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- **Nishikawa, Naoto, Nagoya Engineering Center of Oaza-Kurozasa Nishikamo Aichi 470-0201 (JP)**
- **Sasaki, Shoichi, Nagoya Engineering Center of Oaza-Kurozasa Nishikamo Aichi 470-0201 (JP)**

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(74) Representative: **W.P. Thompson & Co.
Coopers Building
Church Street
Liverpool L1 3AB (GB)**

(71) Applicant: **J.S.T. Mfg. Co., Ltd.
Osaka-shi, Osaka 542-0081 (JP)**

(72) Inventors:
• **Chiran, Kiyohiko, Nagoya Engineering Center of Oaza-Kurozasa Nishikamo Aichi 470-0201 (JP)**

(54) **Piercing contact, flat cable with piercing contact, flat cable with connector, and methods of manufacturing the same**

(57) A piercing contact (4) is electrically connected to a flat cable (2), which has a belt-like conductor (21) of predetermined width covered by an insulating sheath (22). The contact (1,4) includes: a piercing part (12, 42) pierced through the belt-like conductor (21) for electrical connection; and a contact part (11) connected to the piercing part (12, 42) for electrical connection of the flat cable (2) with an electrical part. The piercing part (12, 42) includes: a bottom plate part (121, 421), having a long shape of narrower width than the width of the belt-

like conductor (21) of the flat cable (2); a piercing protrusion (122, 422), erected from a side edge of the bottom plate part (121, 421) in a direction orthogonal to the longitudinal direction of the bottom plate part (121, 421), to be pierced through the belt-like conductor (21); and a contacting protrusion (123, 423), erected substantially parallel to the piercing protrusion (122, 422) at a side edge of the bottom plate part (121, 421) at the opposite side of the piercing protrusion (122, 422), to be pierced through the insulating sheath (22) of the flat cable (2) and put in contact with the belt-like conductor (21).

FIG. 1 (a)

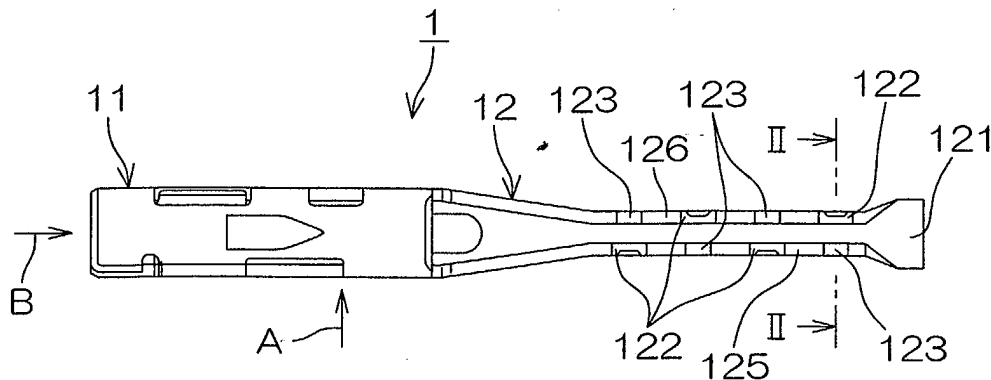
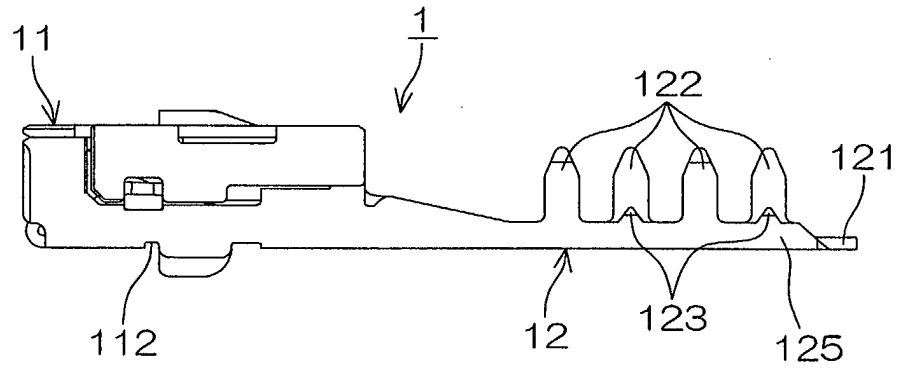


FIG. 1(b)



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention concerns a piercing contact, a flat cable with piercing contact, a flat cable with connector, and methods of manufacturing the same.

2. Description of the Related Art

[0002] So-called flat cables, such as FFCs (Flexible Flat Cables), are used as wiring in limited spaces, such as the interior of an automobile. Such a flat cable normally has a plurality of belt-like conductors aligned in parallel which are covered with an insulating sheath made of resin, etc., and since a plurality of belt-like conductors are gathered together as wiring, such a flat cable is suited for wiring applications in limited spaces. Also, since the surface area is large, flat cables provide such merits as being high in heat radiation and are thus high in performance as wiring. As a contact to be electrically connected to such a flat cable, a so-called piercing contact is used such that a piercing member equipped by the contact is pierced through a belt-like conductor. A piercing contact is convenient since an electrical connection with a flat cable is achieved by piercing the piercing member through a belt-like conductor and the electrical connection can thus be made readily.

[0003] For example, piercing contacts, equipped with a crimp member and a guide member as the piercing members, have been proposed as in the prior art described in Japanese Unexamined Patent Publication (Kokai) No. 2003-142188. The crimp member and the guide member are positioned so as to oppose each other in the width direction of the contact, and electrical connection of the contact with a flat cable is achieved by piercing the crimp member and the guide member through the flat cable (belt-like conductor), pressing the crimp member, which has protruded from the flat cable, down towards the guide member, and the flat cable becoming pressed by the tip of the crimp member as it is guided by the inner surface of the guide member.

[0004] However, since the prior art is of an arrangement with which the crimp member is pressed down towards the guide member, a fixed distance or more is required between the two members for enabling the inner surface of the guide member to guide the crimp member.

[0005] There is thus the possibility for either the guide member or the crimp member to be pierced away from the narrow belt-like conductor. The strength of attachment of the piercing contact to the flat cable could thus be insufficient and the reliability of electrical connection between the piercing contact and the belt-like conductor was thus not necessarily high.

SUMMARY OF THE INVENTION

[0006] An object of this invention is to provide a piercing contact, with which secure attachment to a flat cable can be achieved and the reliability of electrical connection can be improved.

[0007] Another object of this invention is to provide a flat cable with piercing contact, a flat cable with connector, and methods of manufacturing these flat cables using the piercing contact mentioned above to enable a high reliability to be secured.

[0008] A piercing contact of the present invention is electrically connected to a flat cable having a belt-like conductor of predetermined width covered by an insulating sheath. This piercing contact includes a piercing part, which is pierced through the belt-like conductor and achieves electrical connection, and a contact part, which is connected to the piercing part and is for electrically connecting the flat cable to an electrical part. The piercing part includes a bottom plate part, having an elongated shape of narrower width than the width of the belt-like conductor of the flat cable, a piercing protrusion, erected from a side edge of the bottom plate part in a direction orthogonal to the longitudinal direction of the bottom plate part, to be pierced through the belt-like conductor, and a contacting protrusion, erected substantially parallel to the piercing protrusion at a side edge of the bottom plate part at the opposite side of the piercing protrusion, to be pierced through the insulating sheath of the flat cable and put in contact with the belt-like conductor.

[0009] The contacting protrusion may be erected from a position opposing the piercing protrusion. In this case, it is preferable that, in the state in which the piercing contact is attached to the flat cable by the piercing protrusion being pierced through the flat cable so as to be pierced through the belt-like conductor and being bent (inflected or curved) towards the tip of the contacting protrusion, a tip part of the piercing protrusion and a tip part of the contacting protrusion oppose each other while clamping the belt-like conductor or are pierced through the belt-like conductor and made to contact each other to form a clamping/contacting member.

