(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 591 682 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
08.01.2020 Bulletin 2020/02

(21) Application number: **18761352.6**

(22) Date of filing: **28.02.2018**

(51) Int Cl.:
H01H 13/16 *(2006.01)* ***A47C 7/62*** *(2006.01)*
H01H 35/00 *(2006.01)*

(86) International application number:
PCT/JP2018/007590

(87) International publication number:
WO 2018/159704 (07.09.2018 Gazette 2018/36)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(30) Priority: **28.02.2017 JP 2017037786**

(71) Applicant: **Fujikura Ltd.**
Tokyo 135-8512 (JP)

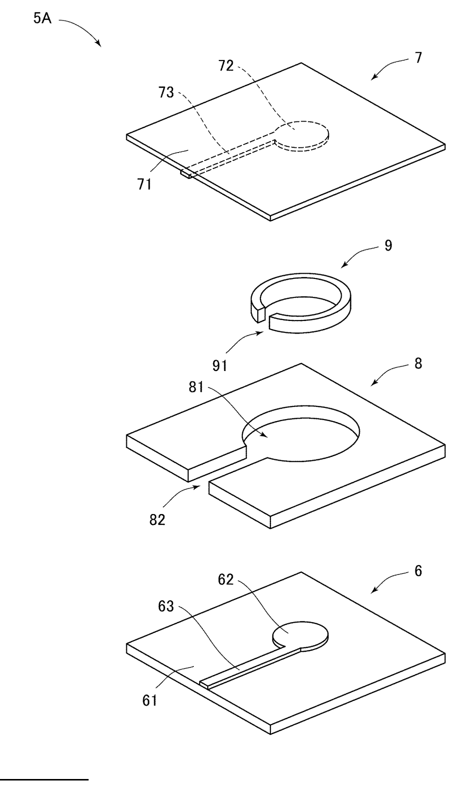
(72) Inventors:
- **KAMESHIMA, Takashi**
Sakura-shi, Chiba 285-8550 (JP)
- **KAWAHIRA, Tetsuya**
Tokyo 135-8512 (JP)
- **HAYASHI, Eriko**
Tokyo 135-8512 (JP)
- **NAKAZAKI, Shigeru**
Tokyo 135-8512 (JP)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) LOAD DETECTION SENSOR

(57) A load detection sensor (5A) includes: a first electrode sheet (6) including a first electrode (62); a second electrode sheet (7) including a second electrode (72) opposed to the first electrode (62); a spacer (8) interposed between the first electrode sheet (6) and the second electrode sheet (7), the spacer (8) having an opening (81) between the first electrode (62) and the second electrode (72); an annular member (9) disposed in the opening (81); and an adhesive layer (10) disposed at least either between the spacer (8) and the first electrode sheet (6) or between the spacer (8) and the second electrode sheet (7). The annular member (9) is in contact with at least one of the first electrode sheet (6) exposed at the opening (81) and the second electrode sheet (7) exposed at the opening (81), and has no adhesion to both of the first electrode sheet (6) and the second electrode sheet (7).

FIG. 1



EP 3 591 682 A1

Description

Technical Field

[0001] The present invention relates to a load detection sensor suitable for detection of a load due to, for example, seating.

Background Art

[0002] As a safety system in a vehicle, an alarm system for warning that a seat belt has not been fastened at boarding, has been commercially practical. In the alarm system, a warning is issued in a case where it is not sensed that a seat belt has been fastened, with person's seating sensed. As a device that senses seating of a person, a load detection sensor that detects a load due to seating, is used in some cases.

[0003] Patent Literature 1 discloses a load detection sensor including: a pair of resin films; and a pair of electrodes provided on the pair of resin films, respectively, the pair of electrodes being opposed to each other at a predetermined interval. The pair of films of the load detection sensor described in Patent Literature 1 bonds together through glue disposed outside between the mutually opposed electrodes.

[0004] [Patent Literature 1] JPH09-315199 A

Summary of Invention

[0005] However, generally, such glue tends to soften due to a rise in temperature. Therefore, in a case where the load detection sensor described in Patent Literature 1 is subjected to a high-temperature environment, such as the inside of a motor vehicle under a blazing sun, there is concern that a drop occurs in the load necessary for contact between the respective electrodes provided at the films. Meanwhile, in a case where the load detection sensor described in Patent Literature 1 is subjected to a low-temperature environment at approximately -40°C, there is concern that a rise occurs in the load necessary for contact between the respective electrodes provided at the films due to hardening of the glue.

[0006] In some cases, long-term pressing causes such glue to be creep-deformed. Creep deformation of the glue varies the distance between the resin films, and thus there is concern that a variation occurs in the load necessary for contact between the respective electrodes provided at the films.

