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(12) **United States Patent**
Komoto et al.

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(45) **Date of Patent: Aug. 19, 2025**

(54) **CONNECTOR**

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(73) Assignee: **JAPAN AVIATION ELECTRONICS INDUSTRY, LIMITED**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 337 days.

(21) Appl. No.: **18/143,303**

(22) Filed: **May 4, 2023**

(65) **Prior Publication Data**

US 2024/0072481 A1 Feb. 29, 2024

(30) **Foreign Application Priority Data**

Aug. 25, 2022 (JP) 2022-133968

(51) **Int. Cl.**

H01R 13/00	(2006.01)
H01R 13/436	(2006.01)
H01R 13/72	(2006.01)
H01R 13/74	(2006.01)
H01R 107/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 13/4367*** (2013.01); ***H01R 13/72*** (2013.01); ***H01R 13/74*** (2013.01); *H01R 2107/00* (2013.01); *H01R 2201/12* (2013.01)

(58) **Field of Classification Search**

CPC H01R 13/72; H01R 13/74

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,559,769	B2 *	7/2009	Hsiao	H05K 7/1069 439/700
9,088,083	B2 *	7/2015	Mason	H01R 13/2435
9,595,773	B2 *	3/2017	Hemmi	H01R 4/48
9,797,925	B2 *	10/2017	Teranishi	G01R 1/06738
11,387,587	B1 *	7/2022	Ramsey	H01R 13/2421
12,259,406	B2 *	3/2025	Liu	G01R 1/06722
2018/0233854	A1	8/2018	Komoto et al.	
2024/0072481	A1 *	2/2024	Komoto	H01R 12/7011

FOREIGN PATENT DOCUMENTS

EP	3376601 A1	9/2018
EP	3739689 A1	11/2020
JP	2018129244 A	8/2018

* cited by examiner

Primary Examiner — Phuong Chi Thi Nguyen

(74) *Attorney, Agent, or Firm* — MUNCY, GEISSLER, OLDS & LOWE, P.C.

(57) **ABSTRACT**

The connector includes an inner contact formed of a plate member inserted into a recess of a plug contact, the plate member having a first constituent portion including an elastically displaceable contact portion and a second constituent portion including a pressing portion that is elastically displaceable independently of elastic displacement of the contact portion, part of a sheet-like connection target in which a flexible conductor is exposed on at least one surface being sandwiched between the pressing portion and an inner surface of the recess in a direction orthogonal to the fitting axis, the inner surface of the recess coming into contact with a front surface of the connection target while the pressing portion coming into contact with a back surface of the connection target.