[0010] With this arrangement, the electrical connection of the piercing contact with the flat cable is achieved by the piercing protrusion being pierced through the belt-like conductor, this piercing protrusion being bent towards the tip of the contacting protrusion and the tip parts of the piercing protrusion and the contacting protrusion opposing each other while clamping the belt-like conductor or being put in mutual contact upon being pierced through the belt-like conductor. Thus, in the state in which the piercing contact is attached to the flat cable, the tip part of the piercing protrusion and the tip part of the contacting protrusion, for example, oppose each other along a substantially straight line.

[0011] By thus providing an arrangement wherein the tip part of the piercing protrusion and the tip part of the

contacting protrusion oppose each other in the state in which the piercing contact is attached to the flat cable, the distance between the piercing protrusion and the contacting protrusion in the width direction of the contact can be minimized within a range in which the function of the piercing protrusion will not be lowered. The piercing protrusion can thus be pierced through the belt-like conductor while enabling the contacting protrusion to be pierced through the insulating sheath of the flat cable and made to contact the belt-like conductor securely, so that the reliability of electrical connection can be improved.

[0012] In one embodiment of the present invention, a plurality of the piercing protrusions and a plurality of the contacting protrusions are aligned alternately in the longitudinal direction of the bottom plate part at one side edge and the other side edge of the bottom plate part, the piercing protrusions and the contacting protrusions are aligned so as to oppose each other in the width direction of the bottom plate part, and the piercing protrusions and the contacting protrusions are aligned in a staggered manner at the bottom plate part, respectively.

[0013] With this arrangement, when the piercing contact is attached to a flat cable, the piercing protrusions and the contacting protrusions can be distributed uniformly without bias towards one side edge of a belt-like conductor. Therefore, the strength of connection of the piercing contact to the flat cable can be improved.

[0014] A method of manufacturing a flat cable with piercing contact of a first aspect of the present invention uses the piercing contact described above. More specifically, this method includes: a step of piercing the piercing protrusion through the flat cable so as to pierce it through the belt-like conductor; and a step of bending (inflecting or curving) and pressing the piercing protrusion towards the tip of the contacting protrusion to make the belt-like conductor be clamped by the tip part of the piercing protrusion and the tip part of the contacting protrusion or to make the tip part of the piercing protrusion and the tip part of the contacting protrusion contact each other upon piercing them through the belt-like conductor.

[0015] With this method, the tip part of the piercing protrusion and the tip part of the contacting protrusion of the piercing contact can, for example, be made to face each other along substantially a straight line. Thus, even if the distance between the piercing protrusion and the contacting protrusion in the width direction of the contact is short, the piercing protrusion can be bent without fail towards the tip of the contacting protrusion.

[0016] The contacting protrusion may include a pair of contacting protrusions, which are erected substantially parallel to the piercing protrusion so as to form a trough part that receives the tip of the piercing protrusion at a position opposing the piercing protrusion and are made to contact the belt-like conductor upon being pierced through the insulating sheath of the flat cable. In this case, it is preferable that, the tip part of the pierc-

ing protrusion and the tip parts of the contacting protrusions form penetrating members, which are respectively penetrated into the belt-like conductor in the state in which the piercing contact is attached to the flat cable by the piercing protrusion being pierced through the flat cable so as to be pierced through the belt-like conductor and being bent (inflected or curved) towards the trough part between the pair of contacting protrusions.

[0017] With this arrangement, the electrical connection of the piercing contact to the flat cable is achieved by the piercing protrusion being pierced through the belt-like conductor and the tip part of the piercing protrusion and the pair of contacting protrusions being penetrated into the belt-like conductor by the bending of the piercing protrusion towards the trough part of the pair of contacting protrusions. Thus, in the state in which the piercing contact is attached to the flat cable, the tip part of the piercing protrusion and the trough part between the pair of contacting protrusions oppose each other, for example, along a substantially straight line.

[0018] By thus providing an arrangement wherein the tip part of the piercing protrusion and the trough part between the pair of contacting protrusions oppose each other in the state in which the piercing contact is attached to the flat cable, the distance between the piercing protrusion and the pair of contacting protrusions in the width direction of the contact can be minimized within a range in which the function of the piercing protrusion will not be lowered. The piercing contact can thus be pierced through the belt-like conductor while enabling the pair of contacting protrusions to be pierced through the insulating sheath of the flat cable and made to contact the belt-like conductor securely. As a result, the reliability of electrical connection can be improved. Furthermore, since the piercing contact is of an arrangement including the piercing protrusion and the pair of contacting protrusions, the area of contact with the belt-like conductor is large and the strength of connection of the piercing contact to the belt-like conductor and the reliability of the electrical connection can be improved further.

[0019] In one embodiment of the present invention, a plurality of the piercing protrusions and a plurality of the pairs of contacting protrusions are aligned alternately in the longitudinal direction of the bottom plate part at one side edge and the other side edge of the bottom plate part, the piercing protrusions and the trough parts between adjacent pairs of contacting protrusions are aligned so as to oppose each other in the width direction of the bottom plate part, and the piercing protrusions and the pairs of contacting protrusions are aligned in a staggered manner at the bottom plate part, respectively.

[0020] With this arrangement, the piercing protrusions and the pairs of contacting protrusions of the piercing contact are aligned in a staggered manner at the bottom plate part, respectively. Thus, when the piercing contact is attached to a flat cable, the piercing protrusions and the respective pairs of contacting protrusions

can be distributed uniformly without bias towards one side edge of a belt-like conductor. As a result, the strength of connection of the piercing contact to the flat cable can be improved.

[0021] A method of manufacturing a flat cable with piercing contact of a second aspect of the present invention uses a piercing contact of an arrangement described above. More specifically, this method includes: a step of piercing the piercing protrusion through the flat cable so as to pierce it through the belt-like conductor; and a step of bending (inflecting or curving) and pressing the piercing protrusion towards the trough part between the pair of contacting protrusions to make the tip part of the piercing protrusion and the tip parts of the pair of contacting protrusions respectively penetrate into the belt-like conductor.

[0022] With this method, the tip part of the piercing protrusion and the trough part between the pair of contacting protrusions of the piercing contact can, for example, be made to face each other along substantially a straight line. Thus, even if the distance between the piercing protrusion and the pair of contacting protrusions in the width direction of the contact is short, the piercing protrusion can be bent without fail towards the trough part between the pair of contacting protrusions.

[0023] A flat cable of the present invention with piercing contact comprises: the piercing contact with the characteristics described above; and the flat cable, to which the piercing contact is attached. This arrangement provides a flat cable with piercing contact of high reliability since the respective protrusions of the piercing contact are electrically connected securely to the belt-like conductor inside the flat cable.

[0024] A flat cable of the present invention with connector comprises: the flat cable with piercing contact described above; and a connector housing that holds the piercing contact. This arrangement provides a flat cable with connector of high reliability since the respective protrusions of the piercing contact are electrically connected securely to the belt-like conductor inside the flat cable.

[0025] A method of manufacturing a flat cable with connector of the present invention includes: a step of preparing a flat cable with piercing contact by the method described above; and a step of attaching the piercing contact to the connector housing. By this method, a flat cable with connector of high reliability, in which the respective protrusions of the piercing contact are electrically connected securely to the belt-like conductor inside the flat cable, can be provided.