[0007] Thus, according to the load detection sensor in Patent Literature 1, the load necessary for contact between the electrodes provided at the films varies along with a variation in temperature or a variation in age, and thus there is a possibility that a proper load cannot be detected.

[0008] Therefore, an object of the present invention is to provide a load detection sensor capable of detecting a load properly.

[0009] In order to solve the problems, a load detection sensor according to the present invention includes: a first electrode sheet including a first electrode; a second electrode sheet including a second electrode opposed to the first electrode; a spacer interposed between the first electrode sheet and the second electrode sheet, the spacer having an opening between the first electrode and the second electrode; an annular member disposed in the opening; and an adhesive layer disposed at least either between the spacer and the first electrode sheet or between the spacer and the second electrode sheet, in which the annular member is in contact with at least one of the first electrode sheet exposed at the opening and the second electrode sheet exposed at the opening, and has no adhesion to both of the first electrode sheet and the second electrode sheet.

[0010] In the load detection sensor, the first electrode sheet exposed at the opening of the spacer and the second electrode sheet exposed at the opening of the spacer are supported by the annular member disposed in the opening. The annular member has no adhesion to both of the first electrode sheet exposed at the opening of the spacer and the second electrode sheet exposed at the opening of the spacer. Thus, in comparison to a case where the annular member adheres to at least one of the first electrode sheet and the second electrode sheet through an adhesive layer, there is no influence of the adhesive layer due to a variation in temperature.

[0011] That is the adhesive layer tends to soften under a high-temperature environment and tends to harden under a low-temperature environment, easily. Thus, in a case where no annular member is provided, variation of the adhesive layer at the edge portion of the opening of the spacer, corresponding to a temperature environment, causes a variation in the degree of inward deflection to the opening of the spacer between the first electrode sheet and the second electrode sheet. The variation in the degree of deflection causes a variation in the load necessary for contact between the first electrode and the second electrode. In contrast to this, because the annular member disposed in the opening of the spacer has no adhesion to both of the first electrode sheet and the second electrode sheet, a variation in temperature environment due to the adhesive layer does not occur at the edge portion of the opening of the annular member. Thus, the degree of inward deflection inside the annular member in the opening of the spacer due to pressing of at least one of the first electrode sheet and the second electrode sheet, substantially does not change. Thus, in comparison to a case where the annular member adheres to at least one of the first electrode sheet and the second electrode sheet through an adhesive layer, the load necessary for contact between the first electrode and the second electrode can be prevented from varying.

[0012] The presence of the annular member causes less load to be applied to the adhesive layer, and thus the adhesive layer is less likely to be creep-deformed. Even if the adhesive layer is creep-deformed by long-term pressing of the load detection sensor, the distance between the first electrode sheet and the second electrode sheet is substantially constantly retained by the annular member. As a result, variation in the load necessary for contact between the first electrode and the second electrode along with creep deformation, is reduced.

[0013] Thus, the load detection sensor capable of detecting a load properly, is achieved.

[0014] Preferably, the annular member is in contact with both of the first electrode sheet and the second electrode sheet.

[0015] In this case, because there is no gap between the first electrode sheet exposed at the opening of the spacer, the second electrode sheet exposed at the opening of the spacer, and the annular member, the annular member can support the first electrode sheet and the second electrode sheet, more stably. Therefore, variation in the load necessary for contact between the first electrode and the second electrode, can be further reduced.

[0016] Preferably, at least part of an outer circumferential face of the annular member is spaced apart from the spacer.

[0017] Even when the adhesive layer disposed at least either between the spacer and the first electrode sheet or between the spacer and the second electrode sheet softens and flows into the opening side due to the load detection sensor under a high-temperature environment, the adhesive layer can be stored in the gap between the annular member and the spacer. Therefore, flowing of the softened adhesive layer between the annular member and the first electrode sheet or the second electrode sheet, is avoided. As a result, variation in the load necessary for contact between the first electrode and the second electrode, can be further reduced.

[0018] Preferably, the annular member is identical in material to the spacer.

[0019] In this case, the annular member is approximately equivalent in expansion due to the load detection sensor under a high-temperature environment, to the spacer. Thus, the distance between the first electrode sheet and the second electrode sheet is substantially constantly retained. Therefore, variation of the inter-electrode distance due to thermal expansion is reduced. As a result, variation in load can be further reduced.

[0020] Preferably, the annular member has a vent for deflation of air in the opening of the spacer.