11 Claims, 17 Drawing Sheets

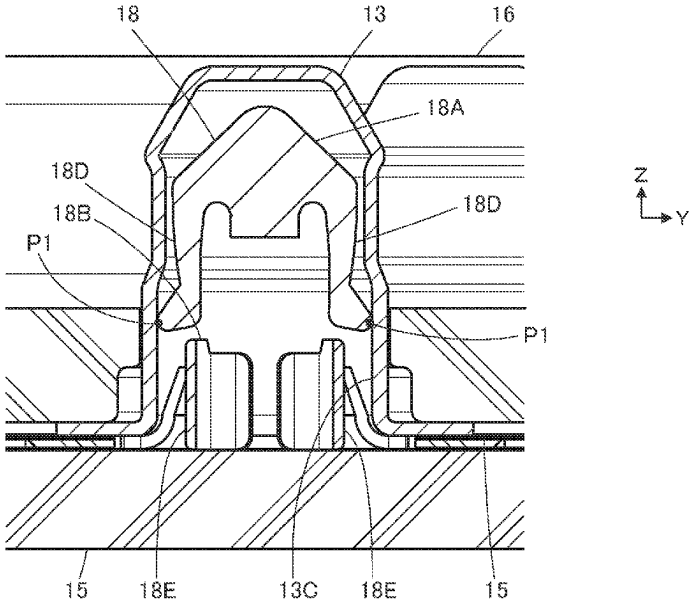


FIG. 1

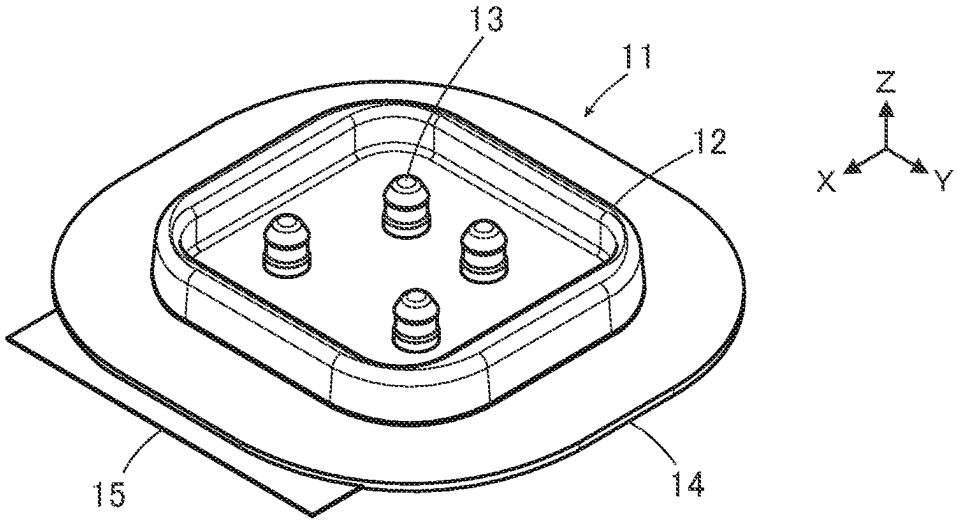


FIG. 2

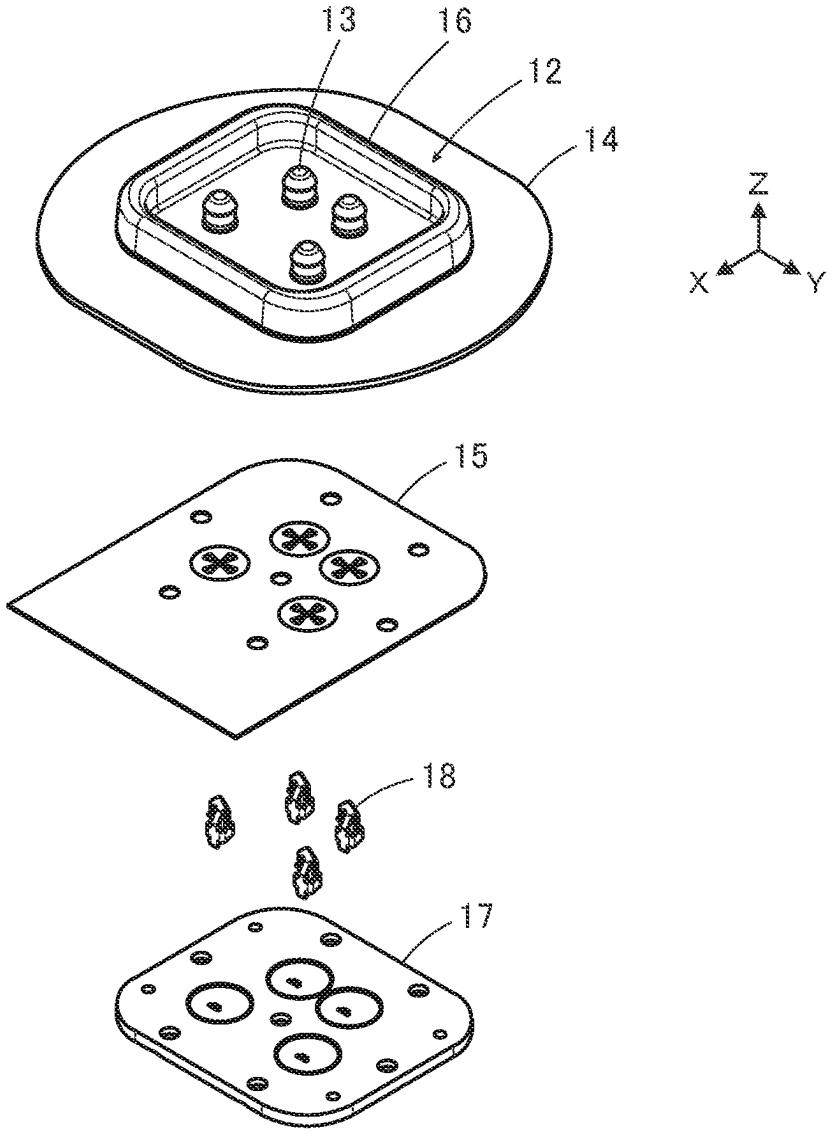


FIG. 3

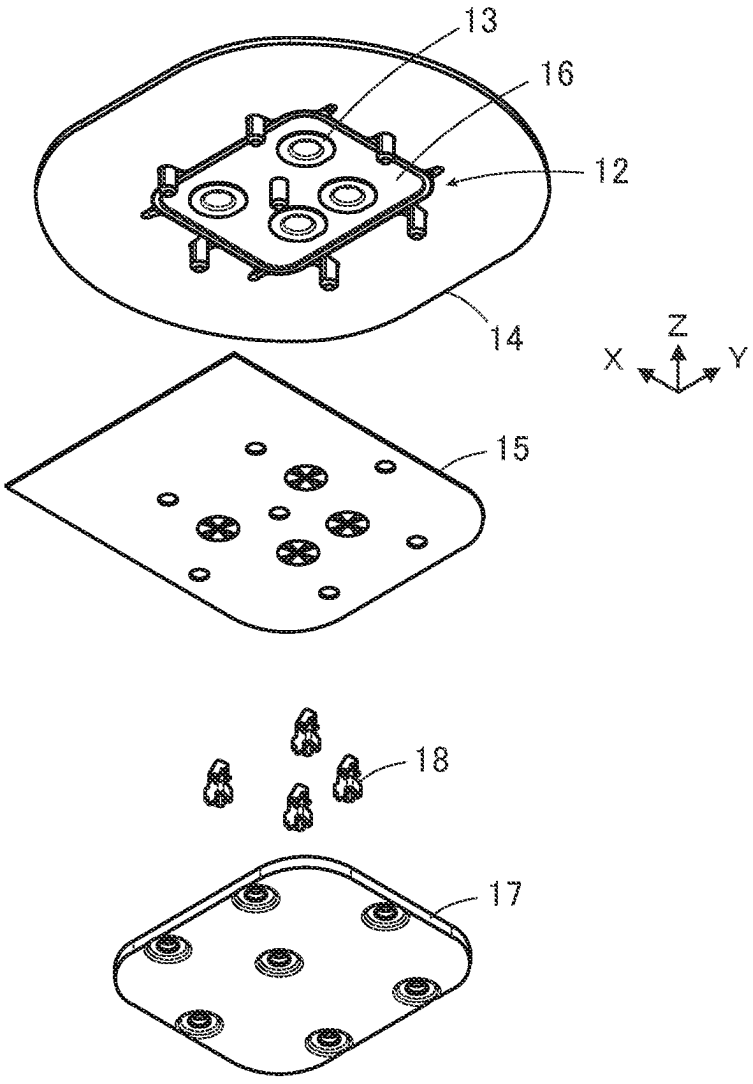


FIG. 4

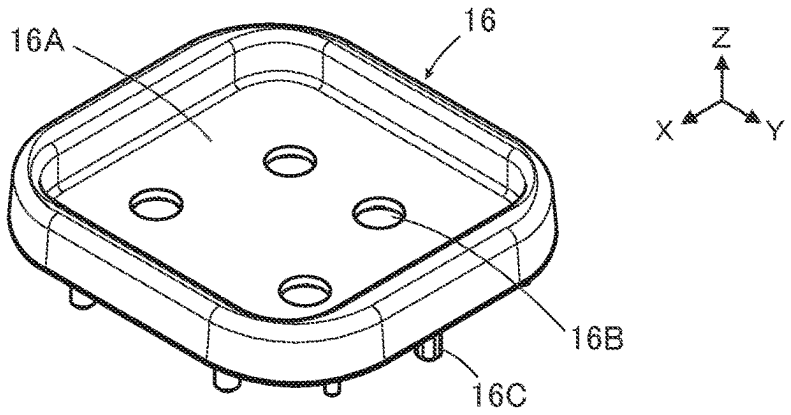


FIG. 5

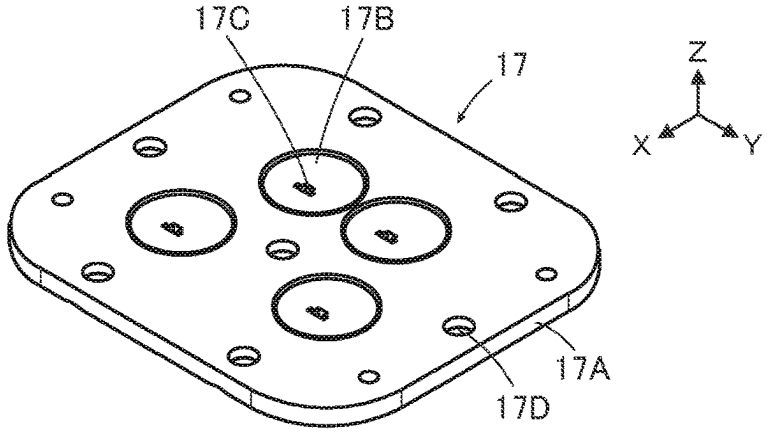


FIG. 6

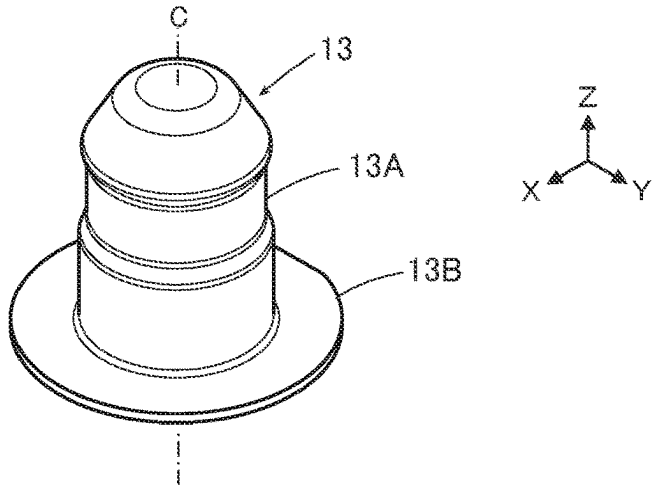


FIG. 7

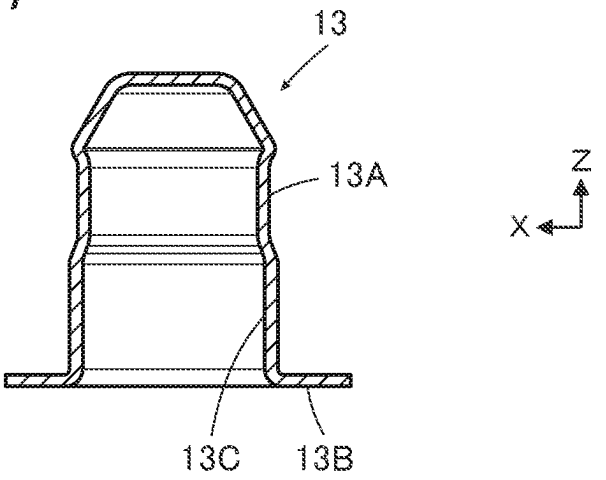


FIG. 8

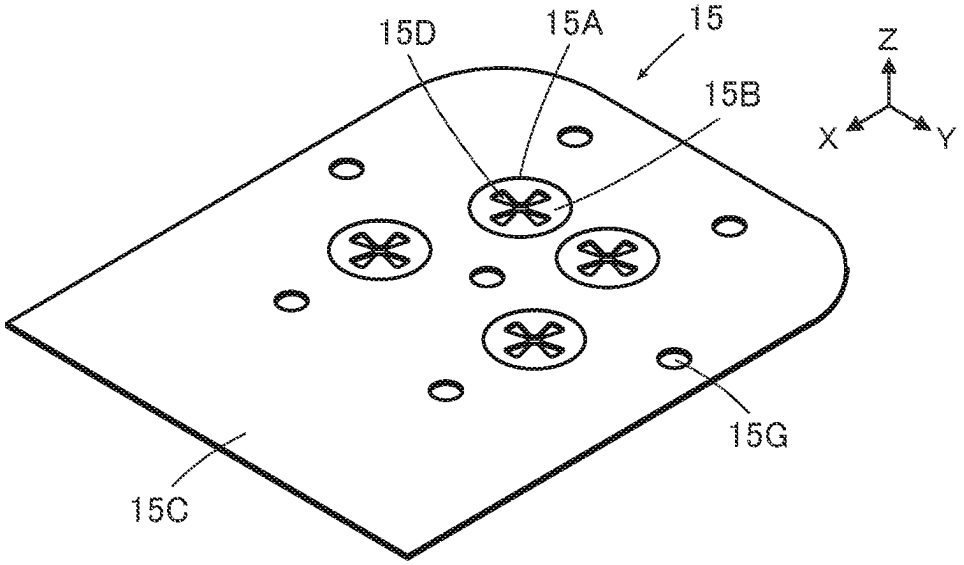


FIG. 9

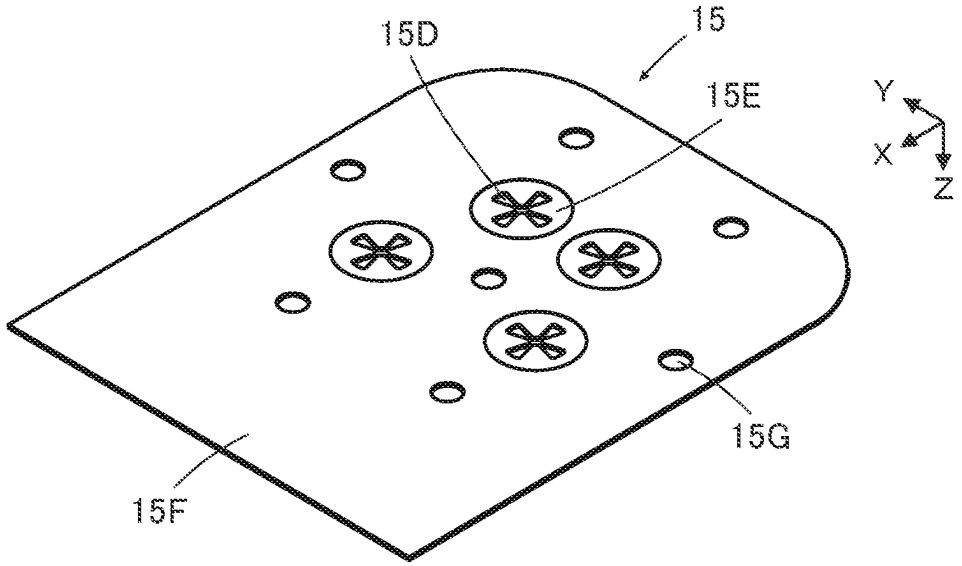


FIG. 10

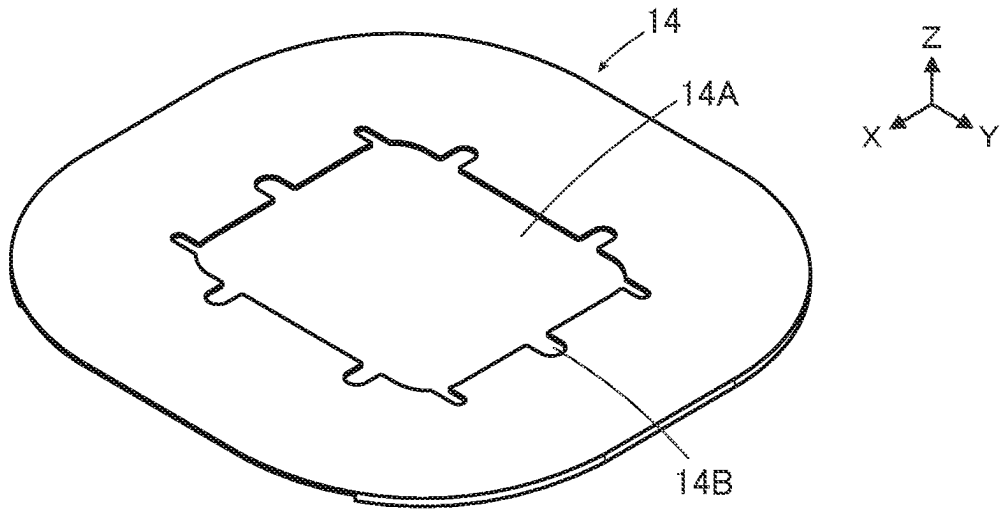


FIG. 11

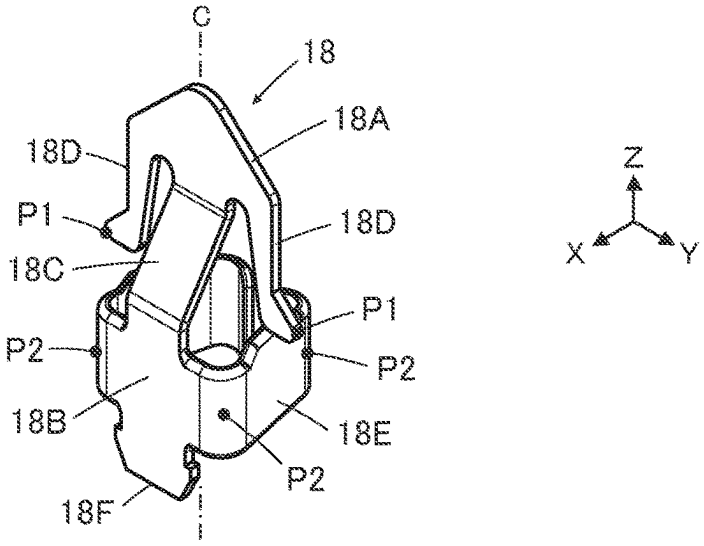
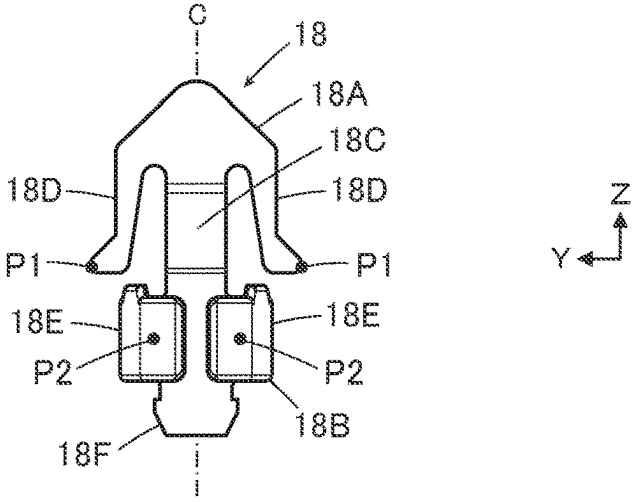


FIG. 12



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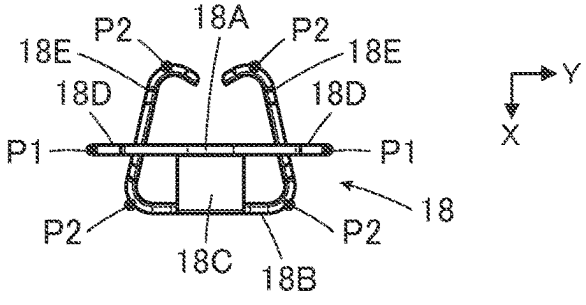


