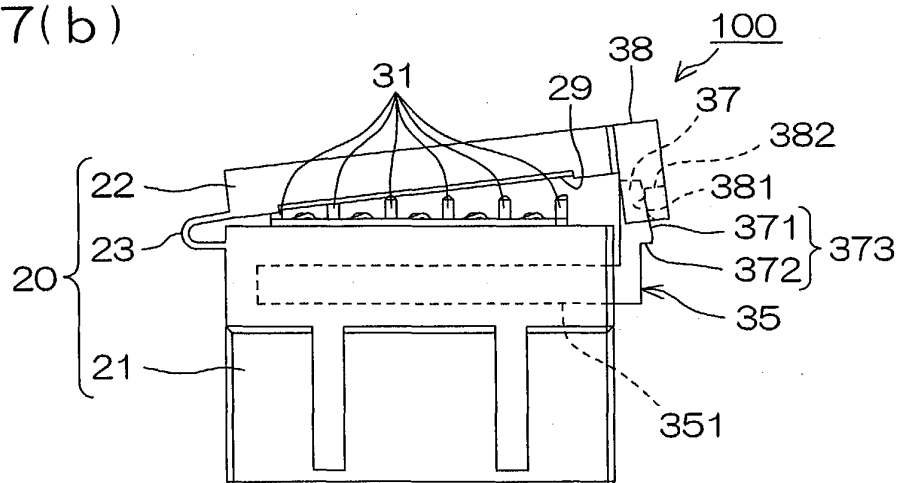
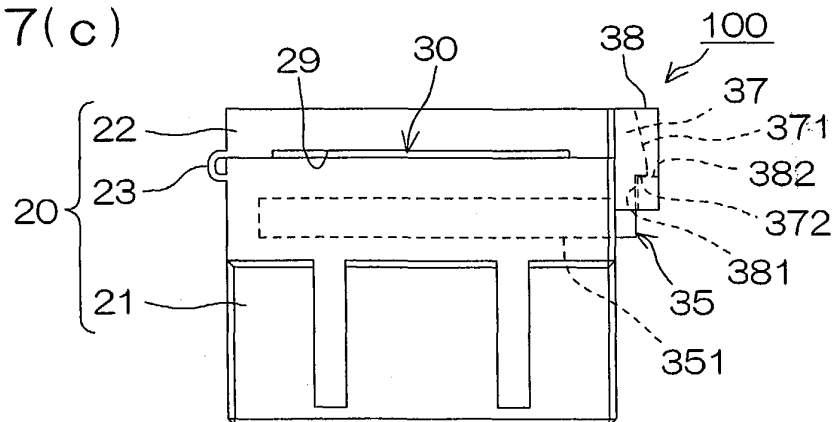


FIG. 7(c)





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 25 6282

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Y	* page 6, line 26 - page 9, line 8 *	2	
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			H01R
Place of search		Date of completion of the search	Examiner
The Hague		18 November 2004	Bertin, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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