[0021] In this case, when inward deflection of the first electrode sheet or the second electrode sheet inside the annular member in the opening of the spacer causes contact between the first electrode and the second electrode, the air in the opening of the spacer discharges from the vent. Therefore, inhibition of deflection of the second electrode sheet due to the air in the opening of the spacer, is avoided, so that the load detection sensor can be prevented from performing false detection.

[0022] Preferably, the spacer has a slit connected to the opening, at least one of the first electrode sheet and the second electrode sheet has an air outlet, and a communication member is disposed in the slit, the communication member allowing communication between the vent of the annular member and the air outlet.

[0023] In this case, when inward deflection of the first electrode sheet or the second electrode sheet inside the annular member in the opening of the spacer causes contact between the first electrode and the second electrode, the air in the opening of the spacer discharges from the air outlet to the outside of the load detection sensor through the communication member. Therefore, inhibition of deflection of the first electrode sheet or the second electrode sheet due to the air in the opening of the spacer, is avoided, so that the load detection sensor can be prevented from performing false detection.

[0024] Preferably, the spacer has a slit connected to the opening, at least one of the first electrode sheet and the second electrode sheet includes a pair of wires mutually adjacently spaced part and an air outlet, an end of the pair of wires is located inside the annular member, and a communicating-passage formation member is disposed in the slit, the communicating-passage formation member forming a gap between the pair of wires as a communicating passage allowing communication between an inside of the annular member in the opening of the spacer and the air outlet.

[0025] In this case, when inward deflection of at least one of the first electrode sheet and the second electrode sheet inside the annular member in the opening of the spacer causes contact between the first electrode and the second electrode, the air inside the annular member in the opening of the spacer discharges from the air outlet to the outside of the load detection sensor through the gap between the pair of wires formed by the communicating-passage formation member. Therefore, inhibition of deflection of the first electrode sheet or the second electrode sheet due to the air inside the annular member, is avoided, so that the load detection sensor can be prevented from performing false detection due to the inhibition of electrode-sheet deflection due to the air.

[0026] Preferably, in a case where a sheet face of the first electrode sheet is viewed in plan view, the annular member overlaps the first electrode and the second electrode.

[0027] In this case, the annular member is interposed between the first electrode and the second electrode. Thus, even when the first electrode itself and the second electrode itself each have variation in thickness, the distance between the first electrode and the second electrode is substantially constantly retained by the annular member. Therefore, the variation in distance between the first electrode and the second electrode between a plurality of load detection sensors can be reduced by the annular member, so that the variation in the load necessary for contact between the first electrode and the second electrode between the load detection sensors is reduced.

[0028] Preferably, a sum of a thickness of the spacer and a thickness of the adhesive layer is approximately equivalent to a sum of a height of the annular member, a thickness of the first electrode, and a thickness of the second electrode.

[0029] In this case, even when the annular member has no adhesion to the first electrode sheet and the second electrode sheet, the annular member is inhibited from moving in the opening of the spacer. Under no load in which no load is applied to the load detection sensor, stress can be prevented from occurring in a direction in which the spacer and the electrode sheet adhering through the adhesive layer peel off.

[0030] Preferably, in a case where a sheet face of the first electrode sheet is viewed in plan view, the annular member does not overlap the first electrode and the second electrode.

[0031] In this case, the first electrode and the second electrode can be less damaged in comparison to a case where the annular member overlaps the first electrode and the second electrode.

[0032] Preferably, a sum of a thickness of the spacer and a thickness of the adhesive layer is approximately equivalent to a height of the annular member.

[0033] In this case, even when the annular member has no adhesion to the first insulating sheet and the second insulating sheet, the annular member is inhibited from moving in the opening of the spacer. Under no load in which no load is applied to the load detection sensor, stress can be prevented from occurring in a direction in which the spacer and the electrode sheet adhering through the adhesive layer peel off.

[0034] According to the present invention described above, the load detection sensor capable of detecting a load properly, can be provided.

Brief Description of Drawings

[0035]

FIG. 1 is an exploded view of the configuration of a load detection sensor according to a first embodiment.
FIG. 2 is a sectional view of the configuration of the load detection sensor.
FIG. 3 is a view of the ON state of the load detection sensor.
FIG. 4 is an exploded view of the configuration of a load detection sensor unit according to a second embodiment.
FIG. 5 is a sectional view of the load detection sensor unit attached to S-shaped springs of a seat device.
FIG. 6 is an exploded view of a load detection sensor according to the second embodiment.
FIG. 7 is a sectional view of the load detection sensor according to the second embodiment.
FIG. 8 is a view of a sheet face of a first electrode sheet of the load detection sensor in plan view.
FIG. 9 is a view of the ON state of the load detection sensor unit.
FIG. 10 is a sectional view of a load detection sensor according to a third embodiment.
FIG. 11 is an exploded view of the configuration of a load detection sensor according to a fourth embodiment.
FIG. 12 is a view of the load detection sensor in plan view from the second electrode sheet side.
FIG. 13 is an exploded view of the configuration of a load detection sensor according to a fifth embodiment.
FIG. 14 is a sectional view of the load detection sensor taken along line X-X of FIG. 13.
FIG. 15 is an exploded view of the configuration of a load detection sensor according to a sixth embodiment.
FIG. 16 is a table of part of experimental conditions and experimental results.
FIG. 17 is a table of part of other experimental conditions and experimental results.