FIG. 14

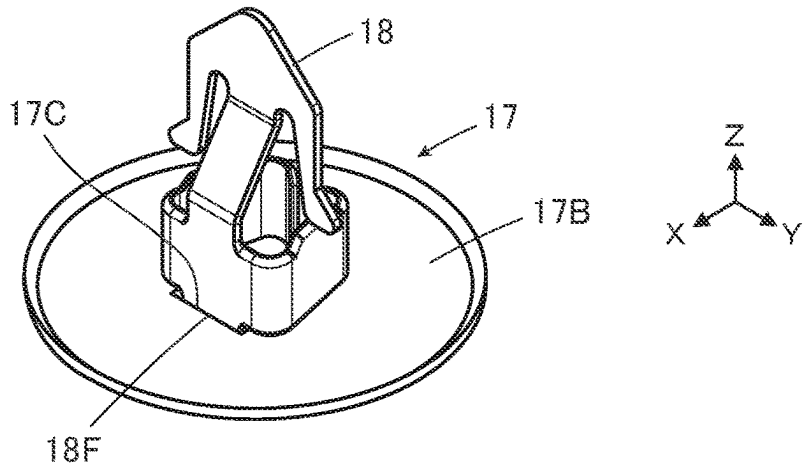

18
17C
17
17B
18F
Z
X
Y

FIG. 15

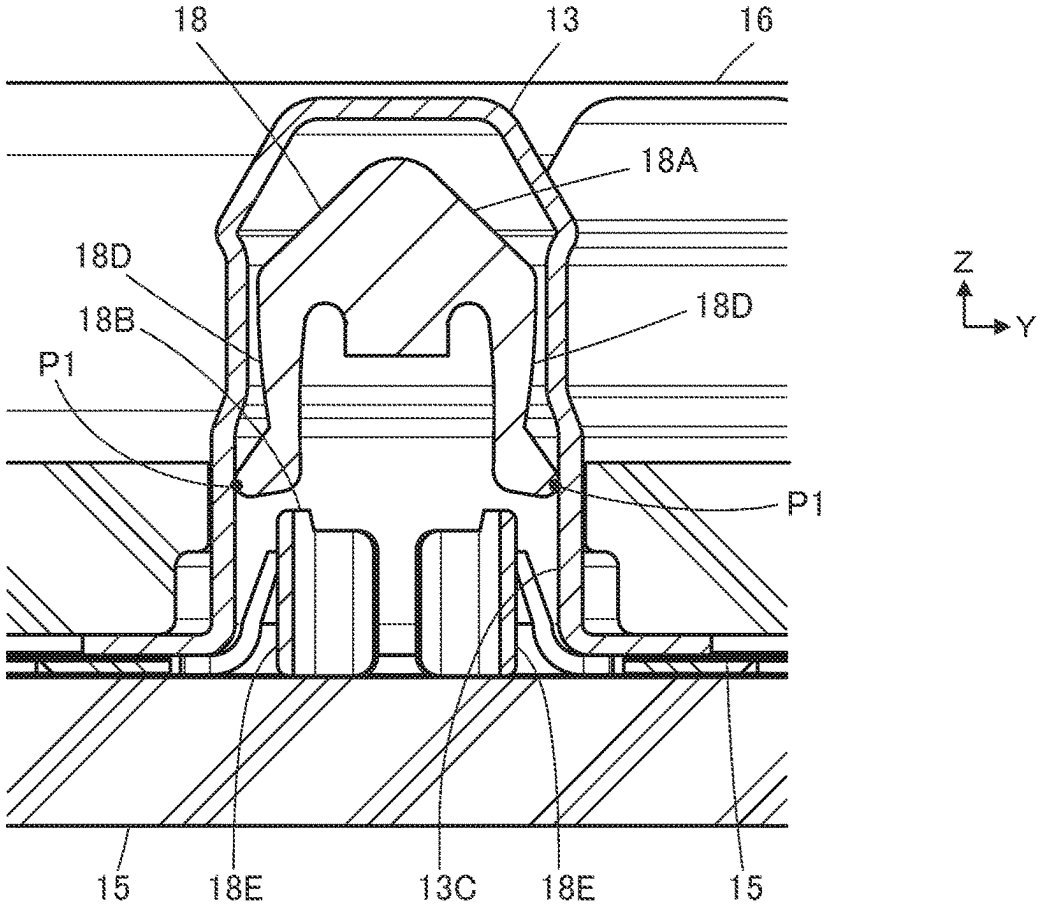
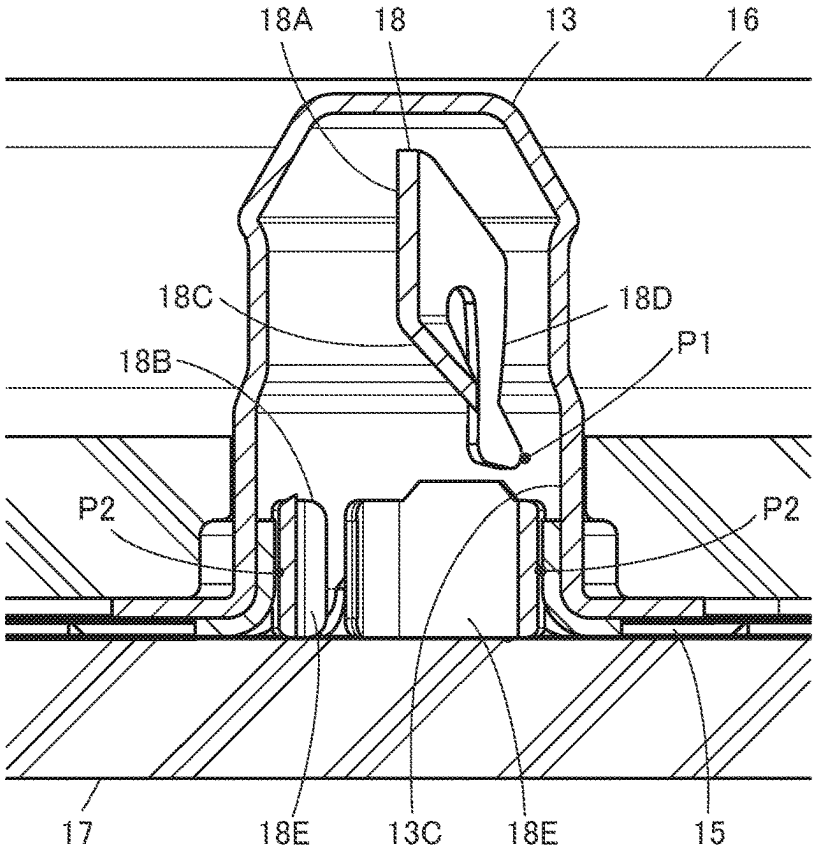

18
13
16
18A
18D
18B
P1
18D
P1
Z
Y
15
18E
13C
18E
15

FIG. 16


18A
18
13
16
18C
18D
P1
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P2
P2
17
18E
13C
18E
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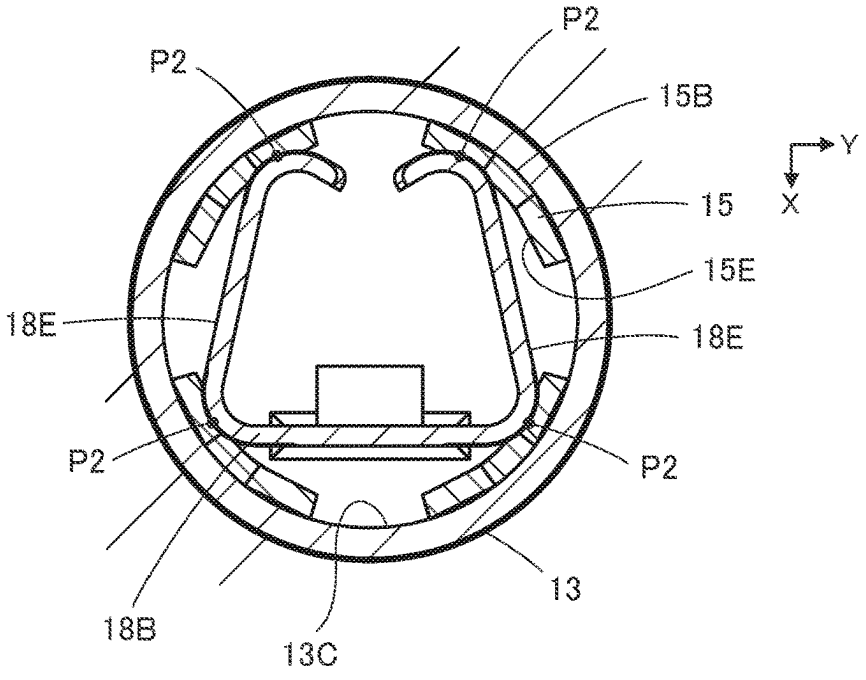
FIG. 17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18B
13C

FIG. 18

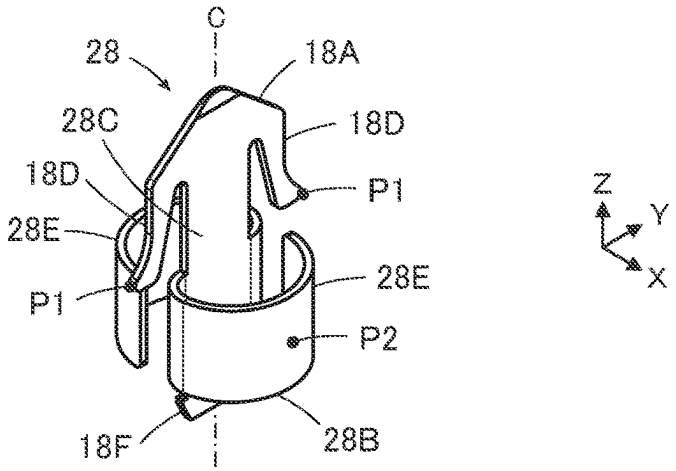


FIG. 19

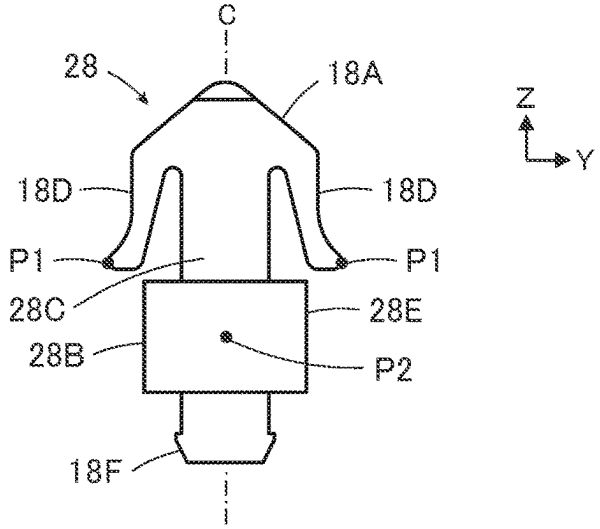
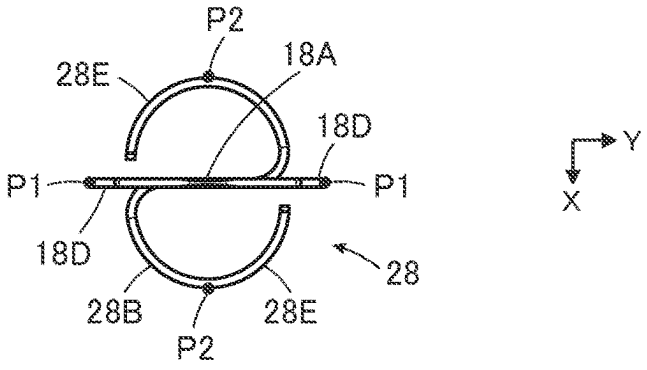


