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(54) Electrical connector

(57) A connector (1) of the invention is connected to a battery (40) and has a connector housing (10) having contact retaining portions and a connection face that is brought close to the battery; and contacts constituted of a conductive plate-form body and having a fixing portion that is fixed to the connector housing by a contact retaining portion; a contacting portion that projects from the connection face and contacts with a conductive member of the counterpart unit; a resilient portion that is located between the fixing portion and the contacting portion and that biases the contacting portion so as to protrude from the connection face; and a latching portion that regulates the amount by which the contacting portion protrudes from the connection face. In the connection face of the connector housing there are provided contact support portions which protrude a certain distance from the connection face, and so that the latching portions are arranged to latch onto the contact support portions. Embodiments of the present technique can provide an electrical connector which has contacts that will have an adequate stroke displacement amount, and be able to contact with adequate contacting force, even in cases where the counterpart conductive members are located in a deep position.

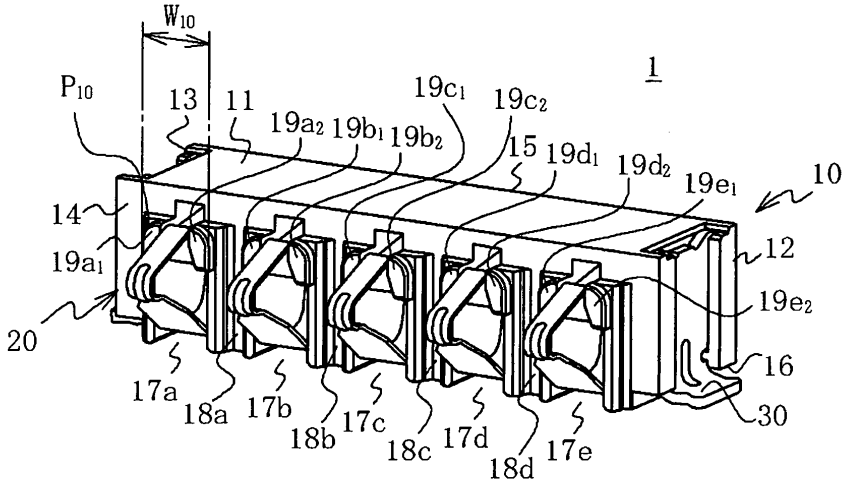

FIG.1

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Description

BACKGROUND

1. Technical Field

[0001] The present invention relates to electrical connectors. More particularly, the present invention relates to electrical connectors which include contacts that are installed in a connector housing and protrude therefrom, which is electrically connectable to a counterpart unit through press-connection of such contacts to conductive parts provided in the counterpart unit, and which can for instance be applied as a battery connector used in portable electronic equipment.

2. Related Art

[0002] In the related art, battery connectors used in portable electronic equipment such as mobile telephones are composed of a connector housing and contacts that protrude from the connection face thereof and possess bias force. When a battery's electrodes are pressed against the contacts, the contacts are displaced, against their bias force, and a connected state is maintained by means of the contacting force generated by the bias force.

[0003] Fig. 6 is an exterior perspective view illustrating an example of a battery connector of the related art that has long been in use. Fig. 7 gives cross-sectional views of the battery connector in Fig. 6, Fig. 7A being a cross-sectional view illustrating the unconnected state, and Fig. 7B being a cross-sectional view illustrating the connected state. As Fig. 6 shows, the connector 600 is composed of a connector housing 610 and contacts 620. In the front face 614 of the connector housing 610, which is the connection face, there are provided multiple openings 617 that are separated by multiple partitioning walls 618. The interior of the connector housing 610 is partitioned by the partitioning walls 618 into separate contact housing spaces that house the contacts 620. As Fig. 7 shows, the contacts 620 are constituted of a piece of conductive metallic sheet material and composed of a fixing portion 621 that is fixed to the connector housing 610, a resilient portion 622 that is endued with bias force by being bent into an approximate S-shape, a contacting portion 623 that has a curved contacting part, and a latching portion 624 that is bent into a hook shape and is provided at the opposite end of the contact 620 to the end where the fixing portion 621 is provided. Through the openings 617, the contacting portions 623 protrude forward from the front face 614 of the connector housing 610. The upper portions of the connector housing 610's partitioning walls 618 widen out, rendering the upper portions of the openings 617 narrow, and such narrowed portions latch with the latching portions 624, thereby regulating the amount by which the contacting portions 623 protrude from the front face 614.

[0004] When a battery (secondary battery) 640 is connected to the connector 600, the pressing force brings the electrodes 650 disposed at the innermost part of the hollows 647 provided in the connection face 645 of the battery 640 into contact with the contacting portions 623 of the contacts 620, and the shape of the contacts 620 is changed at the resilient portions 622, against the bias force, so that the contacting portions 623 are displaced toward the connector housing 610 (see Fig. 7B). The larger the stroke displacement amount of the contacting portions 623, the greater will be the contacting force between the contacting portions 623 and the electrodes 650. Therefore, an issue in the related art has been how to increase the stroke displacement amount of the contacting portions 623.

[0005] Accordingly, the connector disclosed in JP-A-2005-129374, which can be rendered compact and effects good contacting, has contacts possessing a retained portion, a contacting portion, and an elastic deformation portion, with the elastic deformation portion forming, between the retaining portion and contacting portion, an approximate S-shape composed of a first curved portion, a connecting portion and a second curve portion that are joined together in the order given, and with a displacement regulating protrusion being formed on the connecting portion. In the inner wall of the connector's contact housing chamber, displacement regulating engagement slots are provided that engage with the displacement regulating protrusions. When the contacts and battery pack are connected by being pushed together from opposite directions, the displacement of the contacts' elastic deformation portions is regulated by the engagement action of the displacement regulating protrusions and displacement regulating engagement slots. Thereby, the displacement amount of the second curved portions is restricted, which enables compactness, and moreover, the displacement amount of the contacting portions can be rendered large.

[0006] Fig. 8, similarly to Fig. 7, gives cross-sectional views of battery connectors of the related art, Fig. 8A being a cross-sectional view illustrating the state prior to connection to a battery with electrodes located in a deep position, Fig. 8B being a cross-sectional view illustrating the state where, to obtain an adequate stroke amount, the battery connector in Fig. 8A is forcibly connected to the battery in such a manner as to interfere therewith, and Fig. 8C being a cross-sectional view illustrating a battery connector in which, to obtain an adequate stroke amount, the amount by which the contacting portions protrude from the connector housing is increased.