Description of Embodiments

[0036] Preferred embodiments of a load detection sensor unit according to the present invention, will be described in detail below with reference to the drawings. Note that, for ease in understanding, in some cases, the respective scales of the figures are different from the scales described in the following description.

(1) First Embodiment

[0037] FIG. 1 is an exploded view of the configuration of a load detection sensor according to a first embodiment. FIG. 2 is a sectional view of the configuration of the load detection sensor. As illustrated in FIGS. 1 and 2, the load detection sensor 5A includes a first electrode sheet 6, a second electrode sheet 7, a spacer 8, an annular member 9, and adhesive layers 10 as main constituent elements. Note that, for convenience, the adhesive layers 10 are omitted in FIG. 1.

[0038] The first electrode sheet 6 includes a first insulating sheet 61 and a first electrode 62. The first insulating sheet 61 is a resin insulating sheet having flexibility. Examples of reins as the material of the first insulating sheet 61 include polyethylene terephthalate (PET), polyimide (PI), and polyethylene naphthalate (PEN).

[0039] The first electrode 62 that is one switch element included in a switch SW in the load detection sensor 5A (FIG. 2), includes, for example, a substantially-circular metallic printed layer. The first electrode 62 disposed on one surface of the first insulating sheet 61, is electrically connected to one terminal of a pair of terminals through a first wire 63.

[0040] The second electrode sheet 7 includes a second insulating sheet 71 and a second electrode 72. The second insulating sheet 71 disposed on the pressing portion PP (FIG. 2) side with respect to the first electrode sheet 6, is a film-shaped insulating sheet having flexibility. The pressing portion PP for pressing the switch SW of the load detection sensor 5A (FIG. 2), is secured to, for example, a member different from the load detection sensor 5A. Referring to FIG. 2, the leading end of the pressing portion PP has a flat shape, but may have a protruding curved shape. The leading end of the pressing portion PP is usually in no-contact with the second insulating sheet 71 of the second electrode sheet 7, but may be in contact with the second insulating sheet 71. Similarly to the first insulating sheet 61, examples of resins as the material of the second insulating sheet 71 include PET, PI, and PEN. The second insulating sheet 71 may be identical in material to or different in material from the first insulating sheet 61.

[0041] The second electrode 72 that is the other switch element included in the switch SW of the load detection sensor 5A (FIG. 2), includes, for example, a substantially-circular metallic printed layer. The second electrode 72 disposed on one surface of the second insulating sheet 71, is electrically connected to the other terminal of the pair of terminals through a second wire 73. Note that, according to the present embodiment, the second electrode 72 is identical in size to the first electrode 62.

[0042] The spacer 8 interposed between the first electrode sheet 6 and the second electrode sheet 7, includes a resin insulating sheet having flexibility. Similarly to the first insulating sheet 61 and the second insulating sheet 71, examples of resins as the material of the spacer 8 include PET, PI, and PEN. Note that the spacer 8 may be identical in material to or different in material from the first insulating sheet 61 or the second insulating sheet 71.

[0043] The spacer 8 has an opening 81 penetrating from one face side to the other face side of the spacer 8. The circumferential-edge shape of the opening 81 is, for example, substantially circular. The opening 81 is formed larger in diameter than the first electrode 62 and the second electrode 72.

[0044] Furthermore, the spacer 8 has a slit 82 allowing communication between the space in the opening 81 and the external space of the load detection sensor 5A. The slit 82 serves as an air vent with the spacer 8 superimposed on the first electrode sheet 6 and the second electrode sheet 7. The air vent is a passage for deflation of the air in the opening 81 to the outside of the load detection sensor 5A.