FIG. 20



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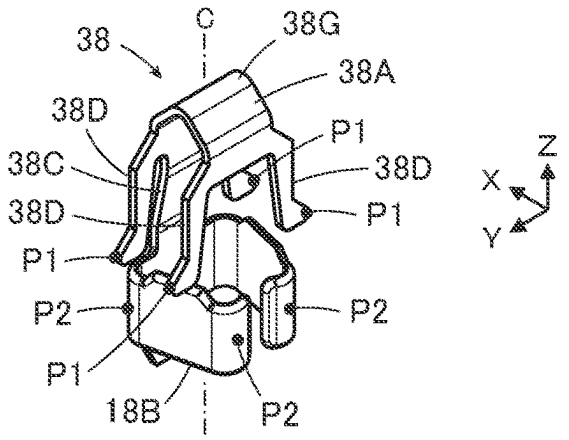

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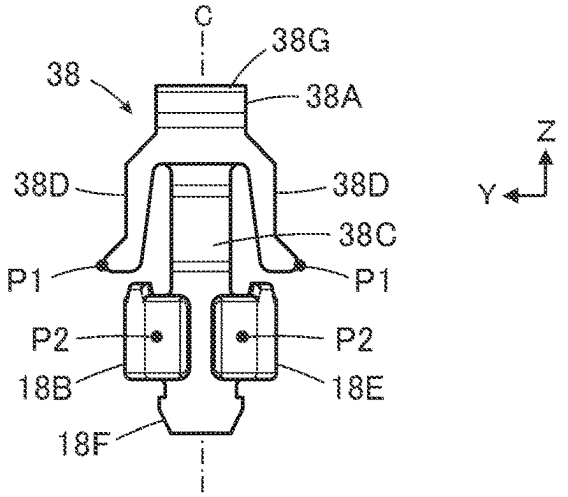

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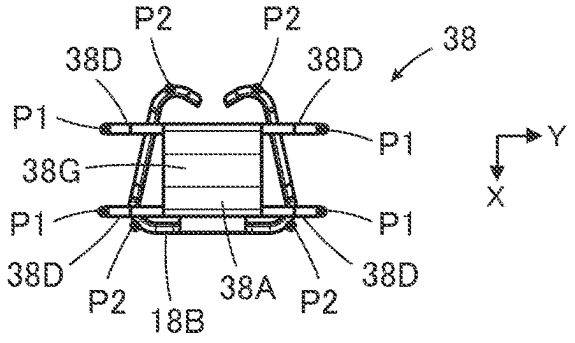


FIG. 24

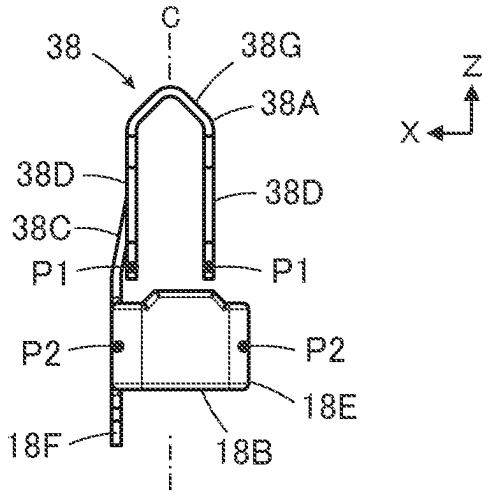
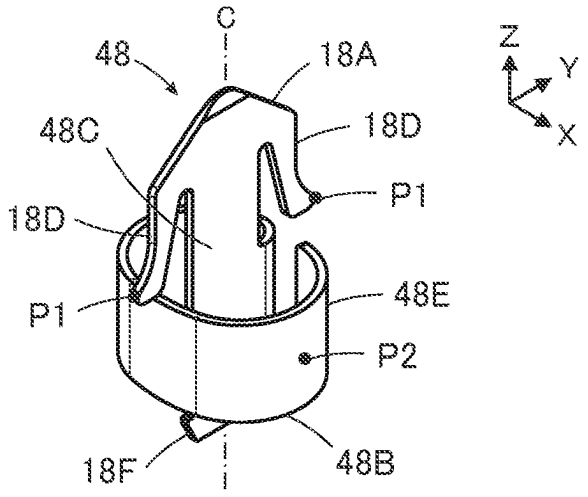

C
38
38G
38A
Z
X
38D
38D
38C
P1
P1
P2
P2
18E
18F
18B

FIG. 25


C
48
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X
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18D
18D
P1
P1
48E
P2
18F
48B