[0007] In the battery connectors of the related art described above, provided that the electrodes 650 of the battery 640 are relatively proximate to the front face of the connector, adequate bias force and contacting force is obtained and hence a good state of conduction is assured. However, there is the problem that the position in which the electrodes are formed varies widely with the battery used, and if the battery connectors of the related

art described above are connected to a battery with electrodes in a position distanced from the battery's connection face, or in other words, to a battery in which the hollows where the electrodes are formed are relatively deep-set (see Fig. 8A), the contacting portions' stroke amount will be inadequate and they will not be able to contact with the battery's electrodes with adequate bias force, which will result in poor contacting or other fault.

[0008] Thus, to obtain an adequate stroke amount for the contacting portions 623 of the connector 600, it is necessary to shift the battery 640 toward the connector 600 by a certain distance. However, if one attempts to secure such shift distance with the connector 600 of the related art, one will have to shift the battery 640 to a position where the connection face 645 thereof and the connector housing 610 of the connector 600 interfere, which is practically impossible (see Fig. 8B).

[0009] It is possible, as in the connector 600' shown in Fig. 8C, to obtain an adequate stroke amount by lengthening the contacting portions 623 of the contacts 620' so as to increase the amount of the projection from the front face 614 of the connector housing 610, but as a result the conductive metallic plate material forming the contacts 620' will be longer and the strength thereof lessened, besides which, to the extent that they project from the connector housing 610, the contacts 620 will be vulnerable to external forces, and so liable to become deformed or damaged.

SUMMARY

[0010] An advantage of some aspects of the present invention is to provide an electrical connector that has contacts that have an adequate stroke displacement amount, and are able to contact with adequate contacting force, even in cases where the conductive members of the counterpart unit - such as the electrodes of a battery - are located in a deep position.

[0011] Another advantage is to provide an electrical connector whose contacts exhibit adequate strength with regard to external forces.

[0012] According to an aspect of the invention, an electrical connector that is connected to a counterpart unit having hollows formed to a certain depth in a face of the casing thereof and provided with conductive members at the innermost part of such hollows, the electrical connector includes: a connector housing having contact retaining portions and a connection face that contacts with the counterpart unit; and contacts constituted of a conductive plate-form body and having: a fixing portion that is fixed to the connector housing by one of the contact retaining portions; a contacting portion that projects from the connection face and contacts with one of the conductive members; a resilient portion that is located between the fixing portion and the contacting portion and that biases the contacting portion so as to protrude from the connection face; and a latching portion that regulates the amount by which the contacting portion protrudes from the connection face. Such electrical connector has the innovative feature that in the connection face of the connector housing there are provided contact support portions which protrude a certain distance from the connection face and onto the contact support portions the latching portions latch.

[0013] With the electrical connector of such aspect, thanks to the connection face of the connector housing being provided with contact support portions that project a certain distance therefrom and latch with the latching portions, the position at which the latching portions latch is shifted further forward than in the related art, thereby enabling the contacting portions to be disposed further forward relative to the connection face, virtually without changing the length of the metallic material. Also, the fact that the contact support portions protrude from the connection face means that the contacting portions can be protected from external forces. Thus, the amount by which the contacts protrude from the connection face of the connector housing is increased without increasing the portion of the contacts that is not shielded by the connector housing. Thereby, the contacts can be connected to the conductive members (electrodes) of the battery or other counterpart unit with an adequate stroke amount even in cases where the counterpart unit's hollows are formed to be relatively deep-set. Thus, reliable connection is enabled. Also, a part of the portion of the contacts that is not shielded by the connector housing is protected by the contact support portions, with the result that deformation, degradation or damage of the contacts by external forces when the device is not in use can be prevented.

[0014] In such electrical connector, preferably there will be openings formed in the connection face of the connector housing, and the contact support portions will be so formed as to protrude from the vicinity of such openings.

[0015] With such preferred mode, openings are formed in the connection face of the connector housing, and the contact support portions are formed so as to protrude from the vicinity of such openings. Thereby, it will be possible to install the contacts into the connector housing interior through the openings, and no hindrance will be posed by the contact support portions during such installation. Also, if the contact support portions are provided at the sides of the openings, deformation of the contacts due to external - especially lateral - forces can be satisfactorily curbed.

[0016] Also, in such electrical connector, the contact support portions will preferably be so shaped as to be inserted into the hollows in the counterpart unit upon connection to the counterpart unit.

[0017] With such preferred mode, the contact support portions are formed in shapes corresponding to the shape of the counterpart unit, and therefore, upon connection, the contact support portions will be received into the corresponding hollows in the counterpart unit, and even if counterpart unit's conductive members are locat-

ed in a deep position in the hollows, the contacts will contact against the conducting members with an adequate stroke, so that connection will be reliably effected.

[0018] Also, preferably the counterpart unit will be a secondary battery and the electrical connector will be a battery connector.

[0019] With such preferred mode, it will be possible to provide a battery connector that, through adequate stroke and bias force, will effect reliable connection even with a battery whose electrodes (conductive members) are located in deep positions. This can prevent occurrence of power failures due to poor contacting with the power source during use of portable electronic equipment and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Embodiments of the invention will now be described with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Fig. 1 is an exterior perspective view of a battery connector in an embodiment of the invention.

Fig. 2 gives other views of the battery connector in Fig. 1, Fig. 2A being a plan view, Fig. 2B a front view, Fig. 2C a bottom view, Fig. 2D a left side view and Fig. 2E a right side view thereof.

Fig. 3 is a cross-sectional view along line III - III in Fig. 2.

Fig. 4 is an exterior perspective view illustrating main elements of a battery to which the battery connector in Fig. 1 is connected.

Fig. 5 gives views illustrating connection of the battery connector of the embodiment to the battery, Fig. 5A being a cross-sectional view of the unconnected state, and Fig. 5B being a cross-sectional view of the connected state.

Fig. 6 is an exterior perspective view illustrating an example of a battery connector of the related art that has long been in use.

Fig. 7A is a cross-sectional view illustrating the unconnected state of the battery connector in Fig. 6, and Fig. 7B is a cross-sectional view illustrating the connected state thereof.