[0045] The annular member 9 is a member in an annular shape disposed in the opening 81 of the spacer 8. The outer diameter of the annular member 9 is smaller than the diameter of the opening 81 of the spacer 8, and the inner diameter of the annular member 9 is larger than the diameters of the first electrode 62 and the second electrode 72. The height of the annular member 9 is approximately equivalent to the sum of the thickness of the adhesive layer 10 between the first insulating sheet 61 and the spacer 8, the thickness of the adhesive layer 10 between the second insulating sheet 71 and the spacer 8, and the thickness of the spacer 8. Note that, for the annular member 9, in a case where a sheet face of the first electrode sheet 6 is viewed in plan view in plan view, the annular member 9 does not overlap the first electrode 62 and the second electrode 72.

[0046] Similarly to the first insulating sheet 61, the second insulating sheet 71, and the spacer 8, examples of resins as the material of the annular member 9 include PET, PI, and PEN. Note that the annular member 9 may be identical in material to or different in material from the spacer 8, the first insulating sheet 61, or the second insulating sheet 71. Note that the spacer 8 and the annular member 9 are preferably identical in material in order to reduce a variation due to expansion between the height of the annular member 9 and the height of the spacer 8 and the adhesive layers 10.

[0047] The annular member 9 has a vent 91 for deflation of the air inside the annular member 9, namely, in the opening of the annular member 9 in the opening 81 of the spacer 8. According to the present embodiment, the vent 91 is a slit formed from one end to the other end in the height direction of the annular member 9, but may be a through hole penetrating from the outer circumferential face to the inner circumferential face of the annular member. Note that the annular member 9 according to the present embodiment has a break at part in the circumferential direction of the annular member 9 due to the vent 91. The length of the break in the circumferential direction of the annular member 9, is preferably not more than one fifth of the entire length in the circumferential direction of the annular member 9 including the break. According to the present embodiment, one break is provided, but a plurality of breaks may be provided. Note that, in a case where a plurality of breaks is provided, the sum of the lengths of the breaks in the circumferential direction of the annular member 9 is preferably not more than one third of the entire length in the circumferential direction of the annular member 9 including the plurality of breaks. Thus, as long as a ring-like shape exists, the annular member 9 includes one break or intermittent breaks. Note that, from the viewpoint of inhibition of the man-hour for assembly from increasing due to division of the annular member 9 into a plurality of members or from the viewpoint of inhibition of a variation in load due to the annular member deviated in arrangement by, for example, vibration due to division of the annular member 9 into a plurality of members, preferably, the number of breaks is one or less.

[0048] The respective adhesive layers 10 are disposed between the first insulating sheet 61 of the first electrode sheet

6 and the spacer 8 and between the second insulating sheet 71 of the second electrode sheet 7 and the spacer 8. The adhesive layers 10 are not particularly limited as long as the first insulating sheet 61, the second insulating sheet 71, and the spacer 8 bond together. Examples of the adhesive layers 10 include glue, adhesive, and double-sided tape including a base material, such as PET or nonwoven fabric, having each face provided with glue or adhesive. Examples of the material of the adhesive layers 10 include thermoplastic resin, thermosetting resin, and photo-curable resin. Note that examples of the glue include silicon glue, urethane glue, and acrylic glue. The respective adhesive layers 10 may be disposed over the entire faces between the first insulating sheet 61 and the spacer 8 and over the entire faces between the second insulating sheet 71 and the spacer 8. Alternatively, the respective adhesive layers 10 may be dispersedly disposed at a plurality of portions between the first insulating sheet 61 and the spacer 8 and at a plurality of portions between the second insulating sheet 71 and the spacer 8. The annular member 9 is preferably larger in elastic modulus than the adhesive layers 10.

[0049] The load detection sensor 5A includes the above constituent elements in combination. That is the load detection sensor 5A includes the first electrode sheet 6 adhering on the one face side of the spacer 8 through the adhesive layer 10 and the second electrode sheet 7 adhering on the other face side of the spacer 8 through the adhesive layer 10 with the annular member 9 disposed in the opening 81 of the spacer 8.

[0050] In the load detection sensor 5A, the annular member 9 is in contact with both of the first insulating sheet 61 exposed on one opening face side of the opening 81 of the spacer 8 and the second insulating sheet 71 exposed on the other opening face side of the opening 81. Specifically, one end of the annular member 9 is in contact with the inner circumferential portion exposed from the opening 81, in the first insulating sheet 61, and the other end of the annular member 9 is in contact with the inner circumferential portion exposed from the opening 81, in the second insulating sheet 71. Therefore, the annular member 9 can support the inner circumferential portion exposed from the opening 81, in the first insulating sheet 61 and the inner circumferential portion exposed from the opening 81, in the second insulating sheet 71. Note that the annular member 9 has no adhesion to both of the first insulating sheet 61 exposed on the one opening face side of the opening 81 of the spacer 8 and the second insulating sheet 71 exposed on the other opening face side of the opening 81.