[0026] The above and yet other objects, characteristics, and effects of the present invention shall be made clear by the following description of the embodiments in reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

- 5 FIG. 1(a), FIG. 1(b), and 1(c) are drawings showing the arrangement of a piercing contact of an embodiment of the present invention.
- 10 FIG. 2 is a schematic transverse section showing the arrangement of a piercing protrusion and a contacting protrusion.
- 15 FIG. 3(a) and FIG. 3(b) are diagrams showing the arrangement of a flat cable with piercing contacts.
- 20 FIG. 4 (a) and FIG. 4 (b) are schematic transverse sections showing an example of the state of attachment of the piercing protrusion and the contacting protrusion of the piercing contact to the flat cable.
- 25 FIG. 5(a), FIG. 5(b), and FIG. 5(c) are drawings showing the arrangement of a piercing contact of another embodiment of the present invention.
- FIG. 6 (a) , FIG. 6 (b) , FIG. 6 (c) , and FIG. 6 (d) are drawings showing the arrangement of connector housing.
- FIG. 7 (a), FIG. 7(b), FIG. 7(c), and FIG. 7 (d) are drawings showing the arrangement of a flat cable with connector.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

- 30 **[0028]** FIG. 1(a), FIG. 1(b), and FIG. 1(c) are drawings showing the arrangement of a piercing contact of an embodiment of the present invention, with FIG. 1(a) being a plan view, FIG. 1(b) being a side view along arrow A shown in FIG. 1(a), and FIG. 1(c) being a front view
- 35 along arrow B shown in FIG. 1(a). In the following, the left side in FIG. 1(a) shall be referred to as the front side and the right side shall be referred to as the rear side.
- [0029]** A piercing contact 1 has a contact part 11, having a substantially rectangular parallelepiped shape and being electrically connected to an electrical part, and a piercing part 12, having a long shape, being connected to a lower part of the rear end of contact part 11, being made gradually narrower towards the rear from contact part 11, and thereafter being maintained at a fixed width.
- 40 Contact part 11 has a through hole 111, extending in the front/rear direction, and piercing contact 1 is thus arranged as a female contact. Electrical connection of piercing contact 1 with an electrical part is achieved by the insertion of a counterpart male contact (electrical part) into through hole 111. Also, an engaging indentation 112 is formed at a lower part of contact part 11 for engagement with a connector housing when piercing contact 1 is to be attached to the connector housing.
- 45 **[0030]** Piercing part 12 includes a bottom plate part 121, a left side plate part 125 and a right side plate part 126, which are erected upwards from the left and right side edges, respectively, of bottom plate part 121, and four each of piercing protrusions 122 and contacting
- 50

protrusions 123, which are erected from the upper edges of left side plate part 125 and right side plate part 126. Piercing protrusions 122 and contacting protrusions 123 are formed at a fixed width part of piercing part 12 (bottom plate part 121), a total of four piercing protrusions 122 and contacting protrusions 123 are aligned alternately in the longitudinal direction of each of left side plate part 125 and right side plate part 126, and piercing protrusions 122 and contacting protrusions 123 are aligned so as to oppose each other in the width direction (left/right direction) of bottom plate part 121. That is, four piercing protrusions 122 and four contacting protrusions 123 are aligned in a so-called staggered manner at piercing part 12.

[0031] FIG. 2 is a schematic transverse section showing the arrangement of piercing protrusion 122 and contacting protrusion 123 and is a sectional view along sectioning line II-II shown in FIG. 1(a). Piercing protrusions 122 and contacting protrusions 123 protrude upward from left side plate part 125 and right side plate part 126 with their respective inner surfaces 122a and 123a opposing each other, and the length of each contacting protrusion 123 is approximately 1/3rd the length of each piercing protrusion 122. The tip parts of piercing protrusion 122 and contacting protrusion 123 are respectively provided with tapered shapes that narrow towards the tips by gradually inclining from outer surfaces 122b and 123b to inner surfaces 122a and 123a and gradually inclining from the respective side edges towards the tip. In the present embodiment, the distance from outer surface 122b of piercing protrusion 122 to outer surface 123b of contacting protrusion 123 is approximately 0.9mm in the width direction of bottom plate part 121. The tip parts of piercing protrusion 122 and contacting protrusion 123 are not limited to those described above and various types of chamfering may be applied as necessary.

[0032] As shall be described later, piercing protrusion 122 and contacting protrusion 123 serve as attachment parts for attachment to a flat cable, and in the attachment process, piercing protrusion 122 and contacting protrusion 123 are penetrated into the flat cable. Thus, by making the tip parts of piercing protrusion 122 and contacting protrusion 123 have sharp shapes as described above, both protrusions can be penetrated readily into the flat cable.

[0033] FIG. 3 (a) and FIG. 3 (b) are diagrams showing the arrangement of a flat cable 3 with piercing contacts, with FIG. 3 (a) being a plan view and FIG. 3 (b) being a side view along arrow C shown in FIG. 3(a). FIG. 4 (a) and FIG. 4(b) are schematic transverse sections showing an example of a state of attachment of a piercing protrusion 122 and a contacting protrusion 123 of piercing contact 1 to flat cable 2 and are sectional views along sectioning line IV-IV shown in FIG. 3(a). Flat cable 3 with piercing contacts includes a plurality (five in the present embodiment) of piercing contacts 1 and a flat cable 2. Flat cable 2 has an arrangement wherein a plurality (five

in the present embodiment) of belt-like conductors 21 are aligned at equal intervals on a single plane and covered by an insulating sheath 22. This flat cable 2 is a so-called FFC (Flexible Flat Cable). At parts between the five belt-like conductors 21 at the tip of flat cable 2 are respectively formed notches 23, with which insulating sheath 22 is notched in the longitudinal direction of belt-like conductors 21. Each notch 23 has a length such that it extends close to the rear end of a piercing contact 1 in the state in which piercing contacts 1 are attached.

[0034] The five piercing contacts 1 are aligned at equal intervals, the five belt-like conductors 21 of flat cable 2 are made to respectively oppose piercing parts 12 of the respective piercing contacts 1 from above, and piercing protrusions 122 of the respective piercing parts 12 are pierced through insulating sheath 22 and belt-like conductors 21 of flat cable 2 and protruded upward from flat cable 2. In this process, contacting protrusions 123 of each piercing part 12 are pierced through insulating sheath 22 of flat cable 2 and put in contact with belt-like conductor 21. And by then pressing the respective piercing protrusions 122, with the bottom surfaces of bottom plate parts 121 of piercing parts 12 being received by punch bases of a press machine, the respective piercing protrusions 122 that protrude upward from flat cable 2 are bent into an inverted U-like shape towards the tips of opposing contacting protrusions 123. The tip parts of piercing protrusions 122 and the tip parts of contacting protrusions 123 are thereby made to face each other along a substantially straight line and flat cable 2 is held by piercing protrusions 122 and contacting protrusions 123. Flat cable 3 with piercing contacts is thus arranged.

[0035] In the arrangement in which each piercing protrusion 122 and contacting protrusion 123 hold flat cable 2, by piercing protrusion 122 being pierced through flat cable 2 and then being bent and pressed towards the tip of contacting protrusion 123, piercing protrusion 122 is pierced through insulating sheath 22 again from above and put in contact with belt-like conductor 21, and belt-like conductor 21 is clamped by the tip part of piercing protrusion 122 and the tip part of contacting protrusion 123 as shown in FIG. 4(a). Here, the tip part of piercing protrusion 122 and the tip part of contacting protrusion 123 may be put in mutual contact within the range of the thickness of belt-like conductor 21. Also, as shown in FIG. 4(b), flat cable 2 may be held by contacting protrusion 123 being pierced through belt-like conductor 21 and the tip part of piercing protrusion 122 and the tip part of contacting protrusion 123 being put in contact with each other.

[0036] The bending of piercing protrusion 122 may be achieved by curving as shown in FIG. 4 (a) and FIG. 4 (b) or may be achieved by inflecting.

[0037] In general, the width of a contact is narrower than the width of a belt-like conductor, and with piercing contact 1, by providing an arrangement with which the tip parts of piercing protrusion 122 and contacting protrusion 123 are attached to flat cable 2 upon being made

to face each other, the width of bottom plate part 121 is made as narrow as possible. To be more detailed, in the width direction of bottom plate part 121, the distance from outer surface 122b of piercing protrusion 122 to outer surface 123b of contacting protrusion 123 is set to approximately 0.9mm as mentioned above. Furthermore, the thickness of each of piercing protrusion 122 and contacting protrusion 123 is set to approximately 0.2mm and the distance from inner surface 122a of piercing protrusion 122 to inner surface 123a of contacting protrusion 123 is set to approximately 0.5mm. In general, the distance from inner surface 122a of piercing protrusion 122 to inner surface 123a of contacting protrusion 123 is preferably no more than approximately 2.5 times of the thickness of each protrusion.