Fig. 8A is a cross-sectional view illustrating the state prior to connection to a battery having electrodes located in a deep position, Fig. 8B is a cross-sectional view illustrating the state where the battery connector in Fig. 8A is connected to the battery in such a manner as to interfere therewith, and Fig. 8C is a cross-sectional view illustrating a battery connector in which the amount by which the contacting portions protrude from the connector housing is increased.

DESCRIPTION OF EXEMPLARY EMBODIMENT

[0021] An exemplary embodiment of the present invention will now be described with reference to the accompanying drawings. It should however be understood that the following embodiment is intended by way of an example of a battery connector serving as an instance of an electrical connector that carries out the technical concepts of the invention, not by way of limiting the invention to this particular battery connector. The invention can equally well be adapted by those skilled in the art to yield other embodiments within the scope and spirit of the claims.

First Embodiment

[0022] To begin with, a battery connector in an embodiment of the invention is described with reference to Figs. 1 to 3. Fig. 1 is an exterior perspective view of the battery connector of the embodiment, Fig. 2 gives other views of the battery connector in Fig. 1, Fig. 2A being a plan view, Fig. 2B a front view, Fig. 2C a bottom view, Fig. 2D a left side view and Fig. 2E a right side view thereof, while Fig. 3 is a cross-sectional view along line III - III in Fig. 2.

[0023] A battery connector 1 of this embodiment is composed of a connector housing 10 and multiple contacts 20 installed inside the connector housing 10. In the example used here, five identically shaped contacts are installed in the connector housing 10.

[0024] The connector housing 10 takes the form of a rectangular solid composed of a top face 11, left and right faces 12, 13, a front face 14, a rear face 15 and a bottom face 16. In the interior thereof is formed a contact housing space 101 for housing the contacts 20 (see Fig. 3). The front face 14 of the connector housing 10 constitutes a connection face for connection with a battery 40 which is the counterpart unit.

[0025] In the front face 14 of the connector housing 10 there are provided multiple openings 17a to 17e that communicate with the contact housing space 101 in the interior of the connector housing 10. The openings 17a to 17e are separated by partitioning walls 18a to 18d provided therebetween. These partitioning walls 18a to 18d connect the front face 14 and rear face 15 inside the connector housing 10, and form the contact housing space 101 into separate spaces. These separate contact housing spaces 101 each house a contact 20.

[0026] In an upper location on both sides of the openings 17a to 17e in the front face 14, contact support portions $19a_1$, $19a_2$ to $19e_1$, $19e_2$ (denoted by the numeral "19" when referred to collectively below) are provided so as to protrude forward from the front face 14. These contact support portions 19 are formed in left-right symmetrical pairs at the two sides of each opening 17a to 17e. Thus, the contact support portions $19a_1$ and $19a_2$ are provided at the two sides of the opening 17a, and likewise the contact support portion pairs 19bi and $19b_2$ to $19e_1$ and $19e_2$ are provided at the two sides of the openings

17b to 17e respectively.

[0027] The sides of the contact support portions 19 formed on both sides of the openings 17a to 17a widen out in the direction of the opening 17a to 17e to which each is proximate, and the latching portions 24 of the contacts 20 latch onto such widened portions.

[0028] A distance W_{10} from the right edge to the left edge of each pair of contact support portions 19 provided at an opening 17 is made slightly smaller than a width W_{40} of hollows 47 provided in a connection face 45 of the battery 40 to be described hereafter. Also, the contact support portions 19 have a contour P_{10} which is shaped so as to be received onto an inner surface P_{40} of the hollows 47 in the battery 40. It should be noted that although in the foregoing the contact support portions 19 are described as being formed at both sides of the openings 17a to 17e, they could alternatively be provided at only one side thereof.

[0029] On the inside surface of the rear face 15 of the connector housing 10 there are provided latching means, not shown in the drawings, which are able to retain retained portions 21b of fixing portions 21 of the contacts 20 to be described hereafter.

[0030] The contacts 20 are composed of the fixing portion 21, a resilient portion 22, a contacting portion 23 and the latching portion 24.

The fixing portion 21 of the contacts 20 has at its rear end a contact tail 21a that extends horizontally and is both physically and electrically connected to a printed wiring board (not shown in the drawings) on which the bottom face 16 of the connector housing 10 is placed, and has also the retained portion 21b that is bent vertically upward from the contact tail 21a and extends upward. The retained portion 21b is provided with a latching member or the like attaching structure, not shown in the drawings, which, by latching with the latching means formed on the inside surface of the connector housing 10's rear face 15, fixes the contact 20 to the connector housing 10.

[0031] The resilient portion 22 of the contacts 20 has: a first curved portion 22a that curves in a U-shape from the top extremity of the fixed portion 21; a first connecting portion 22b that extends downward from the first curved portion 22a; a second curved portion 22c that curves in a horizontal and forward direction from the bottom extremity of the first connecting portion 22b; a second connecting portion 22d that extends horizontally forward from the forward extremity of the second curved portion 22c; a third curved portion 22e that curves obliquely upward from the forward extremity of the second connecting portion 22d; and an extension 22f that extends obliquely forward and upward from the forward extremity of the third curved portion 22e. Through such structure, the resilient portion 22 forms an approximate S-shape and the contact 20 is able to generate adequate bias force in the forward-backward direction.

[0032] The contacting portion 23 of the contacts 20 takes the form of an approximate U-shape, or of an arc, that starts at the forward extremity of the resilient portion 22's extension 22f and curves rearward, the curved surface thereof constituting a contacting part 23a. The contacting portion 23's contacting part 23a and vicinity are narrower than the other parts thereof.

[0033] The latching portion 24 of the contacts 20 is formed by the metallic material beyond the end of the contacting portion 23 being folded back and downward. This latching portion 24 latches onto the contact support portion 19.

[0034] The contacts 20 are inserted into the contact housing spaces 101 through the openings 17 formed in the front face 14 of the connector housing 10, and are fixed to the connector housing 10 by latching of the retained portions 21b of the fixing portions 21 with latching members or the like (not shown in the drawings) that are provided on the inside surface of the connector housing 10's rear wall 15, or in a like location. The extension 22f of the contact 20's resilient portion 22 protrudes forward beyond the connector housing 10's front face 14, so that the contacting parts 23a of the contacting portions 23 are located to the front of the connector housing 10 when the device is not in use. Also, as Fig. 3 shows, the latching portions 24 latch onto the contact support portions 19 which are formed protruding from the front face 14. Thereby, deformation and deterioration/damage of the contacts 20 will be prevented if external forces should act on the contacting portions 23 when the device not in use.