[0051] In the load detection sensor 5A, the vent 91 of the annular member 9 is in communication with the outside of the load detection sensor 5A through the slit 82 of the spacer 8, with the outer circumferential face of the annular member 9 disposed apart from the spacer 8. Note that only part of the outer circumferential face of the annular member 9 may be in contact with the spacer 8. That is the outer circumferential face of the annular member 9 requires at least spacing apart from part of the spacer 8.

[0052] Furthermore, in the load detection sensor 5A, the first electrode 62 is located inside one opening end in the annular member 9, and the second electrode 72 is located inside the other opening end in the annular member 9. The first electrode 62 and the second electrode 72 opposed to each other inside the annular member 9, are included in the switch SW.

[0053] Next, detection of a load by the load detection sensor 5A according to the present embodiment, will be described.

[0054] FIG. 3 is a view of the ON state of the load detection sensor 5A. Downward movement of the pressing portion PP due to reception of a load, causes contact with the face opposite to the face on the spacer 8 side of the second insulating sheet 71 of the second electrode sheet 7, resulting in pressing of the second insulating sheet 71. Inward deflection of the second insulating sheet 71 inside the annular member 9 due to the press of the pressing portion PP, causes the second electrode 72 in contact with the first electrode 62, so that the switch SW of the load detection sensor 5A changes to the ON state. In this case, the load is detected by a vehicular control unit, not illustrated, electrically connected to the second electrode 72 and the first electrode 62.

[0055] Note that deflection of the second insulating sheet 71 causes the air inside the annular member 9 to discharge outside the annular member 9 through the vent 91 of the annular member 9 and causes the air in the opening 81 of the spacer 8 to discharge through the slit 82. Therefore, inhibition of deflection between the first insulating sheet 61 and the second insulating sheet 71 due to the air inside the annular member 9 and the air in the opening 81 of the spacer 8, is avoided, so that the switch SW of the load detection sensor 5A changes to the ON state, properly.

[0056] As described above, the load detection sensor 5A according to the present embodiment includes: the first electrode sheet 6 including the first electrode 62; the second electrode sheet 7 including the second electrode 72 opposed to the first electrode 62; and the spacer 8 interposed between the first electrode sheet 6 and the second electrode sheet 7, the spacer 8 having the opening 81 between the first electrode 62 and the second electrode 72. The load detection sensor 5A includes: the annular member 9 disposed in the opening 81 of the spacer 8; and the respective adhesive layers 10 disposed between the spacer 8 and the first electrode sheet 6 and between the spacer 8 and the second electrode sheet 7.

[0057] In the load detection sensor 5A, because the annular member 9 is disposed in the opening 81 of the spacer 8, the annular member 9 supports the inner circumferential portion exposed from the opening 81 of the first electrode sheet 6 and the inner circumferential portion exposed from the opening 81 of the second electrode sheet 7. The annular member 9 has no adhesion to both of the first electrode sheet 6 exposed at the opening 81 of the spacer 8 and the second electrode sheet 7 exposed at the opening 81 of the spacer 8.

[0058] Thus, in comparison to a case where the annular member 9 adheres to at least one of the first electrode sheet 6 and the second electrode sheet 7 through an adhesive layer 10, there is no influence of the adhesive layer due to a variation in temperature.

[0059] That is the adhesive layer 10 tends to soften under a high-temperature environment and tends to harden under a low-temperature environment, easily. Thus, in a case where no annular member 9 is provided, variation of the adhesive layers 10 at the edge portion of the opening 81 of the spacer 8, corresponding to a temperature environment, causes a variation in the degree of inward deflection to the opening 81 of the spacer 8 between the first electrode sheet 6 and the second electrode sheet 7. The variation in the degree of deflection causes a variation in the load necessary for contact between the first electrode 62 and the second electrode 72. In contrast to this, according to the present embodiment, because the annular member 9 disposed in the opening 81 of the spacer 8 has no adhesion, a variation in temperature environment due to the adhesive layers 10 does not occur at the edge portion of the opening of the annular member 9. Thus, the degree of inward deflection inside the annular member 9 due to pressing of the second electrode sheet 7, substantially does not change. Therefore, in comparison to a case where the annular member 9 adheres to at least one of the first electrode sheet 6 and the second electrode sheet 7 through an adhesive layer, the load necessary for contact between the first electrode 62 and the second electrode 72 can be prevented from varying.