[0038] Also, the width of the belt-like conductor 21 of flat cable 2 is set to approximately 1.5mm. In general, the distance from outer surface 122b of piercing protrusion 122 to outer surface 123b of contacting protrusion 123 is preferably no more than approximately 3/5th the width of belt-like conductor 21. An allowance of approximately 0.6mm (distance of no less than approximately 2/3rd of the distance from outer surface 122b to outer surface 123b) can thus be secured between the distance between piercing protrusion 122 and contacting protrusion 123 and the width of belt-like conductor 21 in electrically connecting (attaching) piercing contact 1 to flat cable 2. Both piercing protrusion 122 and contacting protrusion 123 can thus be made to contact belt-like conductor 21 securely and the attachment strength and reliability of electrical connection can be improved.

[0039] Also, as described above, each piercing protrusion 122 and each contacting protrusion 123 are aligned in a staggered manner on piercing part 12. Piercing protrusions 122 and contacting protrusions 123 can thus be distributed uniformly without bias towards one side edge at belt-like conductor 21. The strength of connection of piercing contact 1 to flat cable 2 can thus be improved.

[0040] FIG. 5(a), FIG. 5(b), and FIG. 5(c) are drawings showing the arrangement of a piercing contact 4 of another embodiment of the present invention. FIG. 5(a) is a plan view, FIG. 5(b) is a side view along arrow D shown in FIG. 5(a), and FIG. 5(c) is a side view showing the state in which a flat cable 2 is attached to piercing contact 4 of FIG. 5(b). Flat cable 3 with piercing contact can be arranged using this piercing contact 4 in place of piercing contact 1 described above. With piercing contact 4, the numbers and alignment of the respective protrusions are changed with respect to piercing contact 1, and since the arrangement besides the protrusions is the same as that of piercing contact 1, description shall be omitted while providing the same referencing symbols as those of FIG. 1 in FIG. 5. Also, in the following description, the left side in FIG. 5(a) shall be referred to as the front side and right side shall be referred to as the rear side.

[0041] Piercing contact 4 contains a piercing part 42,

which corresponds to piercing part 12 of piercing contact 1. Piercing part 42 includes a bottom plate part 421, a left side plate part 425 and a right side plate part 426, which are erected upwards from the left and right side edges, respectively, of bottomplate part 421, and four piercing protrusions 422 and four corresponding pairs of contacting protrusions 423, which are erected from the upper edges of left side plate part 425 and right side plate part 426. More specifically, on each of the upper edges of left side plate part 425 and right side plate part 426, two piercing protrusions 422 and two pairs of contacting protrusions 423 are formed and these are aligned so that a piercing protrusion 422 and a pair of contacting protrusions 423 alternate. The respective piercing protrusions 422 at the left side plate part 425 side and trough parts 424 of the respective pairs of contacting protrusions 423 at the right side plate part 426 side oppose each other, and the respective piercing protrusions 422 at the right side plate part 426 side and trough parts 424 of the respective pairs of contacting protrusions 423 at the left side plate part 425 side oppose each other. In other words, four piercing protrusions 422 and four pairs of contacting protrusions 423 are aligned in a so-called staggered manner at piercing part 42.

[0042] To arrange flat cable 3 with piercing contact using this piercing contact 4, belt-like conductor 21 of flat cable 2 is positioned to face piercing part 42 of piercing contact 4 from above and piercing protrusions 422 of piercing part 42 are pierced through insulating sheath 22 and belt-like conductor 21 of flat cable 2 and protruded upwards from flat cable 2. In this process, the pairs of contacting protrusions 423 of piercing part 42 are pierced through insulating sheath 22 of flat cable 2 and penetrated into belt-like conductor 21. Then, with the bottom surface of bottomplate part 421 of piercing part 42 being received by a punch base of press machine, each piercing protrusion 422 is pressed from above and each piercing protrusion 422, which is protruded upward from flat cable 2, is thereby bent in an inverted U-like shape towards trough part 424 between the opposing pair of contacting protrusions 423 and then pressed further. Trough part 424 corresponds to the shape of a tip part of piercing protrusion 422 and the tip part of piercing protrusion 422 enters into trough part 424. The tip parts of piercing protrusions 422 and trough parts 424 between pairs of contacting protrusions 423 thus oppose each other along substantially a straight line and piercing protrusions 422 are pierced again through insulating sheath 22 of flat cable 2 from above flat cable 2 and are further penetrated into belt-like conductor 21. Flat cable 3 with piercing contact, in which flat cable 2 is held in this manner, can thus be arranged.

[0043] With piercing contact 4, the distance between a piercing protrusion 422 and a trough part 424 that oppose each other is made the same as in the case of piercing contact 1. Also as described above, piercing contact 4 includes four piercing protrusions 422 and four

pairs of contacting protrusions 423 and these are aligned in a staggered manner at piercing part 42. The area of contact of the respective protrusions with belt-like conductor 21 can thus be increased and, furthermore, piercing protrusions 422 and contacting protrusions 423 can be distributed uniformly without bias towards one side edge of belt-like conductor 21. The strength of connection of piercing contact 4 to flat cable 2 can thus be improved.

[0044] Each of piercing contact 1 and piercing contact 4 may include protrusions that are formed by cutting and erecting inwards intermediate parts in the length direction of piercing protrusions 122 or piercing protrusions 422, or equipped with cut and upwardly erected parts at bottom plate part 121 or bottom plate part 421.

[0045] FIG. 6 (a) , FIG. 6 (b) , FIG. 6 (c) , and FIG. 6 (d) are drawings showing the arrangement of a connector housing 5, with FIG. 6 (a) being a plan view, FIG. 6 (b) being a side view along arrow E shown in FIG. 6(a), FIG. 6(c) being a sectional view along sectioning line VIc-VIc shown in FIG. 6 (b) , and FIG. 6 (d) being a sectional view along sectioning line VIId-VIId shown in FIG. 6(a). In the following description, the left side in FIG. 6 (a) shall be referred to as the front side and right side shall be referred to as the rear side.

[0046] Connector housing 5 is formed of a resin-molded article and, by being equipped with upper plate part 55, lower plate part 56, left side plate part 57, and right side plate part 58, has a space in its interior that passes through in the front/rear direction. In this space, four partitioning walls 59, extending from the front end to near the rear end of connector housing 5, are provided at fixed intervals. By these four partitioning walls 59, the space inside connector housing 5 is partitioned into five contact attachment holes 51. Also, at the rear end of connector housing 5, cable inlet 53 is partitioned by upper plate part 55, lower plate part 56, left side plate part 57, and right side plate part 58, and at the front end, five contact inlets 52 are partitioned by upper plate part 55, lower plate part 56, left side plate part 57, right side plate part 58, and partitioning walls 59. Furthermore, contact latching claws 54, facing the respective contact attachment holes 51, are equipped on the upper surface (inner surface) of lower plate part 56.

[0047] FIG. 7 (a), FIG. 7(b), FIG. 7(c), and FIG. 7 (d) are drawings showing the arrangement of a flat cable 6 with connector, with FIG. 7(a) being a plan view, FIG. 7 (b) being a side view along arrow F shown in FIG. 7(a), FIG. 7(c) being a sectional view along sectioning line VIIc-VIIc shown in FIG. 7(b), and FIG. 7 (d) being a sectional view along sectioning line VIId-VIId shown in FIG. 7(a).

[0048] Flat cable 6 with connector comprises connector housing 5 and flat cable 3 with piercing contacts. Flat cable 3 with piercing contacts may be one that uses piercing contacts 1 or one that uses piercing contacts 4 (an arrangement using piercing contacts 1 is shown in FIG. 7 (a) to FIG. 7 (d)). In the following description, the

left side in FIG. 7(a) shall be referred to as the front side and right side shall be referred to as the rear side.