[0035] Compared with the related art connector 600, the contacting portions 23 of the contacts 20 protrude further forward from the connector housing 10's front face 14 by the amount that the connector housing 10's contact support portions 19 protrude. However, due to the provision of the contact support portions 19, the portion of the contacts 20 that is not shielded by the connector housing 10 does not differ from that in the related art connectors, and consequently the contacts 20 are not liable to be deformed by external forces.

[0036] Further, in the side faces 12, 13 of the connector housing 10 there are formed recesses into which L-shaped gland terminals 30 are inserted. The gland terminals 30 enable gland connection of the connector housing 10, and are also used to fix the connector housing 10 robustly to a printed wiring board (not shown in the drawings).

[0037] In the foregoing the connector housing 10 is described as being provided with five openings 17a to 17e into which five contacts 20 are fitted, but the number of contacts can be altered as appropriate. For instance, three openings could be formed in the connector housing 10, and three contacts 20 fitted thereinto.

[0038] Next will be described the operation of connecting the battery connector 1 of the present embodiment to a battery constituting the counterpart unit. Fig. 4 is an exterior perspective view illustrating the main elements of a battery to which the battery connector of the present embodiment is connected.

[0039] The battery 40 takes the form of a rectangular solid composed of a top face 41, a bottom face 42, side faces 43, 44, the connection face 45 and a rear face 46. Multiple hollows 47 are formed in particular positions in the connection face 45. In Fig. 4, five hollows 47a to 47e are formed, corresponding to the connector 1 shown in Figs. 1 and 2. In the inner recesses of each hollow there is provided an electrode 50 (50a to 50e) serving as conductive member of the counterpart unit. Each hollow 47 has a width W_{40}. Also, each hollow 47 has a streamlined inner surface P_{40}.

[0040] Fig. 5 gives views illustrating connection of the battery connector of the first embodiment to the battery, Fig. 5A being a cross-sectional view of the unconnected state and Fig. 5B being a cross-sectional view of the connected state. In the unconnected state of the battery connector 1 and battery 40, as Fig. 5A shows, the contacting parts 23a of the contacting portions 23 of the contacts 20 in the battery connector 1 protrude forward from the front face 14 of the connector housing 10, due to bias force generated by the first, second and third curved portions 22a, 22c and 22e. Also, the latching portions 24 of the contacts 20 are latched onto the inside of the contact support portions 19, and the contacts 20 are protected from external forces by the contact support portions 19.

[0041] When the battery connector 1 and battery 40 are connected, as Fig. 5B shows, the hollows 47 in the battery 40 receive the contacting portions 23 of the battery connector 1's contacts 20, and the battery 40 is brought close to the battery connector 1 so that the contacting parts 23a contact against the electrodes 50. When, in that state, the battery 40 is shifted further toward the connector 1, rearward pushing force is applied to the contacting parts 23a of the contacting portions 23 by the electrodes 50, and the resilient portions 22 of the contacts 20 change shape, against the bias force, at the first, second and third curved portions 22a, 22c and 22e, as a result of which the contacting parts 23a move rearward, and moreover move upward over the surface of the electrodes 50, so that the contacting parts 23a and the surfaces of the electrodes 50 contact tightly against each other with an adequate wiping action. Also, at this time, the connection face 45 of the battery 40 and the front face 14 of the connector housing 10 becomes close to each other. Further, since the width W_{10} between the two lateral extremities of each pair of contact support portions 19 is smaller than the width W_{40} of the hollows 47 in the battery 40, and the contour P_{10} of the contact support portions 19 is formed to correspond to the shape of the inner surface P_{40} of the hollows 47, the contact support portions 19 fit securely into the hollows 47 in the battery 40.

[0042] Thus, by providing the connector housing 10 with contact support portions 19 that protrude from the front face 14, each contacting portion 23 of the contacts 20 is protected by a pair of contact support portions 19, so that deformation of the contacts 20 due to external forces during use of the device is prevented. Additionally, since the contact support portions 19 protrude from the front face 14 of the connector housing 10, the contacting portions 23 can be made to protrude further forward by the same amount. With such structure that enables the contacting portions 23 to protrude further forward, even if the electrodes 50 provided at the innermost part of the hollows 47 in the battery 40 are located in a position deeper than the connection face 45 of the battery 40, the contacting portions 23 will contact the electrodes 50 with an adequate stroke and there will be a good degree of tight contacting between the electrodes 50 and the contacting parts 23a.

[0043] Also, since the contact support portions 19 are formed with a shape corresponding to that of the hollows 47 of the battery 40, upon connection the contact support portions 19 are introduced into the hollows 47. Thereby, the contacting portions 23 are able to obtain a stroke displacement amount adequate to contact the electrodes 50, without the battery 40 interfering with the connector housing 10.

Industrial Applicability

[0044] The battery connector described in the foregoing embodiment of the invention can be applied as a connector that connects batteries used in portable electronic equipment such as mobile telephones. Also, besides such battery connectors, the invention will also be advantageously applied as a connector for connection with a counterpart unit in which the conductive members are disposed in a position deeply recessed from the housing connection face of the counterpart unit.

Various modifications may be made to the embodiment of the invention herein before described without departing from the scope of the present invention.

Various further aspects and features of the present invention are defined in the appended claims.