[0060] The presence of the annular member 9 causes less load to be applied to the adhesive layers 10, and thus the adhesive layers 10 are less likely to be creep-deformed. Even if the adhesive layers 10 are creep-deformed by long-term pressing of the load detection sensor 5A, the distance between the first electrode sheet 6 and the second electrode sheet 7 is substantially constantly retained by the annular member 9. As a result, variation in the load necessary for contact between the first electrode 62 and the second electrode 72, along with creep deformation, can be reduced.

[0061] Thus, the load detection sensor 5A capable of detecting a load properly, is achieved.

[0062] The annular member 9 according to the present embodiment is in contact with both of the first electrode sheet 6 exposed at the opening 81 of the spacer 8 and the second electrode sheet 7 exposed at the opening 81 of the spacer 8.

[0063] Thus, because there is no gap between the first electrode sheet 6 exposed at the opening 81 of the spacer 8, the second electrode sheet 7 exposed at the opening 81 of the spacer 8, and the annular member 9, the annular member 9 can support the first electrode sheet 6 and the second electrode sheet 7, more stably. Therefore, variation in the load necessary for contact between the first electrode 62 and the second electrode 72, can be further reduced.

[0064] The outer circumferential face of the annular member 9 according to the present embodiment is spaced apart from the spacer 8. Thus, even when the adhesive layer 10 between the spacer 8 and the first electrode sheet 6 and the adhesive layer 10 between the spacer 8 and the second electrode sheet 7 soften and flow into the opening 81 due to the load detection sensor 5A under a high-temperature environment, the adhesive layers 10 can be stored in the gap between the annular member 9 and the spacer 8. Therefore, flowing of the softened adhesive layers 10 between the annular member 9, the first electrode sheet 6, and the second electrode sheet 7, can be avoided. As a result, variation in the load necessary for contact between the first electrode 62 and the second electrode 72, can be further reduced.

[0065] The annular member 9 according to the present embodiment has the vent 91 for deflation of the air inside the annular member 9 in the opening 81 of the spacer 8. Thus, when inward deflection of the second electrode sheet 7 inside the annular member 9 causes contact between the first electrode 62 and the second electrode 72, the air inside the annular member 9 discharges from the vent 91. Therefore, inhibition of deflection of the second electrode sheet 7 due to the air inside the annular member 9 is avoided, so that the load detection sensor can be prevented from performing false detection.

[0066] Note that, in a case where the annular member 9 and the spacer 8 are identical in material, the expansion of the annular member 9 and the expansion of the spacer 8 due to the load detection sensor 5A under a high-temperature environment, are approximately equivalent. Thus, the distance between the first electrode sheet 6 and the second electrode sheet 7 is substantially constantly retained. Therefore, in a case where the annular member 9 and the spacer 8 are identical in material, variation of the inter-electrode distance due to thermal expansion is reduced. As a result, variation in load can be further reduced.

[0067] For the annular member 9, in a case where the sheet face of the first electrode sheet 6 is viewed in plan view, the annular member 9 does not overlap the first electrode 62 and the second electrode 72. This arrangement enables the first electrode 62 and the second electrode 72 to be less damaged in comparison to a case where the annular member 9 overlaps the first electrode 62 and the second electrode 72.

[0068] The height of the annular member 9 is approximately equivalent to the sum of the thickness of the adhesive layer 10 between the first insulating sheet 61 and the spacer 8, the thickness of the adhesive layer 10 between the second insulating sheet 71 and the spacer 8, and the thickness of the spacer 8.

[0069] In this case, even when the annular member 9 has no adhesion to the first insulating sheet 61 and the second insulating sheet 71, the annular member 9 is inhibited from moving in the opening 81 of the spacer 8. Under no load in which no load is applied to the load detection sensor 5A, stress can be prevented from occurring in a direction in which the spacer and each electrode sheet adhering through the adhesive layer 10 peel off.

(2) Second Embodiment

[0070] Next, a load detection sensor unit will be described as a second embodiment. Note that configurations similar to the configurations described above are denoted with the same reference signs. Unless otherwise specified, the duplicate descriptions will be omitted.

[0071] FIG. 4 is an exploded view of the configuration of the load detection sensor unit according to the second embodiment. FIG. 5 is a sectional view of the load detection sensor unit attached to S-shaped springs of a seat device. Note that, for convenience, a load detection sensor 5B is not illustrated in section in FIG. 5. As illustrated in FIGS. 4 and 5, the load detection sensor unit 100 includes a support plate 2, an upper case 4, and the load detection sensor 5B as main constituent elements.