[0049] Flat cable 3 with piercing contacts is inserted, with the contact side facing forward, from cable inlet 53 of connector housing 5. Each piercing contact 1 is then inserted into the corresponding contact attachment hole 51. By each piercing contact 1 being inserted further towards the front, the front end of each piercing contact 1 reaches contact latching claw 54 and each contact latching claw 54 is thereby pressed downwards and deforms elastically. When engaging indentation 112 reaches contact latching claw 54 upon further insertion, contact latching claw 54 enters into engaging indentation 112. At the same time, the respective partitioning walls 59 enter the respective notches 23 of flat cable 3. Piercing contacts 1 are thereby attached to connector housing 5 (flat cable 3 with piercing contacts is positioned inside connector housing 5) and flat cable 6 with connector is arranged.

[0050] In this case, through holes 111 of the respective piercing contacts 1 are matched with the respective contact inlets 52 along the longitudinal direction of piercing contacts 1. Flat cable 6 with connector is electrically connected, for example, to a wiring board 7 by being attached to a counterpart connector 8 that is fixed to wiring board 7. Counterpart connector 8 is not limited to that which is fixed to wiring board 7 and may instead be one that is attached to another cable.

[0051] Counterpart connector 8 is a female type connector including a housing 81, in which a fitting indentation 81a is formed for fitting of flat cable 6 with connector, and rod-like contacts 82 (male contacts) , which are protruded inside fitting indentation 81a of housing 81.

[0052] Flat cable 6 with connector is attached to counterpart connector 8 by inserting rod-like contacts 82 into contact inlets 52 and then into through holes 111 of piercing contacts 1. By a tip part of connector housing 5 fitting inside fitting indentation 81a of counterpart connector 8 in this process, connector housing 5 and housing 81 become joined and positioning among rod-like contacts 82 and piercing contacts 1 is achieved. Flat cable 2 is thereby electrically connected to wiring board 7 via piercing contacts 1 and rod-like contacts 82.

[0053] Though with the present embodiment, flat cable 2 was described as being an FFC (Flexible Flat Cable), other types of flat cables, such as an FPC (Flexible Printed Circuit) , may be used instead. Also, piercing contact 1 (4) may be a male contact and connector housing 5 may be a female housing. Furthermore, piercing part 12 (42) may have an arrangement, which lacks left and right side plate parts 125 and 126 (425 and 426) and with which the respective protrusions protrude from bottom plate part 121 (421).

[0054] Though embodiments of the present invention have been described in detail, these are merely specific examples used for clarifying the technical details of the present invention, and this invention should not be in-

terpreted in restriction to these specific examples, and the spirit and scope of the present invention are restricted only by the attached Claims.

[0055] The present Application corresponds to Japanese Patent Application No. 2003-375892, submitted to the Japan Patent Office on November 5, 2003, and the full disclosure of this Application is incorporated herein by reference.

Claims

1. A piercing contact (1, 4), electrically connected to a flat cable (2), the flat cable including a belt-like conductor (21) of predetermined width and an insulating sheath (22) covering the conductor (21), the piercing contact being **characterized by**:

a piercing part (12, 42) to be pierced through the belt-like conductor (21) to achieve electrical connection; and

a contact part (11), connected to the piercing part (12, 42), for electrically connecting the flat cable (2) to an electrical part;

the piercing part (12, 42) including: a bottom plate part (121, 421), having an elongated shape of narrower width than the width of the belt-like conductor (21) of the flat cable (2); a piercing protrusion (122, 422), erected from a side edge of the bottom plate part (121, 421) in a direction orthogonal to the longitudinal direction of the bottom plate part (121, 421), to be pierced through the belt-like conductor (21); and a contacting protrusion (123, 423), erected substantially parallel to the piercing protrusion (122, 422) at a side edge of the bottom plate part (121, 421) at an opposite side of the piercing protrusion (122, 422), to be pierced through the insulating sheath (22) of the flat cable (2) and to be put in contact with the belt-like conductor (21).

2. The piercing contact according to Claim 1, **characterized in that** the contacting protrusion (123) is erected from a position opposing the piercing protrusion (122) and, in a state in which the piercing contact (1, 4) is attached to the flat cable (2) by the piercing protrusion (122) being pierced through the flat cable (2) so as to be pierced through the belt-like conductor (21) and being bent towards a tip of the contacting protrusion (123), a tip part of the piercing protrusion (122) and a tip part of the contacting protrusion (123) oppose each other while clamping the belt-like conductor (21) or are pierced through the belt-like conductor (21) to contact each other to form clamping/contacting members.

3. The piercing contact according to Claim 2, **characterized in that** a plurality of the piercing protrusions (122) and a plurality of the contacting protrusions (123) are aligned alternately in the longitudinal direction of the bottom plate part (121) at one side edge and the other side edge of the bottom plate part (121), the piercing protrusions (122) and the contacting protrusions (123) are aligned so as to oppose each other in a width direction of the bottom plate part (121), and the piercing protrusions (122) and the contacting protrusions (123) are aligned in a staggered manner at the bottom plate part (121), respectively.

4. The piercing contact according to Claim 1, **characterized in that** the contacting protrusion (423) includes a pair of contacting protrusions (423), which are erected substantially parallel to the piercing protrusion (422) so as to form a trough part (424) that receives a tip part of the piercing protrusion (422) at a position opposing the piercing protrusion (422) and,

the tip part of the piercing protrusion (422) and the tip parts of the contacting protrusions (423) form penetrating members, which are respectively penetrated into the belt-like conductor (21) in a state in which the piercing contact (4) is attached to the flat cable (2) by the piercing protrusion (422) being pierced through the flat cable (2) so as to be pierced through the belt-like conductor (21) and being bent towards the trough part (424) between the pair of contacting protrusions (423).

5. The piercing contact according to Claim 4, **characterized in that** a plurality of the piercing protrusions (422) and a plurality of pairs of the contacting protrusions (423) are aligned alternately in the longitudinal direction of the bottom plate part (421) at one side edge and the other side edge of the bottom plate part (421), the piercing protrusions (422) and the trough parts (424) between adjacent pairs of contacting protrusions (423) are aligned so as to oppose each other in a width direction of the bottom plate part (421), and the piercing protrusions (422) and the pairs of contacting protrusions (423) are aligned in a staggered manner at the bottom plate part (421), respectively.

6. A flat cable (3) with piercing contact comprising: a piercing contact (1, 4) according to any of Claims 1 through 5; and a flat cable (2), to which the piercing contact (1, 4) is attached.

7. A flat cable (6) with connector comprising: the flat cable (3) with piercing contact according to Claim 6; and a connector housing (5), holding the piercing contact (1, 4).

8. A method of manufacturing a flat cable (3) with

piercing contact using the piercing contact according to Claim 2, the method comprising the steps of:

piercing the piercing protrusion (122) through the flat cable (2) so as to pierce it through the belt-like conductor (21); and 5
 bending and pressing the piercing protrusion (122) towards the tip of the contacting protrusion (123) to make the belt-like conductor (21) be clamped by the tip part of the piercing protrusion (122) and the tip part of the contacting protrusion (123) or to make the tip part of the piercing protrusion (122) and the tip part of the contacting protrusion (123) contact each other upon piercing them through the belt-like conductor (21) . 10 15

9. A method of manufacturing a flat cable (3) with piercing contact using the piercing contact according to Claim 4, the method comprising the steps of: 20

piercing the piercing protrusion (422) through the flat cable (2) so as to pierce it through the belt-like conductor (21); and
 bending and pressing the piercing protrusion (422) towards the trough part (424) between the pair of contacting protrusions to make the tip part of the piercing protrusion (422) and the tip parts of the pair of contacting protrusions (423) respectively penetrate into the belt-like conductor (21). 25 30

10. A method of manufacturing a flat cable (6) with connector comprising the steps of: preparing the flat cable (3) with piercing contact by the method according to Claim 8 or 9; and attaching the piercing contact (1, 4) to the connector housing (5). 35

11. A piercing contact (1, 4), adapted to be electrically connectible in use to a flat cable (2) which includes a belt-like conductor (21) of predetermined width and an insulating sheath (22) covering the conductor (21), the piercing contact comprising: 40

a piercing part (12, 42) for piercing through the belt-like conductor (21) to achieve electrical connection; and
 a contact part (11), connected to the piercing part (12, 42), for electrically connecting the flat cable (2) to an electrical part; 45 50
 the piercing part (12, 42) including: a bottom plate part (121, 421), having an elongate shape; a piercing protrusion (122, 422), extending from a side edge of the bottom plate part (121, 421) in a direction orthogonal to the longitudinal direction of the bottom plate part (121, 421), for piercing through the belt-like conductor (21); and a contacting protrusion (123, 423), 55

extending substantially parallel to the piercing protrusion (122, 422) at a side edge of the bottom plate part (121, 421) at an opposite side of the piercing protrusion (122, 422), for piercing through the insulating sheath (22) of the flat cable (2) for being put in contact with the belt-like conductor (21).