FIG. 26

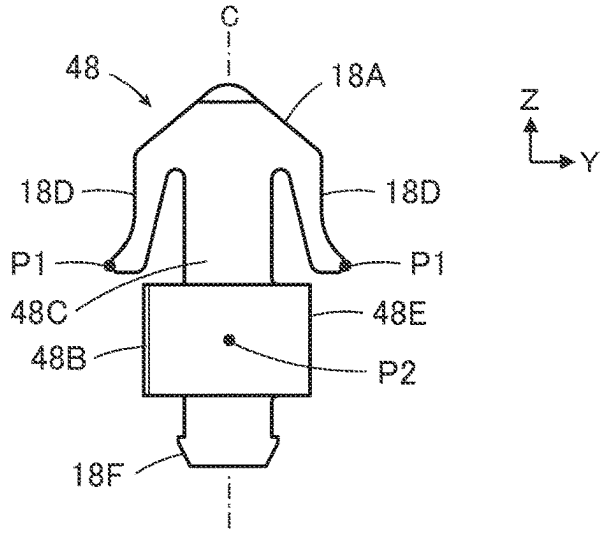


FIG. 27

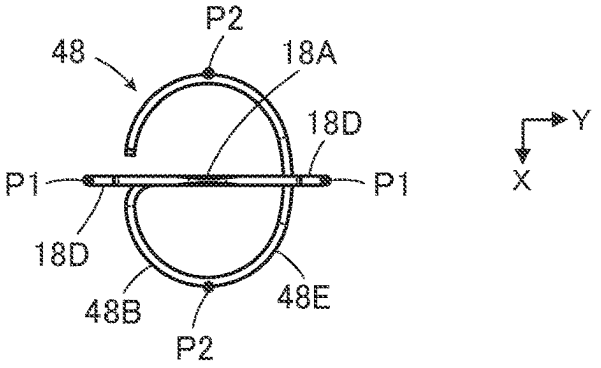


FIG. 28

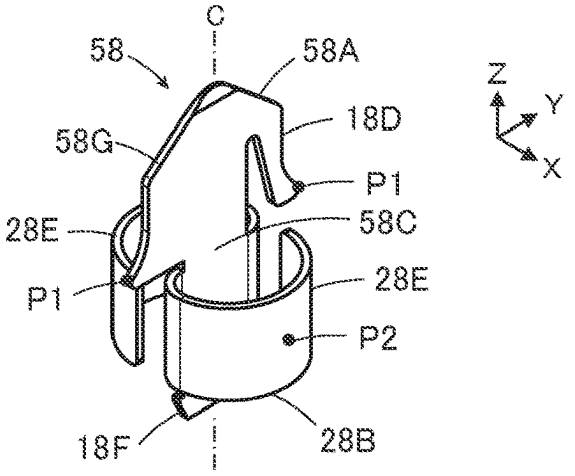


FIG. 29

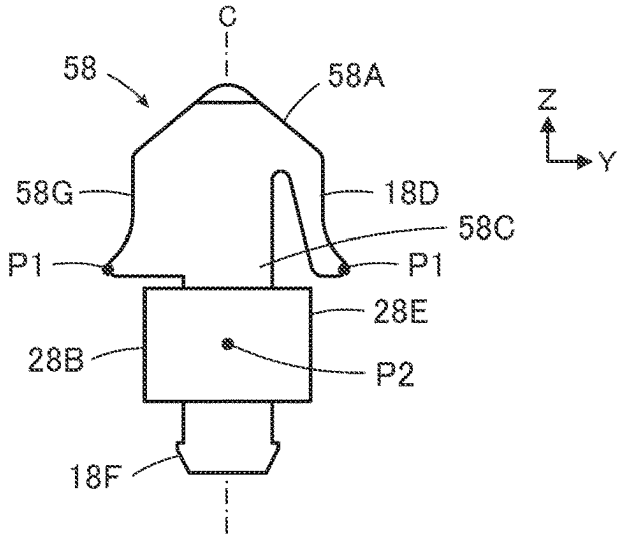


FIG. 30

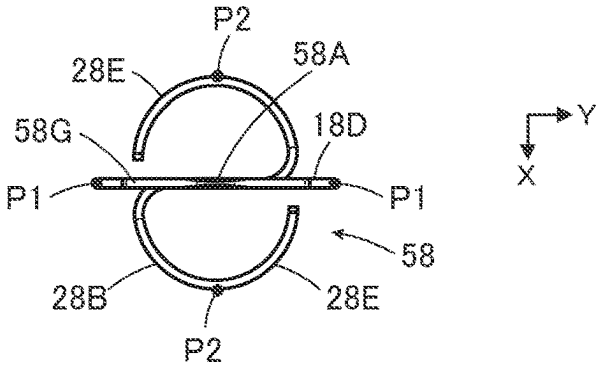


FIG. 31

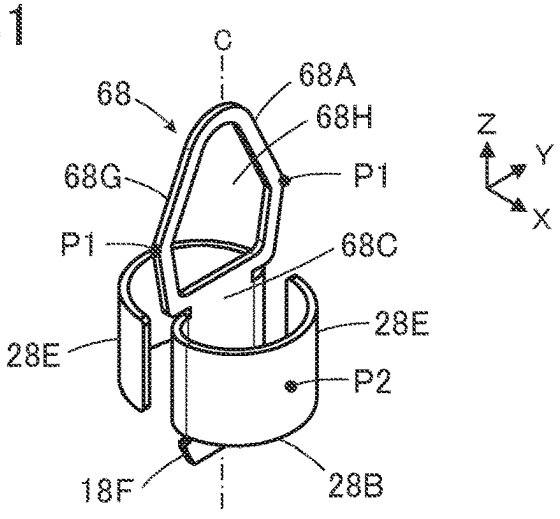


FIG. 32

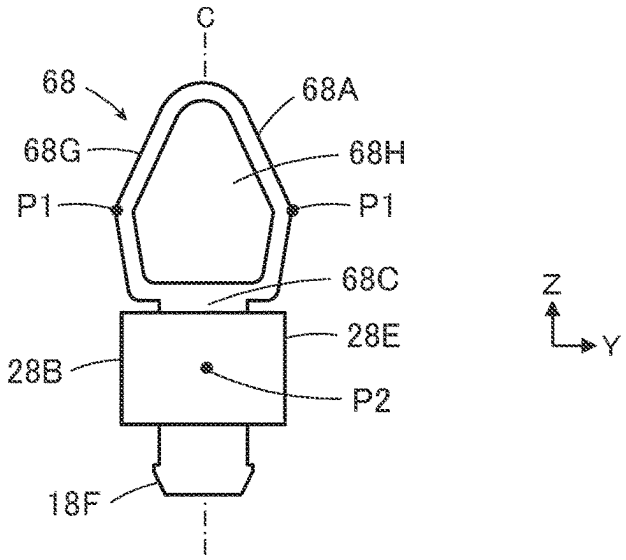


FIG. 33

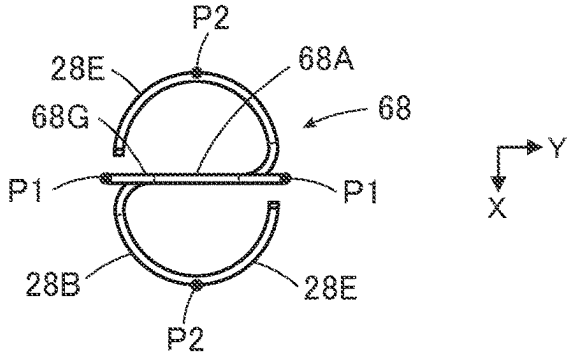


FIG. 34

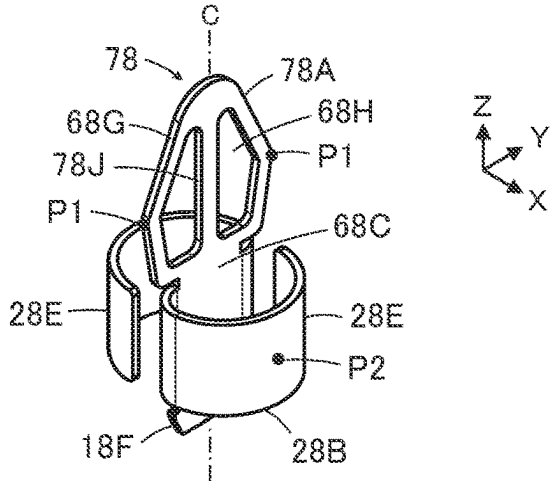


FIG. 35
PRIOR ART

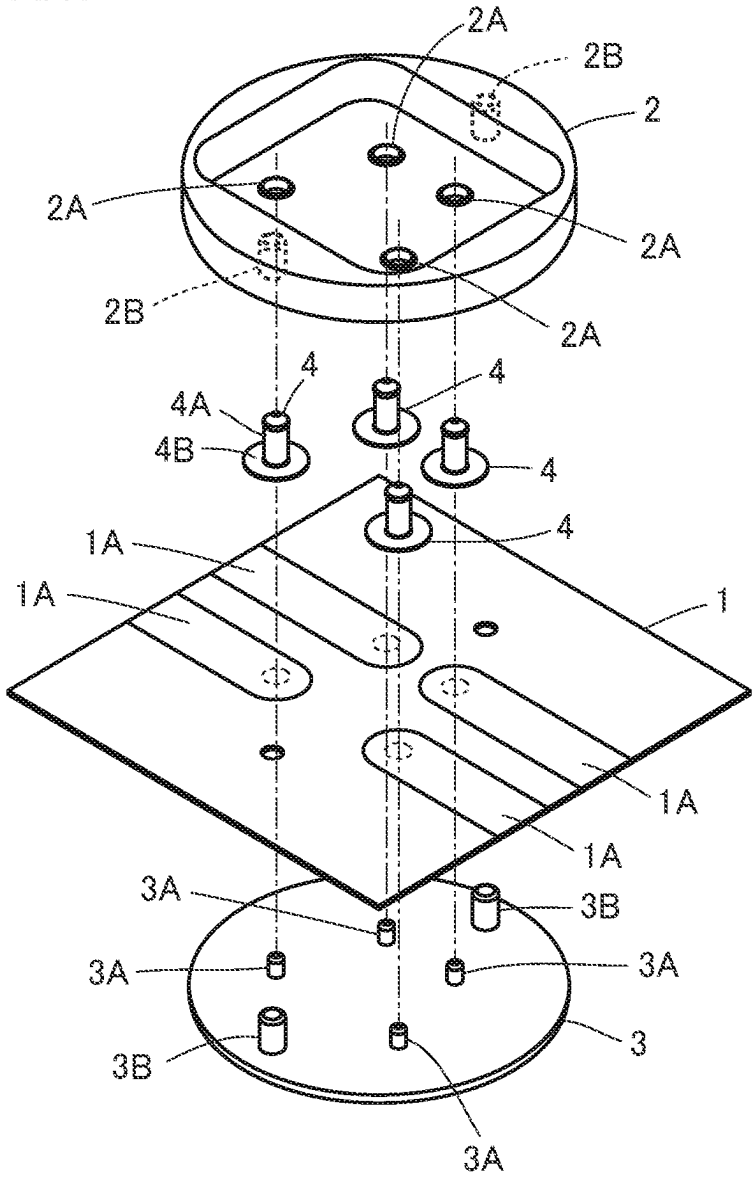
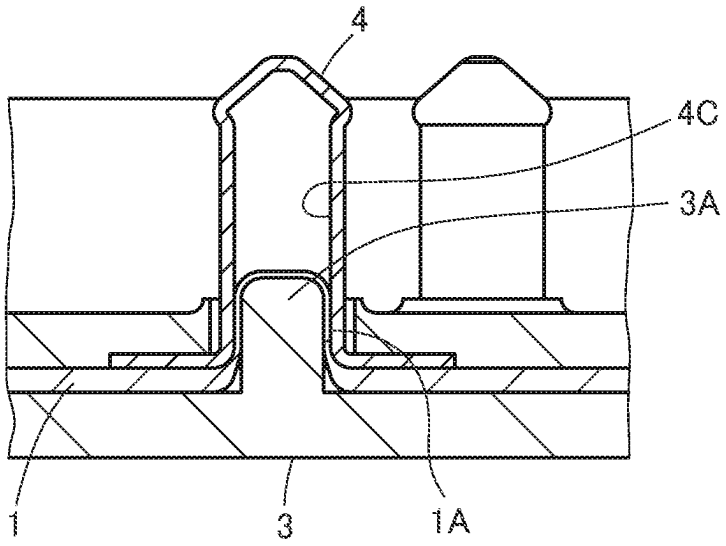


FIG. 36
PRIOR ART



CONNECTOR

BACKGROUND OF THE INVENTION

The present invention relates to a connector, particularly to a connector to be connected to a sheet-like connection target in which a flexible conductor is exposed on at least one surface.

These days, what is called smart cloth, which can acquire biological information of a user such as a heart rate or a body temperature simply by being worn, has attracted attention. The smart cloth includes an electrode placed at a measurement point, and, by electrically connecting a wearable device as a measurement instrument to the electrode, biological information can be transmitted to the wearable device.

The connection between the electrode and the wearable device can be made by, for example, using a connector to be connected to a flexible conductor drawn out from the electrode.

As a connector of this type, for example, a connector like that shown in FIG. **35** is disclosed in JP 2018-129244 A. The connector includes a housing **2** and a base member **3** separately placed on both sides of a flexible substrate **1** to sandwich the flexible substrate **1** therebetween; in the connector, a cylindrical portion **4**A of a contact **4** is passed through a contact through hole **2**A of the housing **2**, and a flange **4**B of the contact **4** is sandwiched between the housing **2** and a flexible conductor **1**A exposed on a surface of the flexible substrate **1**.

By pushing the base member **3** toward the housing **2** in this state, as shown in FIG. **36**, a protrusion **3**A of the base member **3** is inserted into a protrusion accommodating portion **4**C of the contact **4** with the flexible substrate **1** being interposed therebetween, and the inner surface of the protrusion accommodating portion **4**C comes into contact with the flexible conductor **1**A with a predetermined contact force, whereby the contact **4** is electrically connected to the flexible conductor **1**A.

Further, as shown in FIG. **35**, housing fixing posts **3**B formed to protrude on the base member **3** are press-fitted into post accommodating portions **2**B of the housing **2**, whereby the housing **2** and the base member **3** are fixed to each other.

By fitting a wearable device to the connector disclosed in JP 2018-129244 A, the wearable device can be connected to an electrode made of a flexible conductor.

However, there is a problem that, when a flexible conductor **1**B is exposed on the back surface of the flexible substrate **1**, the flexible conductor **1**B cannot be electrically connected to the contact **4** in the connector of JP 2018-129244 A.

SUMMARY OF THE INVENTION

The present invention has been made to solve such an existing problem, and an object of the present invention is to provide a connector capable of electrically connecting a contact to a flexible conductor of a connection target regardless of whether the flexible conductor is exposed on the front surface or the back surface of the connection target.

The connector according to the present invention includes:

a plug contact of cylindrical shape, the plug contact being conductive and having a recess extending along a fitting axis; and

an inner contact formed of a plate member, the inner contact being conductive and inserted into the recess,

wherein the plate member includes:

a first constituent portion including a contact portion that is elastically displaceable in a direction orthogonal to the fitting axis and that comes into contact with the plug contact in the recess;

a second constituent portion including a pressing portion that is elastically displaceable in a direction orthogonal to the fitting axis independently of elastic displacement of the contact portion of the first constituent portion; and

a coupling portion that couples the first constituent portion and the second constituent portion such that the first constituent portion and the second constituent portion are apart from each other along the fitting axis, and

part of a connection target of sheet-like shape in which a flexible conductor is exposed on at least one surface is sandwiched between the pressing portion and an inner surface of the recess in a direction orthogonal to the fitting axis, and the inner surface of the recess comes into contact with a front surface of the connection target while the pressing portion comes into contact with a back surface of the connection target, whereby the plug contact is directly electrically connected to the flexible conductor in a case where the flexible conductor is exposed on the front surface of the connection target, and the plug contact is electrically connected to the flexible conductor via the inner contact in a case where the flexible conductor is exposed on the back surface of the connection target.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a connector according to Embodiment 1.

FIG. **2** is an exploded perspective view of the connector according to Embodiment 1 as viewed obliquely from above.

FIG. **3** is an exploded perspective view of the connector according to Embodiment 1 as viewed obliquely from below.

FIG. **4** is a perspective view showing a top insulator used for the connector of Embodiment 1.

FIG. **5** is a perspective view showing a bottom insulator used for the connector of Embodiment 1.

FIG. **6** is a perspective view showing a plug contact used for the connector of Embodiment 1.

FIG. **7** is a cross-sectional view showing the plug contact used for the connector of Embodiment 1.

FIG. **8** is a perspective view of a connection target to be connected to the connector of Embodiment 1 as viewed obliquely from above.

FIG. **9** is a perspective view of the connection target to be connected to the connector of Embodiment 1 as viewed obliquely from below.

FIG. **10** is a perspective view showing a reinforcing sheet used for the connector of Embodiment 1.

FIG. **11** is a perspective view showing an inner contact used for the connector of Embodiment 1.

FIG. **12** is a front view showing the inner contact used for the connector of Embodiment 1.

FIG. **13** is a plan view showing the inner contact used for the connector of Embodiment 1.

FIG. **14** is a perspective view showing the inner contact in Embodiment 1 held on the bottom insulator.

FIG. **15** is a partial side cross-sectional view showing an internal state of the plug contact into which the inner contact is inserted in the connector of Embodiment 1 connected to the connection target.

FIG. **16** is a partial side cross-sectional view of the internal state of the plug contact into which the inner contact is inserted in the connector of Embodiment 1 connected to a connection target, as viewed from a side different from that in FIG. **15**.

FIG. **17** is a partial plan cross-sectional view showing the internal state of the plug contact into which the inner contact is inserted in the connector of Embodiment 1 connected to the connection target.

FIG. **18** is a perspective view showing an inner contact in Embodiment 2.

FIG. **19** is a front view showing the inner contact in Embodiment 2.

FIG. **20** is a plan view showing the inner contact in Embodiment 2.

FIG. **21** is a perspective view showing an inner contact in Embodiment 3.

FIG. **22** is a front view showing the inner contact in Embodiment 3.

FIG. **23** is a plan view showing the inner contact in Embodiment 3.

FIG. **24** is a side view showing the inner contact in Embodiment 3.

FIG. **25** is a perspective view showing an inner contact in Embodiment 4.

FIG. **26** is a front view showing the inner contact in Embodiment 4.

FIG. **27** is a plan view showing the inner contact in Embodiment 4.

FIG. **28** is a perspective view showing an inner contact in Embodiment 5.

FIG. **29** is a front view showing the inner contact in Embodiment 5.

FIG. **30** is a plan view showing the inner contact in Embodiment 5.

FIG. **31** is a perspective view showing an inner contact in Embodiment 6.