Further aspects include an electrical connector that is connected to a counterpart unit. An electrical connector that is connectable to a counterpart unit having hollows formed to a certain depth in a face of the casing thereof and provided with conductive members at the innermost part of such hollows, the electrical connector comprising:

a connector housing having contact retaining portions and a connection face that comes into close proximity with the counterpart unit; and

contacts constituted of a conductive plate-form body and comprising: a fixing portion that is fixed to the connector housing by one of the contact retaining portions;

a contacting portion that projects from the connection face and contacts with one of the conductive members;

a resilient portion that is located between the fixing portion and the contacting portion and that biases the contacting portion so as to protrude from the connection face; and

a latching portion that regulates the amount by which the contacting portion protrudes from the connection face;
in the connection face of the connector housing there being provided contact support portions which protrude a certain distance from the connection face, and with the effect that the latching portions can latch onto the contact support portions

Claims

1. An electrical connector that is connectable to a counterpart unit having hollows formed to a certain depth in a face of the casing thereof and provided with conductive members at the innermost part of such hollows, the electrical connector comprising:

    a connector housing having contact retaining portions and a connection face that comes into close proximity with the counterpart unit; and
    contacts constituted of a conductive plate-form body and comprising:

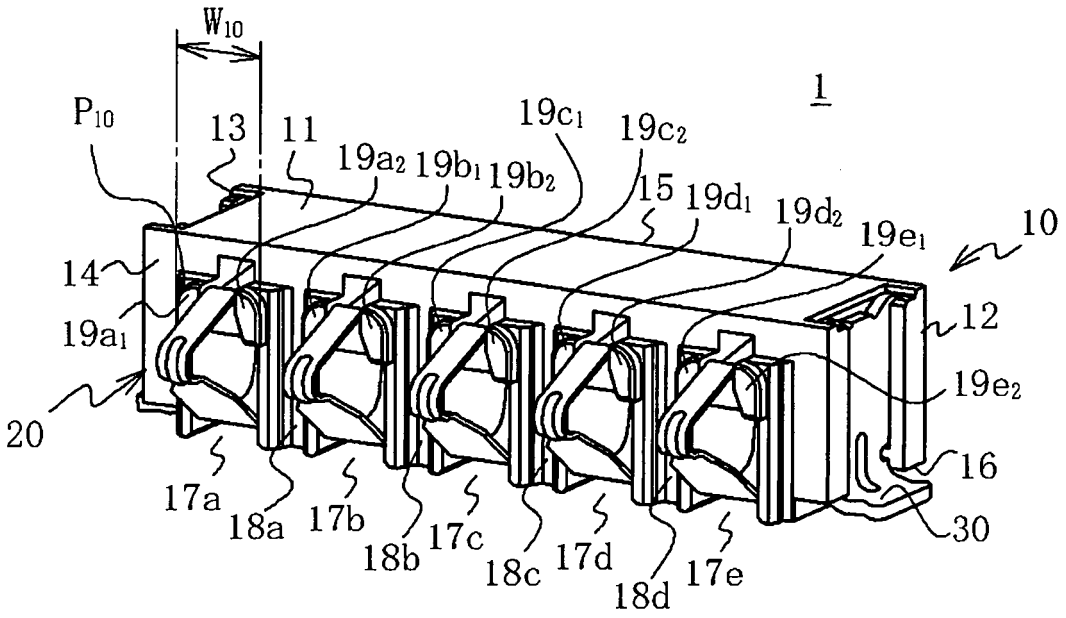
        a fixing portion that is fixed to the connector housing by one of the contact retaining portions;
        a contacting portion that projects from the connection face and contacts with one of the conductive members;
        a resilient portion that is located between the fixing portion and the contacting portion and that biases the contacting portion so as to protrude from the connection face; and
        a latching portion that regulates the amount by which the contacting portion protrudes from the connection face;

    in the connection face of the connector housing there being provided contact support portions which protrude a certain distance from the connection face, and onto the contact support portions the latching portions latch.

2. The electrical connector according to claim 1, wherein openings are formed in the connection face of the connector housing, and the contact support portions are so formed as to protrude from the vicinity of the openings.

3. The electrical connector according to claim 1, wherein the contact support portions are so shaped as to be inserted into the hollows in the counterpart unit upon connection to the counterpart unit.

4. The electrical connector according to claim 1, wherein the counterpart unit is a secondary battery and the electrical connector is a battery connector.


W10
P10
13
11
19a2
19b1
19b2
19c1
19c2
15
19d1
19d2
19e1
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10
14
19a1
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17a
18a
17b
18b
17c
18c
17d
18d
17e

FIG.1

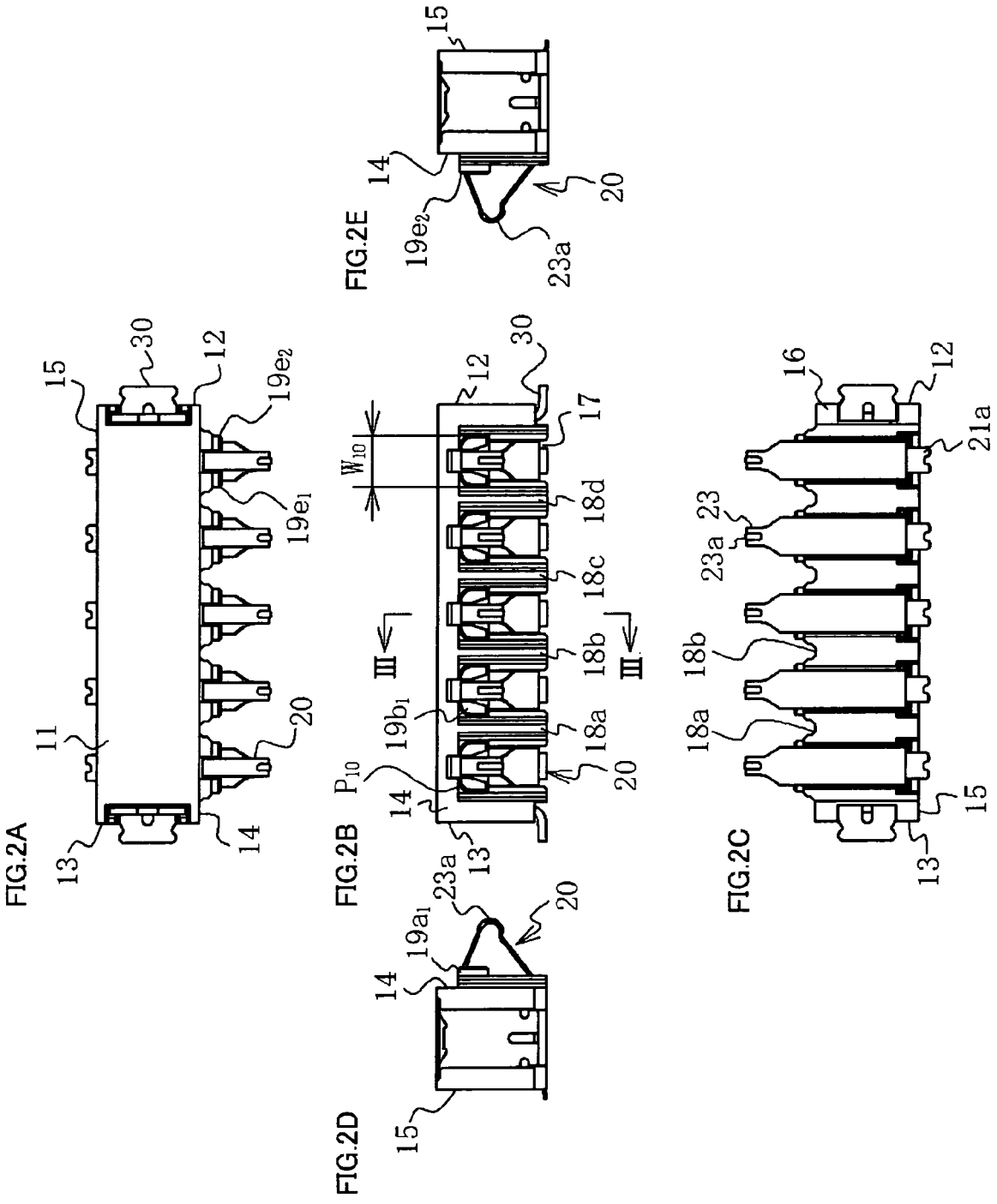
FIG.2A
15
30
12
19e2
19e1
11
20
13
14
FIG.2B
30
12
17
W10
18d
18c
18b
18a
III
III
19b1
P10
14
20
13
23a
FIG.2C
16
12
21a
23
23a
18b
18a
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FIG.2D
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19e2
23a