FIG. 1(a)

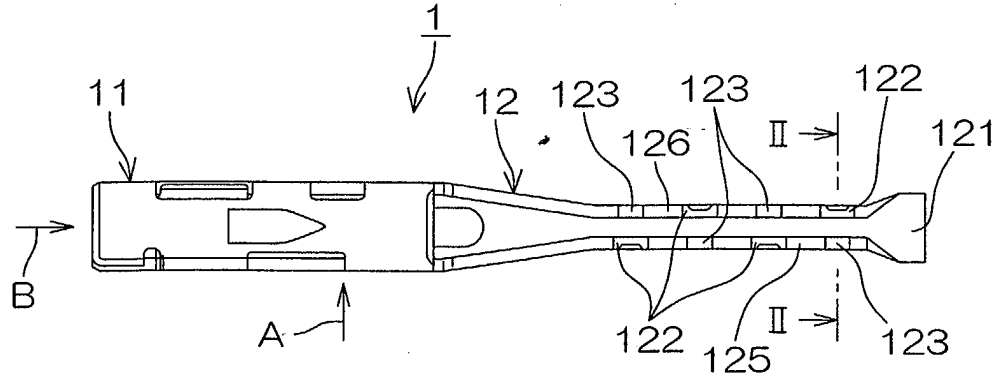


FIG. 1(b)

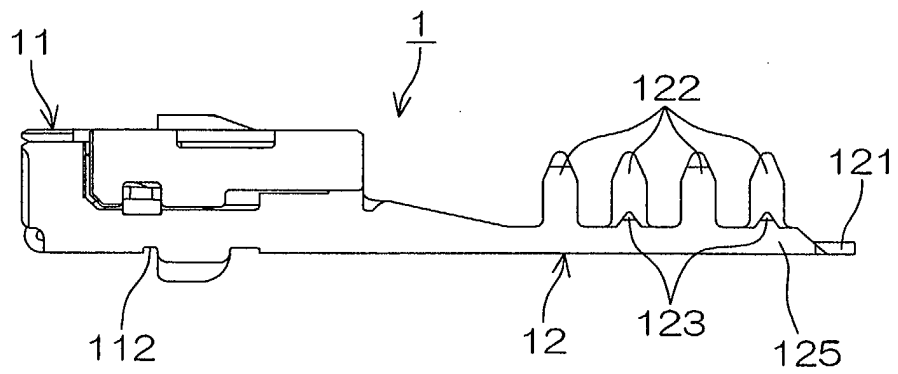


FIG. 1(c)

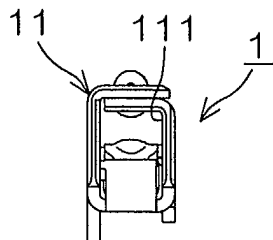


FIG. 2

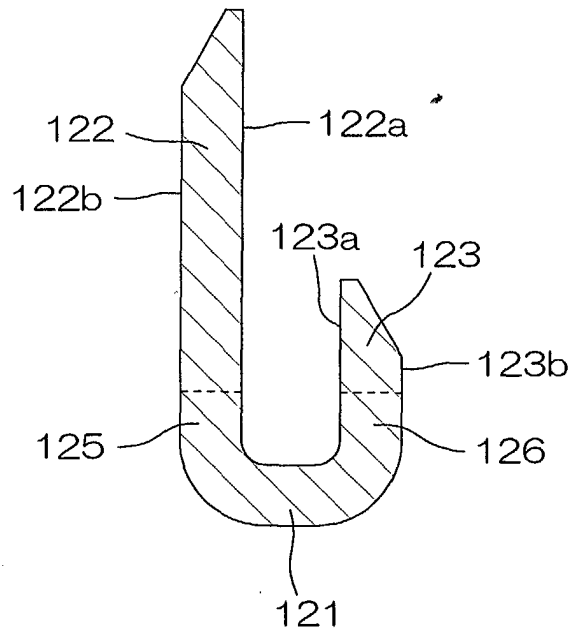


FIG. 3(a)

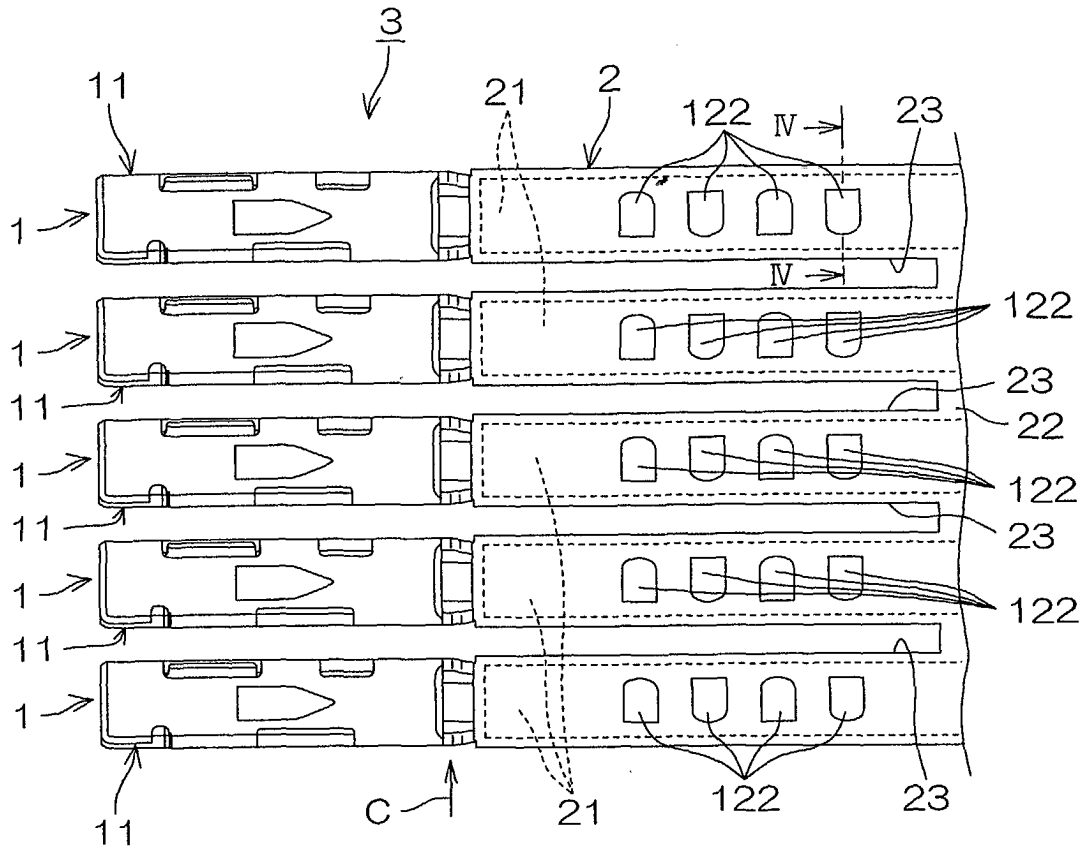


FIG. 3(b)