FIG. **32** is a front view showing the inner contact in Embodiment 6.

FIG. **33** is a plan view showing the inner contact in Embodiment 6.

FIG. **34** is a perspective view showing an inner contact in Embodiment 7.

FIG. **35** is an exploded perspective view of a conventional connector.

FIG. **36** is a partial cross-sectional view showing the conventional connector.

DETAILED DESCRIPTION OF THE INVENTION

Hereinbelow, embodiments of the present invention are described on the basis of the accompanying drawings.

Embodiment 1

FIG. **1** shows a connector **11** according to Embodiment 1. The connector **11** is used as, for example, a garment-side connector for fitting a wearable device, and includes a housing **12** made of an insulating material. Four plug contacts **13** are held in the housing **12**, and a reinforcing sheet **14** and a sheet-like conductive member **15** are further held by the housing **12** while being stacked with each other. The sheet-like conductive member **15** constitutes a connection target to which the connector **11** is connected.

The four plug contacts **13** are arranged in two rows parallel to each other in such a manner as to protrude perpendicularly to the sheet-like conductive member **15**.

Here, for the sake of convenience, it is assumed that the reinforcing sheet **14** and the sheet-like conductive member **15** extend along an XY plane, the arrangement direction of the four plug contacts **13** is referred to as a Y direction, and the direction in which the four plug contacts **13** protrude is referred to as a +Z direction. The Z direction is a fitting direction in which the connector **11** is fitted to a counter connector.

FIGS. **2** and **3** show exploded perspective views of the connector **11**. The connector **11** includes a top insulator **16** and a bottom insulator **17**, and the top insulator **16** and the bottom insulator **17** constitute the housing **12**.

The four plug contacts **13** are held in the top insulator **16**, the reinforcing sheet **14** is placed on the back surface on the −Z direction side of the top insulator **16**, and the sheet-like conductive member **15** is placed on the −Z direction side of the reinforcing sheet **14**. Four inner contacts **18** are placed on the −Z direction side of the sheet-like conductive member **15**, and the bottom insulator **17** is placed on the −Z direction side of the inner contact **18**. The four inner contacts **18** correspond to the four plug contacts **13**.

As shown in FIG. **4**, the top insulator **16** has a recess **16**A opened in the +Z direction and four contact through holes **16**B formed in the recess **16**A. The recess **16**A constitutes a counter connector accommodating portion in which part of a not-illustrated counter connector is accommodated, and the four contact through holes **16**B correspond to the four plug contacts **13**. A plurality of bosses **16**C protruding in the −Z direction are formed on the surface oriented in the −Z direction of the top insulator **16**.

As shown in FIG. **5**, the bottom insulator **17** has a flat plate portion **17**A, and four circular recesses **17**B opened in the +Z direction are formed in the flat plate portion **17**A. The four recesses **17**B correspond to the four plug contacts **13**. A holding hole **17**C for holding the inner contact **18** is formed in each of the four recesses **17**B.

A plurality of through holes **17**D corresponding to the plurality of bosses **16**C of the top insulator **16** are formed in the flat plate portion **17**A.

Each of the four plug contacts **13** is formed of a conductive material such as metal, and is connected to the corresponding contact of the not-illustrated counter connector when part of the counter connector is accommodated in the recess **16**A of the top insulator **16**.

As shown in FIG. **6**, the plug contact **13** has a cylindrical portion **13**A in a circular cylindrical shape extending in the Z direction along a fitting axis C and a flange **13**B extending along an XY plane from an end portion in the −Z direction of the cylindrical portion **13**A. As shown in FIG. **7**, a recess **13**C opened in the −Z direction is formed in the interior of the cylindrical portion **13**A.

The fitting axis C is an axis passing through the center of the cylindrical portion **13**A and extending in the fitting direction of the connector **11** and the counter connector.

While the cylindrical portion **13**A has a circular cylindrical shape, the cross-sectional shape thereof is not limited to a circular shape and may be various cross-sectional shapes such as an ellipse and a polygon as long as the cylindrical portion has the recess **13**C in its interior.

Each of the four plug contacts **13** can be used as a terminal for transmitting an electric signal.

The sheet-like conductive member **15** has a multilayer structure in which a plurality of wiring layers each formed of a flexible conductor and a plurality of insulating layers are stacked.

As shown in FIG. **8**, four contact placement regions **15**A for placing the four plug contacts **13** are defined on the surface oriented in the +Z direction of the sheet-like conductive member **15**. A wiring layer **15**B is exposed in the +Z direction in each of the four contact placement regions **15**A, and an insulating layer **15**C is exposed in the region other than the four contact placement regions **15**A.

A plurality of cutouts **15**D penetrating the sheet-like conductive member **15** in the Z direction are formed in the four contact placement regions **15**A. Since the cutouts **15**D penetrate the sheet-like conductive member **15** in the Z direction, as shown in FIG. **9**, the cutouts **15**D are seen in positions corresponding to the four contact placement regions **15**A also on the back surface oriented in the −Z direction of the sheet-like conductive member **15**.

On the back surface oriented in the −Z direction of the sheet-like conductive member **15**, a wiring layer **15**E is exposed toward the −Z direction in each of positions corresponding to the four contact placement regions **15**A, and an insulating layer **15**F is exposed in the region other than the contact placement regions **15**A.

As shown in FIGS. **8** and **9**, a plurality of through holes **15**G corresponding to the plurality of bosses **16**C of the top insulator **16** are formed in a peripheral edge portion of the sheet-like conductive member **15**.

As shown in FIG. **10**, the reinforcing sheet **14** is for reinforcing a not-illustrated mounting target such as a garment on which the connector **11** is mounted, and is made of an insulating material and has an opening **14**A formed at the center. A plurality of notches **14**B corresponding to the plurality of bosses **16**C of the top insulator **16** are formed along the peripheral edge of the opening **14**A of the reinforcing sheet **14**.

FIGS. **11** to **13** show a configuration of the inner contact **18**. The inner contact **18** is formed of a bent plate member formed of a conductive material such as metal, and has a first constituent portion **18**A placed in an end portion in the +Z direction of the inner contact **18** along the fitting axis C, a second constituent portion **18**B placed on the −Z direction side of the first constituent portion **18**A, and a coupling portion **18**C that couples the first constituent portion **18**A and the second constituent portion **18**B such that the first constituent portion **18**A and the second constituent portion **18**B are apart from each other along the fitting axis C.

The first constituent portion **18**A has a flat shape extending along the YZ plane, and has a pair of cantilever portions **18**D separately on both sides of the fitting axis C across the fitting axis C, which cantilever portions **18**D extend in the −Z direction and of which the distal ends extend in opposite directions to each other in the Y direction.

The second constituent portion **18**B has a pair of arm portions **18**E that extend from the connection portion with the coupling portion **18**C while bending or curving in the −X direction to face each other in the Y direction in the XY plane in such a manner as to form a substantially cylindrical shape surrounding the fitting axis C. Distal end portions of the pair of arm portions **18**E are close to each other and face each other in the Y direction.

The coupling portion **18**C is inclined in the X direction with respect to the fitting axis C and couples the first constituent portion **18**A and the second constituent portion **18**B such that the second constituent portion **18**B is located on the −Z direction side of the first constituent portion **18**A.

The distal ends oriented in opposite directions to each other of the pair of cantilever portions **18**D of the first constituent portion **18**A form a pair of contact portions P**1** that are elastically displaceable in the Y direction orthogonal to the fitting axis C.

Further, the outer surfaces of the pair of arm portions **18**E of the second constituent portion **18**B form a plurality of pressing portions P**2** that are elastically displaceable in the XY plane orthogonal to the fitting axis C. Specifically, as shown in FIG. **13**, the second constituent portion **18**B has a substantially trapezoidal contour when viewed in the Z direction, and four pressing portions P**2** are formed on the outer surfaces of the arm portions **18**E at the four vertices of the trapezoid.

Here, the first constituent portion **18**A and the second constituent portion **18**B are placed to be apart from each other in the Z direction via the coupling portion **18**C, and the four pressing portions P**2** of the second constituent portion **18**B are configured to be elastically displaceable independently of the elastic displacement of the pair of contact portions P**1** of the first constituent portion **18**A. That is, one of the elastic deformation in the contact portion P**1** and the elastic deformation in the pressing portion P**2** does not affect the other.

The inner contact **18** further has a fixing portion **18**F protruding in the −Z direction from the second constituent portion **18**B.

Such an inner contact **18** can be easily produced by, for example, bending a metal plate cut in a predetermined shape.

The spacing in the Y direction between the pair of contact portions P**1** is set slightly larger than the inner diameter of a portion of the recess **13**C of the plug contact **13**, with which portion the pair of contact portions P**1** come into contact when the inner contact **18** is inserted into the recess **13**C.

Therefore, when the inner contact **18** is inserted into the recess **13**C of the plug contact **13**, the pair of contact portions P**1** come into contact with the inner surface of the recess **13**C with a predetermined contact pressure while being elastically displaced in directions toward the fitting axis C.

The distance between the fitting axis C and each pressing portion P**2** in the XY plane is set to be slightly larger than a value obtained by subtracting the thickness of the sheet-like conductive member **15** from ½ of the inner diameter of a portion of the recess **13**C of the plug contact **13** with which portion the four pressing portions P**2** come into contact when the inner contact **18** is inserted into the recess **13**C.

Therefore, when the inner contact **18** is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, each of the four pressing portions P**2** is elastically displaced in a direction toward the fitting axis C, and presses the sheet-like conductive member **15** against the inner surface of the recess **13**C with a predetermined contact pressure.

As shown in FIG. **14**, the inner contact **18** is held on the bottom insulator **17** by inserting the fixing portion **18**F into the holding hole **17**C of the corresponding recess **17**B of the bottom insulator **17**.

The four contact through holes **16**B of the top insulator **16**, the four plug contacts **13**, the four contact placement regions **15**A of the sheet-like conductive member **15**, the four inner contacts **18**, and the four recesses **17**B of the bottom insulator **17** are placed to be aligned with each other in the Z direction.

Further, the plurality of bosses **16**C of the top insulator **16**, the plurality of notches **14**B of the reinforcing sheet **14**, the plurality of through holes **15**G of the sheet-like conductive member **15**, and the plurality of through holes **17**D of the bottom insulator **17** are placed to be aligned with each other in the Z direction.

When assembling the connector **11**, first, as shown in FIG. **14**, the fixing portion **18**F of each inner contact **18** is inserted into the holding hole **17**C of the corresponding recess **17**B of the bottom insulator **17**, whereby the inner contact **18** is held on the bottom insulator **17**.

Next, the plurality of bosses **16**C of the top insulator **16** are inserted into the plurality of notches **14**B of the reinforcing sheet **14**. At this time, the four contact through holes **16**B of the top insulator **16** are located in the opening **14**A of the reinforcing sheet **14**.

Further, the cylindrical portion **13**A of the plug contact **13** is inserted into the corresponding one of the four contact through holes **16**B of the top insulator **16** from the −Z direction, and the bottom insulator **17** is pressed in the +Z direction toward the top insulator **16** with the sheet-like conductive member **15** being interposed therebetween.

At this time, the flange **13**B of each plug contact **13** is located on the corresponding contact placement region **15**A of the sheet-like conductive member **15**, and each inner contact **18** held on the bottom insulator **17** is inserted into the recess **13**C of the corresponding plug contact **13** while pushing the contact placement region **15**A of the sheet-like conductive member **15**.

Since the plurality of cutouts **15**D are formed in each of the four contact placement regions **15**A of the sheet-like conductive member **15**, each of the four inner contacts **18** is inserted into the recess **13**C of the plug contact **13** while opening the plurality of cutouts **15**D of the corresponding contact placement region **15**A.