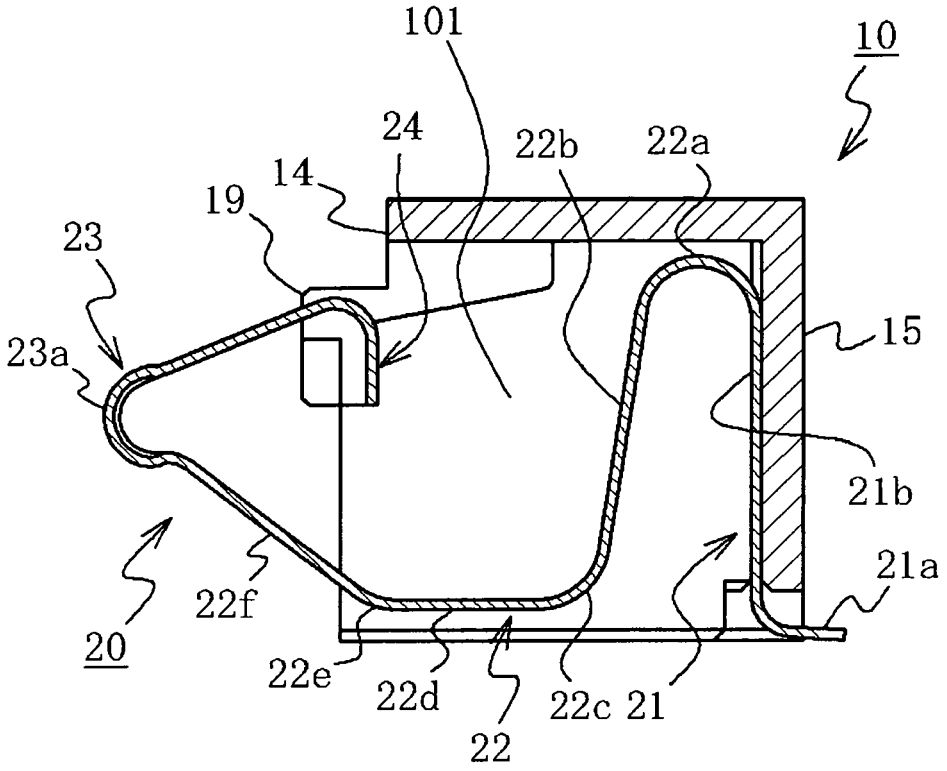
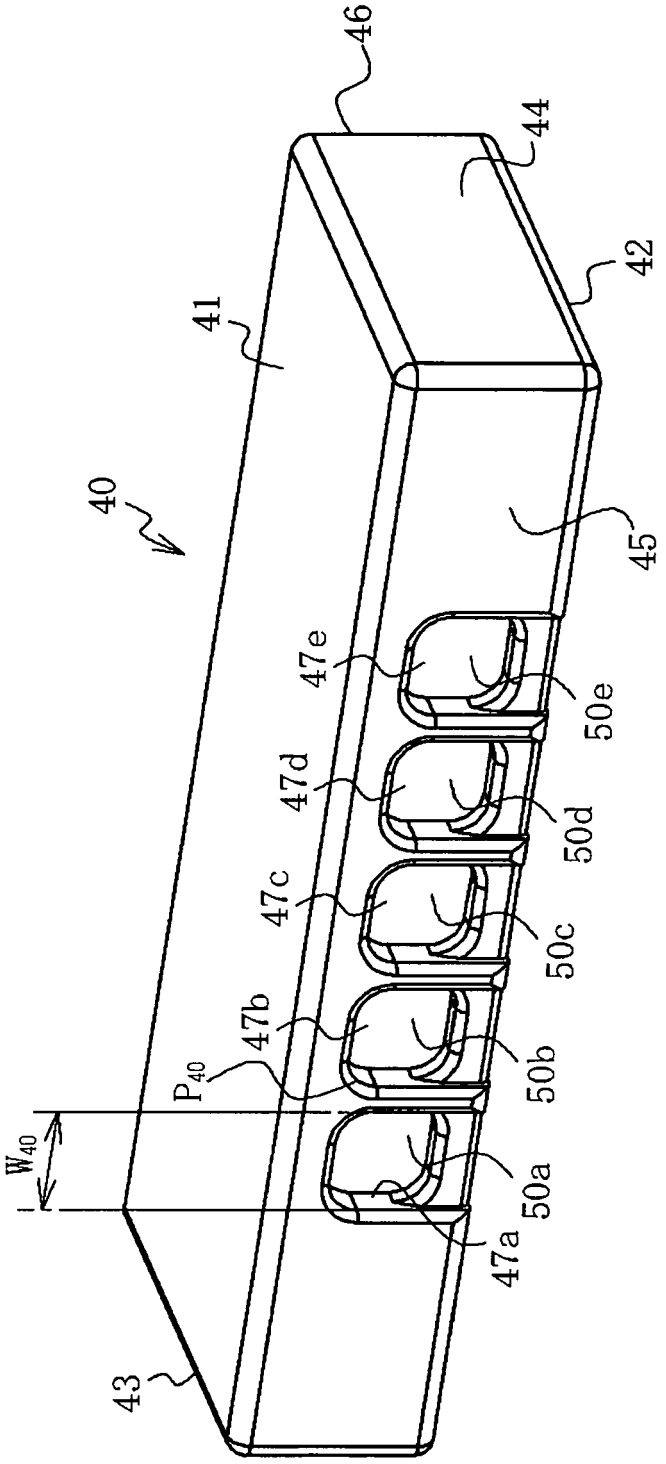