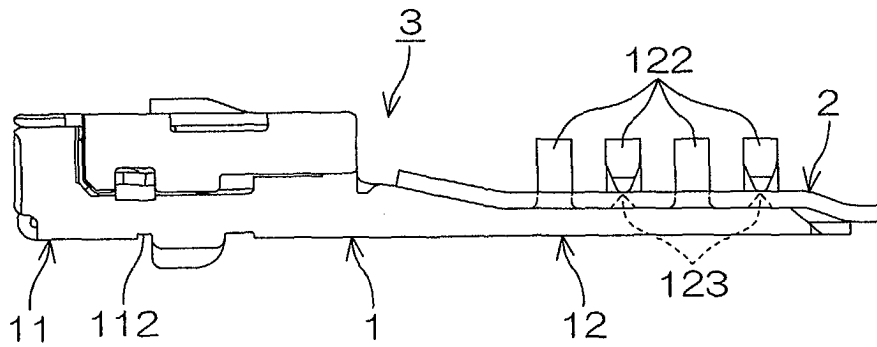


FIG. 4(a)

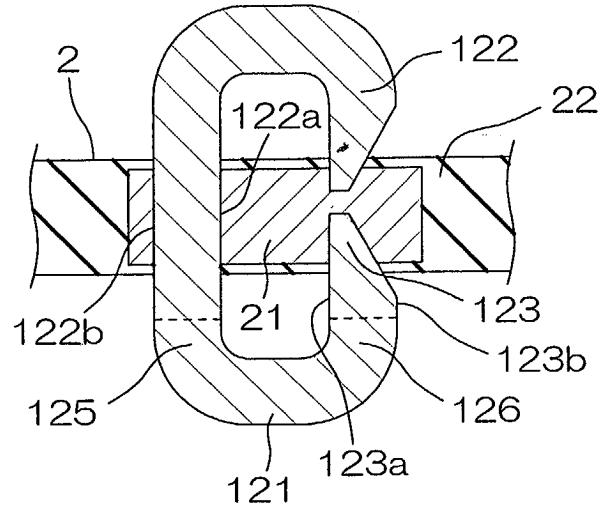


FIG. 4(b)

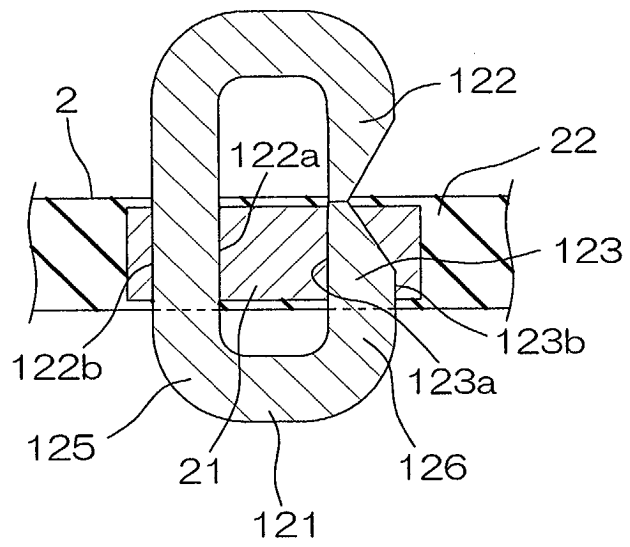


FIG. 5(a)

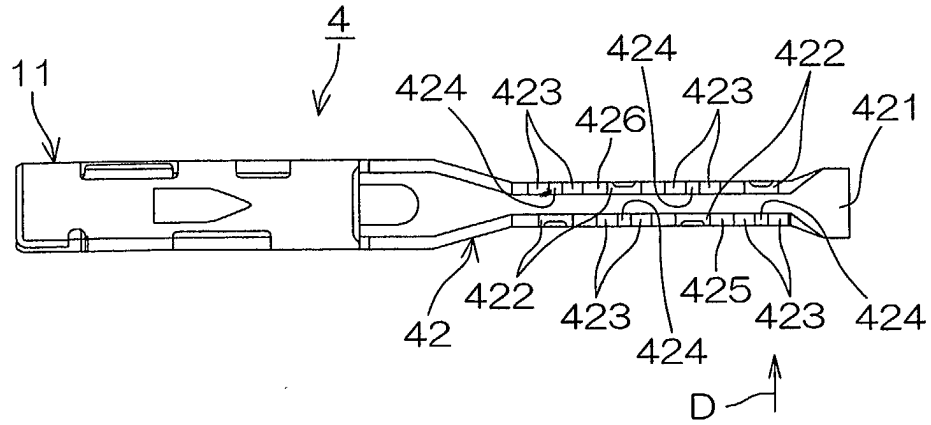


FIG. 5(b)

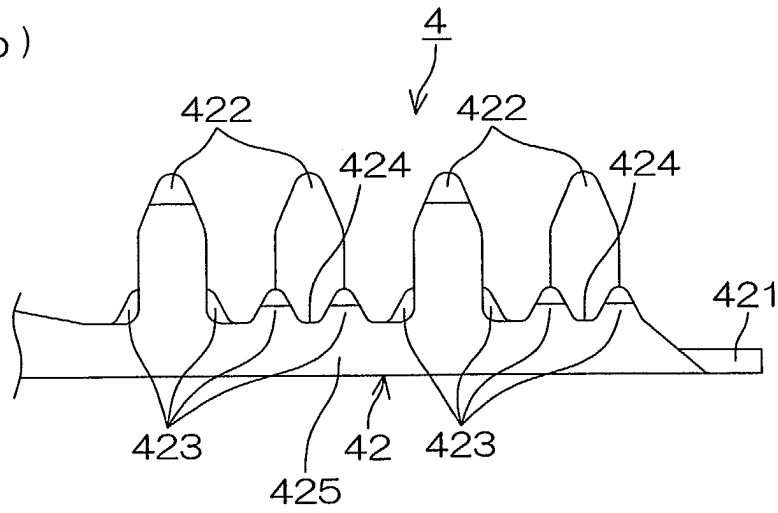


FIG. 5(c)

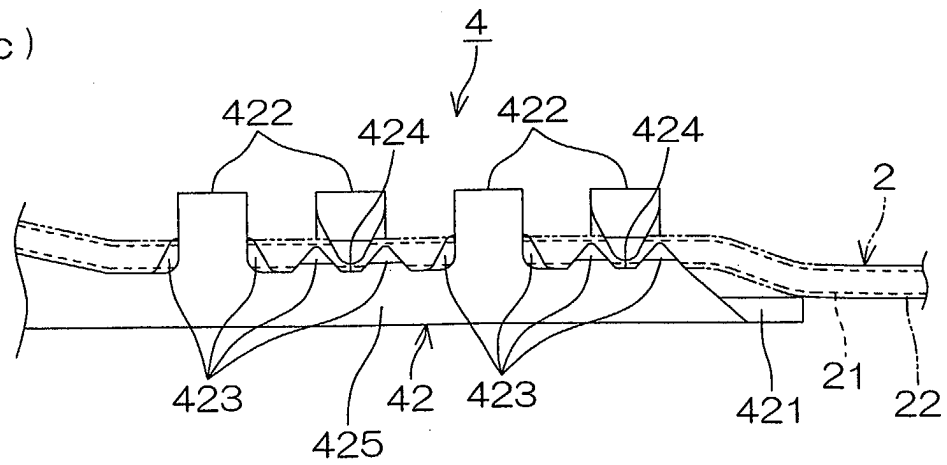


FIG. 6(a)

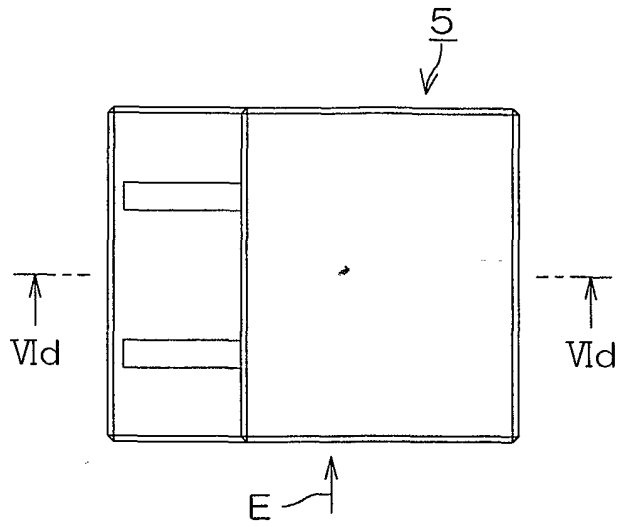


FIG. 6(b)