By pressing the bottom insulator **17** against the top insulator **16**, the plurality of bosses **16**C of the top insulator **16** sequentially penetrate the plurality of notches **14**B of the reinforcing sheet **14**, the plurality of through holes **15**G of the sheet-like conductive member **15**, and the plurality of through holes **17**D of the bottom insulator **17**. Then, the distal ends of the plurality of bosses **16**C protruding on the −Z direction side of the bottom insulator **17** are thermally deformed, whereby the top insulator **16** and the bottom insulator **17** are fixed to each other; thus, the assembly of the connector **11** is completed.

Each plug contact **13** is fixed to the top insulator **16** and the bottom insulator **17** by the flange **13**B being sandwiched between the top insulator **16** and the bottom insulator **17**.

As shown in FIG. **15**, the first constituent portion **18**A of the inner contact **18** is inserted into a deep portion in the recess **13**C of the plug contact **13**, that is, on the +Z direction side in the recess **13**C, and the pair of contact portions P**1** formed in the pair of cantilever portions **18**D of the first constituent portion **18**A are pressed against the inner surface of the recess **13**C of the plug contact **13**; thus, the inner contact **18** is electrically connected to the plug contact **13**.

Further, as shown in FIG. **16**, the second constituent portion **18**B placed on the −Z direction side of the first constituent portion **18**A via the coupling portion **18**C is inserted on the side nearer to an opening end portion of the recess **13**C of the plug contact **13** than the first constituent portion **18**A, that is, on the −Z direction side in the recess **13**C. The sheet-like conductive member **15** pushed into the recess **13**C of the plug contact **13** by the inner contact **18** is pressed toward the inner surface of the recess **13**C of the plug contact **13** by the pressing portions P**2** formed in the pair of arm portions **18**E of the second constituent portion **18**B of the inner contact **18**.

Specifically, as shown in FIG. **17**, the sheet-like conductive member **15** is pressed against the inner surface of the recess **13**C of the plug contact **13** by the four pressing portions P**2** of the second constituent portion **18**B having a substantially trapezoidal contour when viewed in the Z direction.

Here, as shown in FIGS. **8** and **9**, the wiring layer **15**B is exposed in the contact placement region **15**A on the front surface of the sheet-like conductive member **15**, and the wiring layer **15**E is exposed in a position corresponding to the contact placement region **15**A on the back surface of the sheet-like conductive member **15**.

Therefore, the wiring layer **15**B on the front surface of the sheet-like conductive member **15** comes into contact with the inner surface of the recess **13**C of the plug contact **13** with a predetermined contact pressure, and the wiring layer **15**E on the back surface of the sheet-like conductive member **15** comes into contact with the pressing portion P**2** of the inner contact **18** with a predetermined contact pressure.

Accordingly, the wiring layer **15**B exposed on the front surface of the sheet-like conductive member **15** is directly electrically connected to the plug contact **13**, and the wiring layer **15**E exposed on the back surface of the sheet-like conductive member **15** is electrically connected to the plug contact **13** via the inner contact **18**. That is, both the wiring layers **15**B and **15**E are connected to the plug contact **13**.

Thus, in the connector **11**, by using the inner contact **18**, both the wiring layer **15**B made of a flexible conductor placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E made of a flexible conductor placed on the back surface side can be electrically connected to one plug contact **13**.

Therefore, when the connector **11** is connected to a sheet-like conductive member in which a flexible conductor is exposed only on the front surface side, the plug contact **13** can be electrically connected to the flexible conductor on the front surface side of the sheet-like conductive member, and when the connector **11** is connected to a sheet-like conductive member in which a flexible conductor is exposed only on the back surface side, the plug contact **13** can be electrically connected to the flexible conductor on the back surface side of the sheet-like conductive member.

Further, when the connector **11** is connected to a sheet-like conductive member in which a flexible conductor is exposed on each of the front surface side and the back surface side like the sheet-like conductive member **15** in Embodiment 1, the plug contact **13** can be electrically connected to both the flexible conductor on the front surface side and the flexible conductor on the back surface side of the sheet-like conductive member. For example, in a case where the connection target is a sheet-like conductive member of a multilayer structure in which a flexible conductor forming a shield layer is exposed on each of the front surface side and the back surface side, and a flexible conductor forming a signal wiring layer is stacked between the shield layers while being insulated from both the shield layers, the plug contact **13** connected to the shield layers on the front surface side and the back surface side is connected to the ground potential, whereby a shielding effect is exerted on the signal wiring layer, and high-accuracy signal transmission can be performed with the influence of disturbance due to electromagnetic waves or the like being suppressed.

While in the connector **11** of Embodiment 1, the reinforcing sheet **14** is placed between the bottom insulator **17** and

the top insulator **16**, the reinforcing sheet **14** can be omitted when it is not necessary to reinforce a mounting target such as a garment to which the connector **11** is attached.

Embodiment 2

FIGS. **18** to **20** show an inner contact **28** used in a connector according to Embodiment 2. The inner contact **28** uses a second constituent portion **28**B and a coupling portion **28**C instead of the second constituent portion **18**B and the coupling portion **18**C in the inner contact **18** used in Embodiment 1 and shown in FIGS. **11** to **13**, and the other configurations are the same as those of the inner contact **18**. That is, in the inner contact **28**, the second constituent portion **28**B is coupled to the first constituent portion **18**A via the coupling portion **28**C.

The second constituent portion **28**B has a pair of arm portions **28**E that extend from both end portions in the Y direction of a connection portion connected with the coupling portion **28**C while curving in the same rotational direction in the XY plane in such a manner as to form a substantially circular cylindrical shape surrounding the fitting axis C.

The outer surfaces of the pair of arm portions **28**E of the second constituent portion **28**B form a pair of pressing portions P**2** that are elastically displaceable in the XY plane orthogonal to the fitting axis C.

The coupling portion **28**C has a flat plate shape along the YZ plane, and couples the first constituent portion **18**A and the second constituent portion **28**B such that the second constituent portion **28**B is located apart from the first constituent portion **18**A on the −Z direction side.

In this manner, the pressing portion P**2** of the second constituent portion **28**B is configured to be elastically displaceable independently of the elastic displacement of the pair of contact portions P**1** of the first constituent portion **18**A.

When the inner contact **28** of such a configuration is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, the pair of contact portions P**1** of the first constituent portion **18**A are pressed against the inner surface of the recess **13**C of the plug contact **13** and the inner contact **28** is electrically connected to the plug contact **13**, and the sheet-like conductive member **15** pushed into the recess **13**C is pressed toward the inner surface of the recess **13**C of the plug contact **13** by the pair of pressing portions P**2** of the inner contact **28**.

Therefore, also when the inner contact **28** shown in FIGS. **18** to **20** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

While in FIGS. **18** to **20**, the pressing portion P**2** is shown only in a central portion of the outer surface of each arm portion **28**E of the second constituent portion **28**B, it is also possible to configure such that the sheet-like conductive member **15** is pressed toward the inner surface of the recess **13**C of the plug contact **13** with pressing portions P**2** that are formed in band shapes along outer peripheral portions of a pair of arm portions **28**E forming a substantially circular cylindrical shape.

Embodiment 3

FIGS. **21** to **24** show an inner contact **38** used in a connector according to Embodiment 3. The inner contact **38** uses a first constituent portion **38**A and a coupling portion **38**C instead of the first constituent portion **18**A and the coupling portion **18**C in the inner contact **18** used in Embodiment 1 and shown in FIGS. **11** to **13**, and the other configurations are the same as those of the inner contact **18**. That is, in the inner contact **38**, the second constituent portion **18**B is coupled to the first constituent portion **38**A via the coupling portion **38**C.

The first constituent portion **38**A has two pairs of cantilever portions **38**D that are arranged to face each other with a space therebetween in the X direction with each cantilever portion **38**D extending along the YZ plane. The two pairs of cantilever portions **38**D are coupled to each other via a curved portion **38**G curved in a U-shape to open in the −Z direction, and each pair of cantilever portions **38**D has a similar structure to the pair of cantilever portions **18**D of the first constituent portion **18**A of the inner contact **18** in Embodiment 1.

The distal ends of the two pairs of cantilever portions **38**D of the first constituent portion **38**A form two pairs of contact portions P**1** that are elastically displaceable in the Y direction orthogonal to the fitting axis C.

The coupling portion **38**C couples the first constituent portion **38**A and the second constituent portion **18**B while being inclined in the X direction with respect to the fitting axis C such that the second constituent portion **18**B is located apart from the first constituent portion **38**A on the −Z direction side.

In this manner, the two pairs of contact portions P**1** of the first constituent portion **38**A are configured to be elastically displaceable independently of the elastic displacement of the four pressing portions P**2** of the second constituent portion **18**B.

When the inner contact **38** of such a configuration is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, the two pairs of contact portions P**1** of the first constituent portion **38**A are pressed against the inner surface of the recess **13**C of the plug contact **13** and the inner contact **38** is electrically connected to the plug contact **13**, and the sheet-like conductive member **15** pushed into the recess **13**C is pressed toward the inner surface of the recess **13**C of the plug contact **13** with the four pressing portions P**2** of the inner contact **38**.

Therefore, also when the inner contact **38** shown in FIGS. **21** to **24** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

When the inner contact **38** in Embodiment 3 is used, the four contact portions P**1** formed in the two pairs of cantilever portions **38**D of the first constituent portion **38**A come into contact with the inner surface of the recess **13**C of the plug contact **13**, and therefore the reliability of the electrical connection between the inner contact **38** and the plug contact **13** is improved.

Embodiment 4

FIGS. **25** to **27** show an inner contact **48** used in a connector according to Embodiment 4. The inner contact **48** uses a second constituent portion **48**B and a coupling portion **48**C instead of the second constituent portion **18**B and the coupling portion **18**C in the inner contact **18** used in

Embodiment 1 and shown in FIGS. **11** to **13**, and the other configurations are the same as those of the inner contact **18**. That is, in the inner contact **48**, the second constituent portion **48**B is coupled to the first constituent portion **18**A via the coupling portion **48**C.

The second constituent portion **48**B has one arm portion **48**E that extends from an end portion in the +Y direction of the connection portion connected with the coupling portion **48**C while curving in the XY plane in such a manner as to form a substantially circular cylindrical shape surrounding the fitting axis C.

The outer surface of the one arm portion **48**E of the second constituent portion **48**B forms a pair of pressing portions P**2** that are elastically displaceable in the XY plane orthogonal to the fitting axis C.

The coupling portion **48**C has a flat plate shape along the YZ plane, and couples the first constituent portion **18**A and the second constituent portion **48**B such that the second constituent portion **48**B is located apart from the first constituent portion **18**A on the −Z direction side.

In this manner, the pressing portion P**2** of the second constituent portion **48**B is configured to be elastically displaceable independently of the elastic displacement of the pair of contact portions P**1** of the first constituent portion **18**A.

When the inner contact **48** of such a configuration is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, the pair of contact portions P**1** of the first constituent portion **18**A are pressed against the inner surface of the recess **13**C of the plug contact **13** and the inner contact **48** is electrically connected to the plug contact **13**, and the sheet-like conductive member **15** pushed into the recess **13**C is pressed toward the inner surface of the recess **13**C of the plug contact **13** with the pair of pressing portions P**2** of the inner contact **48**.

Therefore, also when the inner contact **48** shown in FIGS. **25** to **27** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

While in FIGS. **25** to **27**, the pressing portion P**2** is shown only at a most +X directional point and a most −X directional point on the outer surface of the arm portion **48**E of the second constituent portion **48**B, it is also possible to configure such that the sheet-like conductive member **15** is pressed toward the inner surface of the recess **13**C of the plug contact **13** with a pressing portion P**2** that is formed in a band shape along an outer peripheral portion of an arm portion **48**E forming a substantially circular cylindrical shape.