FIG.3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40
45
47e
50e
47d
50d
47c
50c
47b
50b
P_{40}
W_{40}
50a
47a
43

FIG.4

FIG.5A

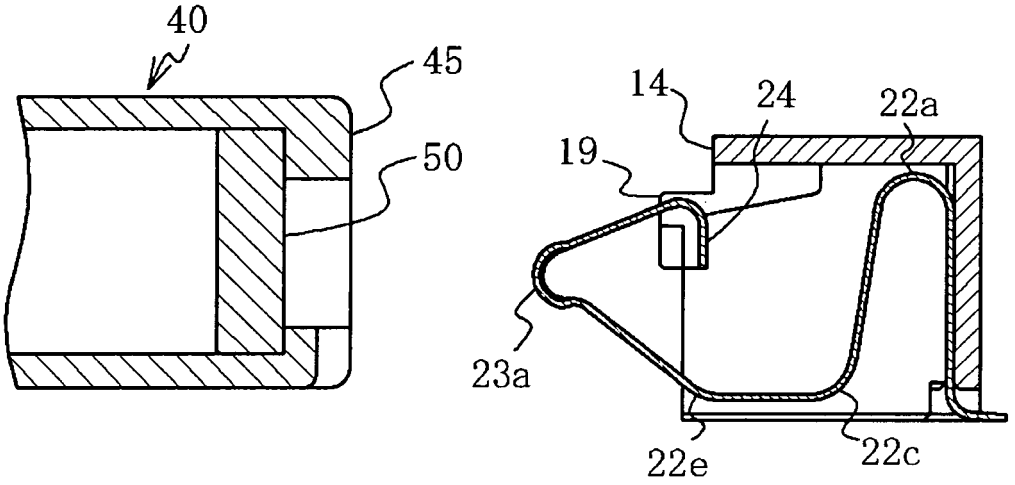
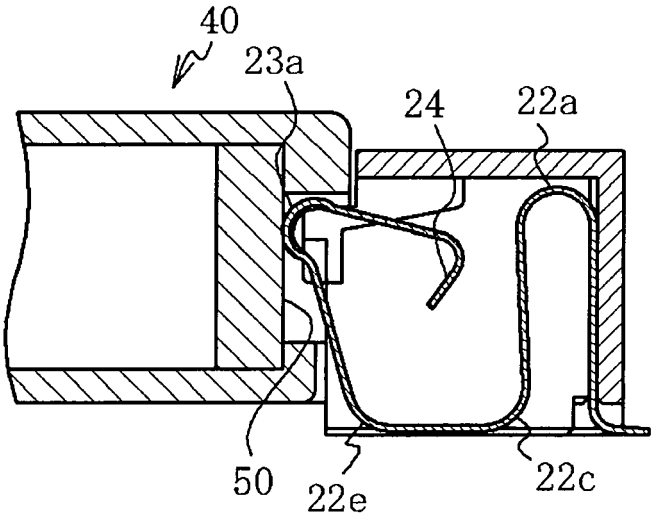


FIG.5B



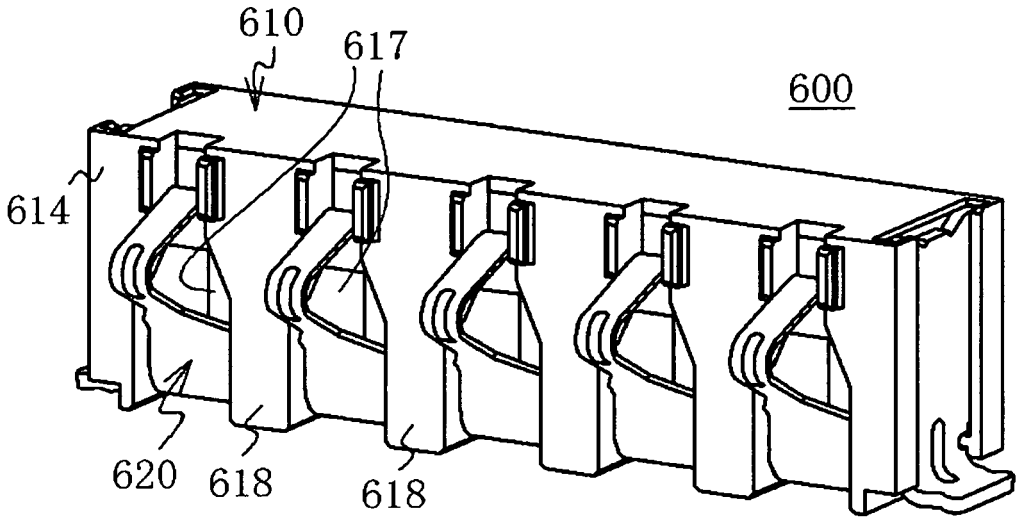


FIG.6 (prior art)

FIG.7A (prior art)