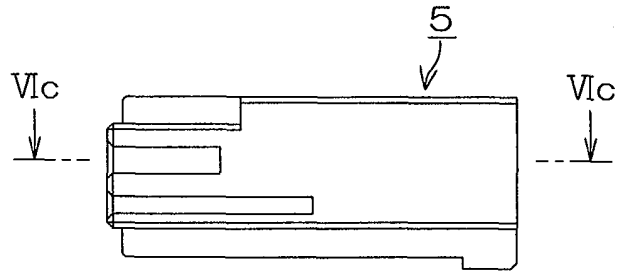


FIG. 6(c)

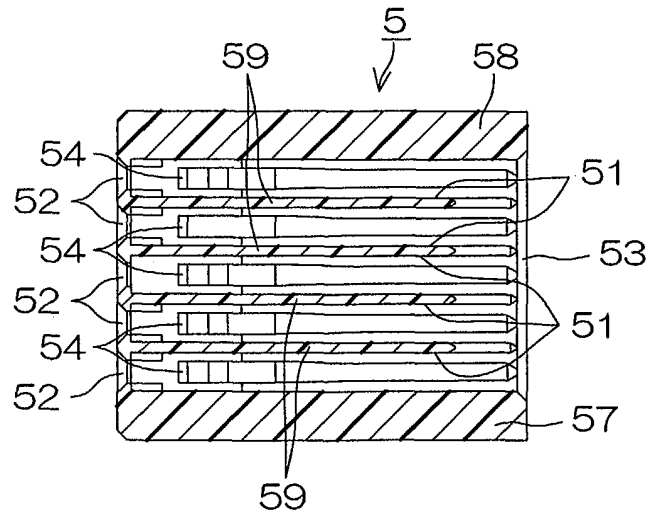


FIG. 6(d)

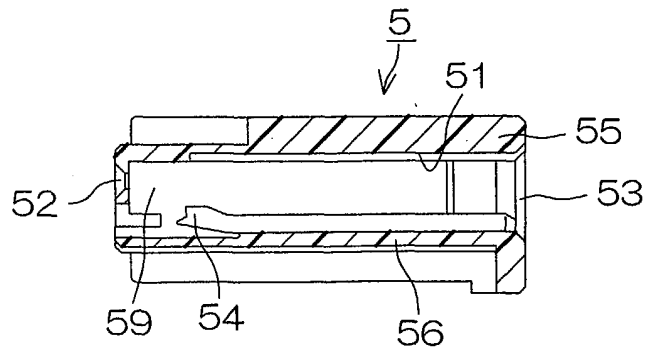


FIG. 7(a)

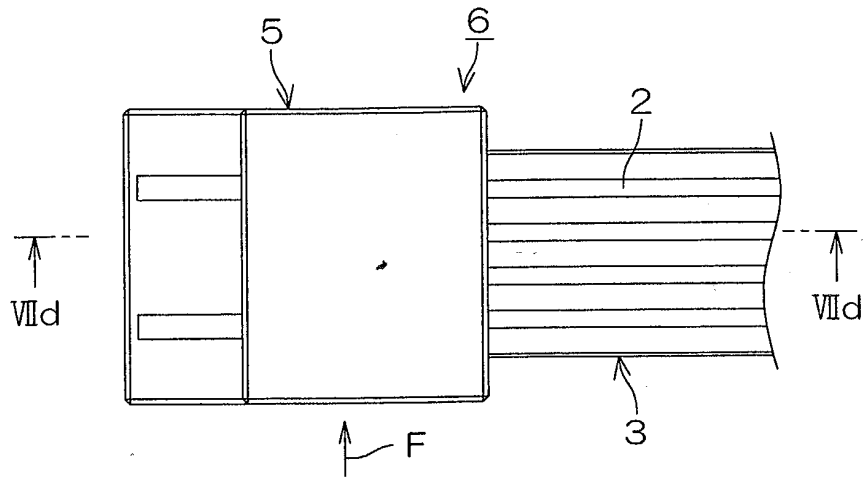


FIG. 7(b)

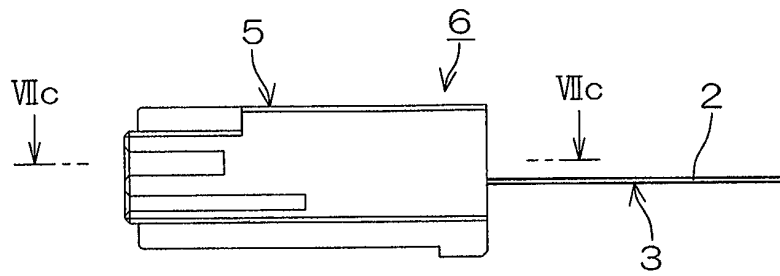


FIG. 7(c)

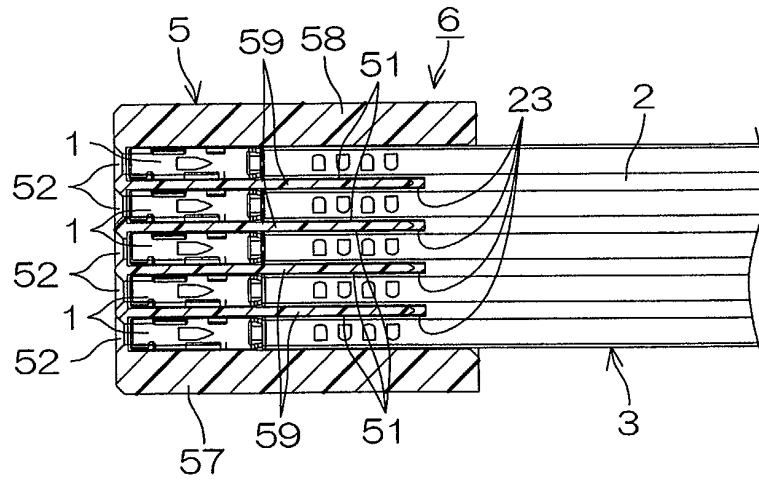
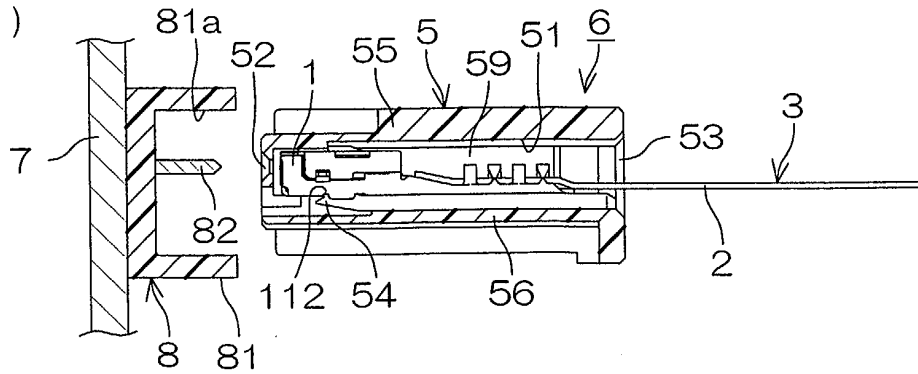


FIG. 7(d)





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X	US 2002/127905 A1 (ONUMA MASANORI) 12 September 2002 (2002-09-12) * paragraphs [0006], [0060], [0063]; figures 2-4 *	1,4,5,7, 9-11	
Y	-----	2,3,8	
X	US 4 066 319 A (BAKER ET AL) 3 January 1978 (1978-01-03) * column 6, line 7 - line 11 *	1,11	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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Place of search		Date of completion of the search	Examiner
Munich		3 February 2005	Garcia Congosto, M
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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