Embodiment 5

FIGS. **28** to **30** show an inner contact **58** used in a connector according to Embodiment 5. The inner contact **58** uses a first constituent portion **58**A and a coupling portion **58**C instead of the first constituent portion **18**A and the coupling portion **28**C in the inner contact **28** used in Embodiment 2 and shown in FIGS. **18** to **20**, and the other configurations are the same as those of the inner contact **28**. That is, in the inner contact **58**, the second constituent portion **28**B is coupled to the first constituent portion **58**A via the coupling portion **58**C.

The first constituent portion **58**A has a flat shape extending along the YZ plane, and has one cantilever portion **18**D that extends in the −Z direction on the +Y direction side of the fitting axis C with the distal end thereof extending in the +Y direction and a flat plate portion **58**G extending along the YZ plane on the −Y direction side of the fitting axis C.

The cantilever portion **18**D is the same as the cantilever portion **18**D of the first constituent portion **18**A of the inner contact **28** used in Embodiment 2 and has its distal end extending in the +Y direction, and the flat plate portion **58**G has its distal end extending in the −Y direction at the −Z directional end.

A contact portion P**1** is formed at each of the distal end extending in the +Y direction of the cantilever portion **18**D and the distal end extending in the −Y direction of the flat plate portion **58**G. Due to elastic deformation of the cantilever portion **18**D having a shape extending in the −Z direction, the pair of contact portions P**1** formed at the distal end of the cantilever portion **18**D and the distal end of the flat plate portion **58**G can be elastically displaced mutually in the Y direction orthogonal to the fitting axis C.

The coupling portion **58**C has a flat plate shape along the YZ plane, and couples the first constituent portion **58**A and the second constituent portion **28**B such that the second constituent portion **28**B is located apart from the first constituent portion **58**A on the −Z direction side.

In this manner, the pressing portion P**2** of the second constituent portion **28**B is configured to be elastically displaceable independently of the elastic displacement of the pair of contact portions P**1** of the first constituent portion **58**A.

When the inner contact **58** of such a configuration is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, the pair of contact portions P**1** of the first constituent portion **58**A are pressed against the inner surface of the recess **13**C of the plug contact **13** and the inner contact **58** is electrically connected to the plug contact **13**, and the sheet-like conductive member **15** pushed into the recess **13**C is pressed toward the inner surface of the recess **13**C of the plug contact **13** with the pair of pressing portions P**2** of the inner contact **58**.

Therefore, also when the inner contact **58** shown in FIGS. **28** to **30** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

While in FIGS. **28** to **30**, the pressing portion P**2** is shown only in a central portion of the outer surface of each arm portion **28**E of the second constituent portion **28**B, it is also possible to configure such that the sheet-like conductive member **15** is pressed toward the inner surface of the recess **13**C of the plug contact **13** with pressing portions P**2** that are formed in band shapes along outer peripheral portions of a pair of arm portions **28**E forming a substantially circular cylindrical shape.

Embodiment 6

FIGS. **31** to **33** show an inner contact **68** used in a connector according to Embodiment 6. The inner contact **68** uses a first constituent portion **68**A and a coupling portion **68**C instead of the first constituent portion **18**A and the coupling portion **28**C in the inner contact **28** used in

Embodiment 2 and shown in FIGS. **18** to **20**, and the other configurations are the same as those of the inner contact **28**. That is, in the inner contact **68**, the second constituent portion **28**B is coupled to the first constituent portion **68**A via the coupling portion **68**C.

The first constituent portion **68**A has a double supported beam portion **68**G extending in both the Y direction orthogonal to the fitting axis C and the +Z direction along the fitting axis C in the YZ plane. The double supported beam portion **68**G extends along the circumference of an opening **68**H located in the fitting axis C such that the double supported beam portion **68**G surrounds the opening **68**H, and both ends of the double supported beam portion **68**G are connected to the +Y directional end and the −Y directional end of a base portion of the first constituent portion **68**A connected to the coupling portion **68**C. A pair of contact portions P**1** oriented in opposite directions to each other in the Y direction are formed in the double supported beam portion **68**G. Each of the contact portions P**1** is configured to be elastically displaceable in the Y direction with elastic deformation of the double supported beam portion **68**G.

The coupling portion **68**C has a flat plate shape along the YZ plane, and couples the first constituent portion **68**A and the second constituent portion **28**B such that the second constituent portion **28**B is located apart from the first constituent portion **68**A on the −Z direction side.

Thereby, the pressing portion P**2** of the second constituent portion **28**B is configured to be elastically displaceable independently of the elastic displacement of the pair of contact portions P**1** of the first constituent portion **68**A.

When the inner contact **68** of such a configuration is inserted into the recess **13**C of the plug contact **13** while pushing the sheet-like conductive member **15** therein, the pair of contact portions P**1** of the first constituent portion **68**A are pressed against the inner surface of the recess **13**C of the plug contact **13** and the inner contact **68** is electrically connected to the plug contact **13**, and the sheet-like conductive member **15** pushed into the recess **13**C is pressed toward the inner surface of the recess **13**C of the plug contact **13** with the pair of pressing portions P**2** of the inner contact **68**.

Therefore, also when the inner contact **68** shown in FIGS. **31** to **33** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

Although in FIGS. **31** to **33** the pressing portion P**2** is shown only in a central portion of the outer surface of each arm portion **28**E of the second constituent portion **28**B, it is also possible to configure such that the sheet-like conductive member **15** is pressed toward the inner surface of the recess **13**C of the plug contact **13** by pressing portions P**2** that are formed in band shapes along outer peripheral portions of a pair of arm portions **28**E forming a substantially circular cylindrical shape.

Embodiment 7

FIG. **34** shows an inner contact **78** used in a connector according to Embodiment 7. The inner contact **78** uses a first constituent portion **78**A instead of the first constituent portion **68**A in the inner contact **68** used in Embodiment 6 and shown in FIGS. **31** to **33**, and the other configurations are the same as those of the inner contact **68**. That is, in the inner contact **78**, the second constituent portion **28**B is coupled to the first constituent portion **78**A via the coupling portion **68**C.

The first constituent portion **78**A is configured such that an auxiliary coupling portion **78**J is formed in the double supported beam portion **68**G in the first constituent portion **68**A of the inner contact **68** in Embodiment 6. The auxiliary coupling portion **78**J extends along the fitting axis C to divide the opening **68**H surrounded by the double supported beam portion **68**G into two in the Y direction, and couples a base portion of the first constituent portion **78**A connected to the coupling portion **68**C and the +Z directional end of the double supported beam portion **68**G.

A contact portion P**1** that is elastically displaceable in the Y direction is formed in each of a portion of the double supported beam portion **68**G located on the +Y direction side of the auxiliary coupling portion **78**J and a portion of the double supported beam portion **68**G located on the −Y direction side of the auxiliary coupling portion **78**J.

Also when the inner contact **78** shown in FIG. **34** is used instead of the inner contact **18** in the connector **11** according to Embodiment 1, similarly both the wiring layer **15**B placed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E placed on the back surface side of the sheet-like conductive member **15** can be electrically connected to the plug contact **13**.

In Embodiments 1 to 7 above, the plug contact **13** placed in the contact placement region **15**A of the sheet-like conductive member **15** is connected to both the wiring layer **15**B exposed on the front surface side of the sheet-like conductive member **15** and the wiring layer **15**E exposed on the back surface side of the sheet-like conductive member **15**; meanwhile, for example, it is also possible to configure such that only the wiring layer **15**E exposed on the back surface side of the sheet-like conductive member **15** is connected to the plug contact **13** placed in the contact placement region **15**A.

While the sheet-like conductive member **15** used in Embodiments 1 to 7 above has a multilayer structure, the sheet-like conductive member is not limited thereto, and may have any structure as long as it has a flexible conductor exposed on at least one surface.

Further, while in Embodiments 1 to 7 above, the two layers of flexible conductors of the wiring layer **15**B and the wiring layer **15**E of the sheet-like conductive member **15** are connected to one plug contact **13**, the configuration is not limited thereto, and three or more layers of flexible conductors may be connected to one plug contact **13**.

Further, while the connector **11** according to Embodiments 1 to 7 above includes four plug contacts **13**, the configuration is not limited to this number of plug contacts **13**, and may be any configuration as long as it includes at least one plug contact **13** to be electrically connected to a flexible conductor exposed on at least one surface of the sheet-like conductive member **15**.

What is claimed is:

1. A connector comprising:

a plug contact of cylindrical shape, the plug contact being conductive and having a recess extending along a fitting axis; and

an inner contact formed of a plate member, the inner contact being conductive and inserted into the recess,

wherein the plate member includes:

a first constituent portion including a contact portion that is elastically displaceable in a direction orthogonal to the fitting axis and that comes into contact with the plug contact in the recess;

a second constituent portion including a pressing portion that is elastically displaceable in a direction orthogonal to the fitting axis independently of elastic displacement of the contact portion of the first constituent portion; and

a coupling portion that couples the first constituent portion and the second constituent portion such that the first constituent portion and the second constituent portion are apart from each other along the fitting axis, and

part of a connection target of sheet-like shape in which a flexible conductor is exposed on at least one surface is sandwiched between the pressing portion and an inner surface of the recess in a direction orthogonal to the fitting axis, and the inner surface of the recess comes into contact with a front surface of the connection target while the pressing portion comes into contact with a back surface of the connection target, whereby the plug contact is directly electrically connected to the flexible conductor in a case where the flexible conductor is exposed on the front surface of the connection target, and the plug contact is electrically connected to the flexible conductor via the inner contact in a case where the flexible conductor is exposed on the back surface of the connection target.

2. The connector according to claim **1**,

wherein the plug contact has a cylindrical portion and a flange formed at one end of the cylindrical portion, and

the recess is formed of an interior of the cylindrical portion.

3. The connector according to claim **2**, comprising

a housing for holding the connection target, the plug contact, and the inner contact, the housing having insulating property

wherein the housing includes:

a top insulator provided with a contact through hole that is penetrated by the cylindrical portion of the plug contact and that is smaller than the flange; and

a bottom insulator provided with a holding hole for holding the inner contact, and

the top insulator is fixed to the bottom insulator such that the cylindrical portion of the plug contact penetrates the contact through hole and that the connection target and the flange are sandwiched between the top insulator and the bottom insulator.

4. The connector according to claim **1**, wherein the second constituent portion is placed on a side nearer to an opening end portion of the recess than the first constituent portion.

5. The connector according to claim **4**,

wherein the first constituent portion has a cantilever portion placed on one side of the fitting axis and extending in a direction orthogonal to the fitting axis and a flat plate portion placed on another side of the fitting axis and extending in a direction orthogonal to the fitting axis, and

the contact portion is formed at each of distal ends of the cantilever portion and the flat plate portion.

6. The connector according to claim **4**,

wherein the first constituent portion has at least two cantilever portions separately arranged on both sides of the fitting axis across the fitting axis, the cantilever portions each extending in a direction orthogonal to the fitting axis, and

the contact portion is formed at each of distal ends of the at least two cantilever portions.

7. The connector according to claim **6**, wherein the first constituent portion has two pairs of the cantilever portions, the two pairs being coupled to each other and arranged to face each other.

8. The connector according to claim **4**,

wherein the first constituent portion has a double supported beam portion extending in both a direction orthogonal to the fitting axis and a direction along the fitting axis, and

a pair of contact portions oriented in opposite directions to each other in a direction orthogonal to the fitting axis are formed in the double supported beam portion.

9. The connector according to claim **8**, wherein the first constituent portion has an auxiliary coupling portion that extends along the fitting axis and that couples a distal end portion of the double supported beam portion and a base portion of the first constituent portion in a direction along the fitting axis.

10. The connector according to claim **4**,

wherein the second constituent portion has at least one arm portion bent or curved around the fitting axis, and

the pressing portion is formed on an outer surface oriented in a direction orthogonal to the fitting axis of the at least one arm portion.

11. The connector according to claim **10**, wherein the second constituent portion has a pair of arm portions bent or curved in opposite directions to each other.

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