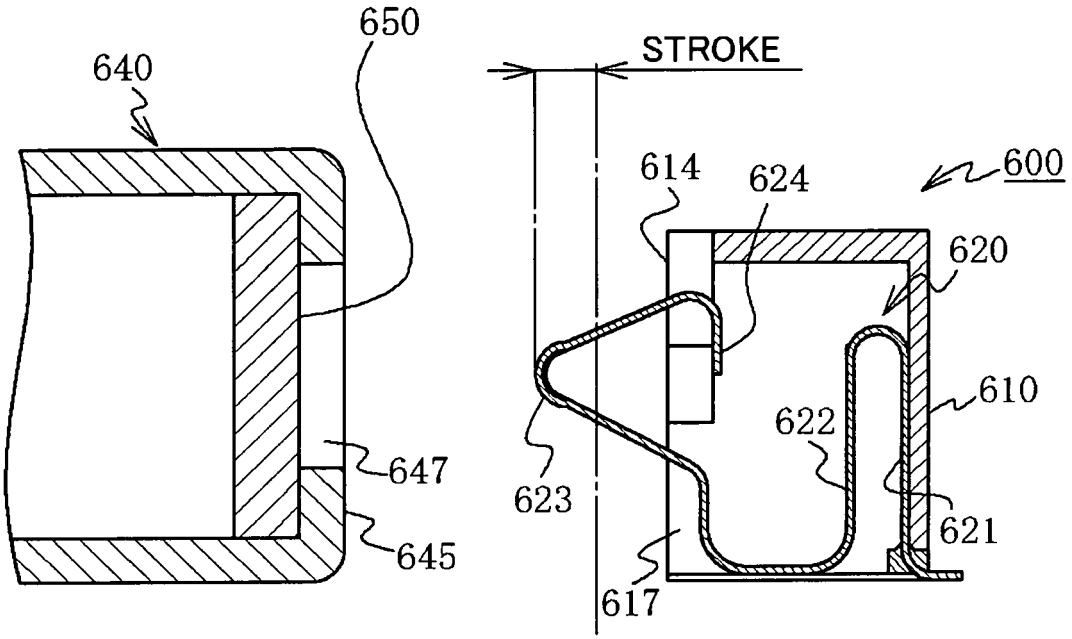


FIG.7B (prior art)

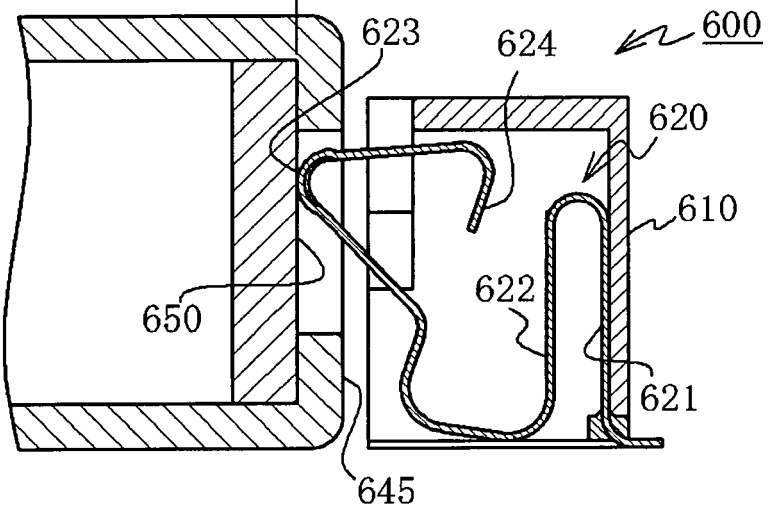


FIG.8A (prior art)

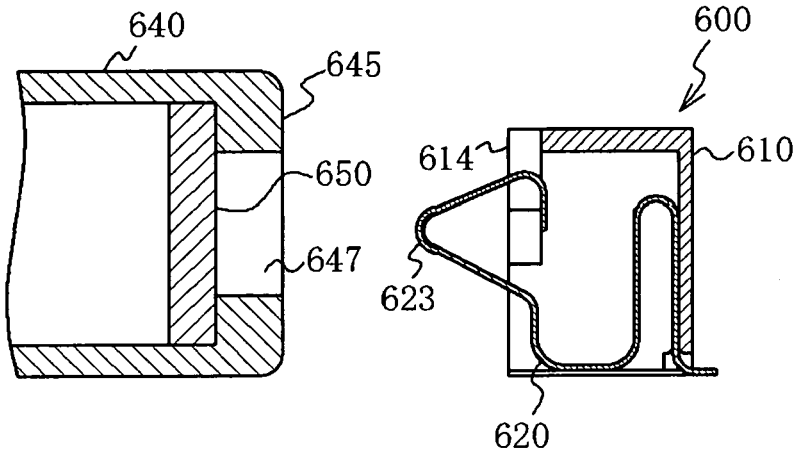


FIG.8B (prior art)

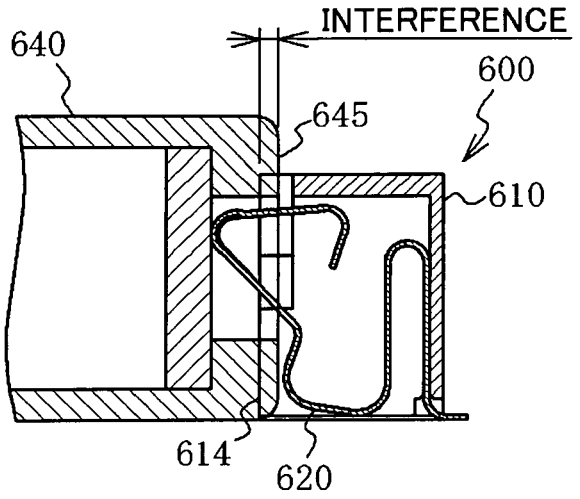
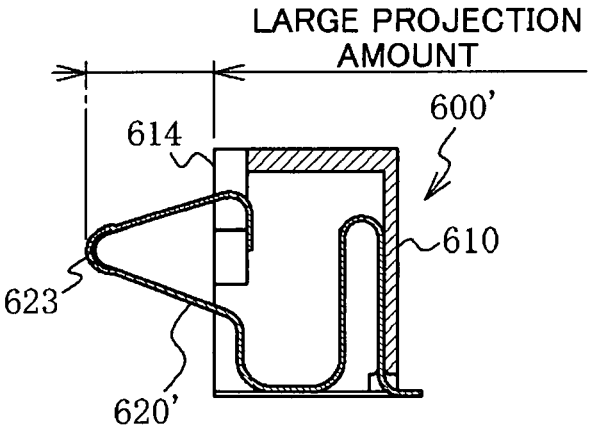


FIG.8C (prior art)



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005129374 A **[0005]**