[0072] The support plate 2 includes a mount portion 21 on which the load detection sensor 5B is mounted, and a pair of hook portions 22 coupled to the mount portion 21. The mount portion 21 includes: a wide main block mount portion 21m; and a tail block mount portion 21t extending from the main block mount portion 21m, the tail block mount portion 21t being narrower in width than the main block mount portion 21m. According to the present embodiment, the hook portions 22 are coupled to the main block mount portion 21m. According to the present embodiment, the mount portion 21 and the pair of hook portions 22 are integrally formed by bending of a metallic plate. Note that the plate thickness of the support plate 2 is, for example, 0.8 mm.

[0073] A main block 50m in the load detection sensor 5B is disposed on a face of the main block mount portion 21m, the face being opposed to a seat cushion SC. As illustrated in FIG. 4, the main block mount portion 21m has a plurality of circular through holes 20H penetrating through the support plate 2, and further has a plurality of substantially-rectangular case-locking openings 24.

[0074] Note that, as illustrated in FIG. 5, the main block mount portion 21m has a degree of size so as to be disposed between two mutually opposed S-shaped springs BN from a plurality of S-shaped springs BN stretched alongside across the opening of a seat frame in the vehicular seat device. Note that the S-shaped springs BN each are a spring serpentine in an S shape.

[0075] The tail block mount portion 21t having a substantially rectangular shape, extends in a direction substantially perpendicular to a direction passing through the pair of hook portions 22 in plan view of the main block mount portion 21m. A tail block 50t in the load detection sensor 5B is disposed on a face of the tail block mount portion 21t, the face being opposed to the seat cushion SC. Note that, according to the present embodiment, the width in a direction perpendicular to the extending direction of the tail block mount portion 21t is smaller than the width of the tail block 50t of the load detection sensor 5B, and the length in the extending direction of the tail block mount portion 21t is smaller than the length of the tail block 50t of the load detection sensor 5B.

[0076] The upper case 4 is a member covering the main block 50m mounted on the main block mount portion 21m of the mount portion 21 such that, for example, a switch SW in the main block 50m is protected. As illustrated in FIG. 5, the upper case 4 doubles as a pressing member that presses the switch SW of the load detection sensor 5B by pressing from the seat cushion SC.

[0077] The upper case 4 includes a top wall 45 and a frame wall 48. According to the present embodiment, the top wall 45 is a tabular member that is substantially rectangular. The frame wall 48 of the upper case 4 includes a plurality of divided portions connected to the top wall 45 in the outer circumference of the top wall 45. A hook piece 47 is connected to the top wall 45 between each of the plurality of divided portions of the frame wall 48. The hook pieces 47 individually engage with the case-locking openings 24 at the main block mount portion 21m of the support plate 2. Individual engagement of the hook pieces 47 with the case-locking openings 24 regulates the relative movement in the mount in-plane direction of the main block mount portion 21m between the support plate 2 and the upper case 4.

[0078] The top wall 45 of the upper case 4 has a bottom face from which a pressing portion 46 protrudes, the bottom face being opposed to the mount portion 21 of the support plate 2. The leading end of the pressing portion 46 has a flat shape. Note that the leading end of the pressing portion 46 may have a protruding curved shape. According to the present embodiment, with the upper case 4 covering the load detection sensor 5B mounted on the mount portion 21 and the hook pieces 47 engaging with the corresponding case-locking openings 24, the leading end of the pressing portion 46 is in contact with the load detection sensor 5B, but is not necessarily in contact with the load detection sensor 5B.

[0079] As illustrated in FIG. 5, with the load detection sensor unit 100 attached to the pair of S-shaped springs BN, the upper face 45S of the top wall 45 of the upper case 4 is spaced apart from the lower face of the seat cushion SC, but may be in contact with the lower face of the seat cushion SC. The upper face 45S has a flat shape. The upper face 45S is a pressure-receiving face that receives pressing from the seat cushion SC. The upper face 45S is larger in area than the portion in contact with the switch SW of the load detection sensor 5B, in the pressing portion 46.

[0080] Note that the upper case 4 is formed of material harder than that of the seat cushion SC. Therefore, the pressing portion 46 that is part of the upper case 4 is formed of the material harder than that of the seat cushion SC. Because, generally, the seat cushion SC includes foamed urethane resin, examples of resin as the material of the upper case 4 include polycarbonate (PC), polybutylene terephthalate (PBT), polyamide (PA), phenolic resin, and epoxy resin.

[0081] As described above, the load detection sensor 5B includes: the main block 50m that is substantially rectangular; and the tail block 50t connected to the main block 50m, the tail block 50t being narrower in width than the main block 50m. The main block 50m is provided with the switch SW. A through hole 50H is formed near each apex of the main block 50m. The through holes 50H are formed in positional relationship so as to be superimposed on the plurality of through holes 20H formed through the mount portion 21 of the support plate 2. The tail block 50t coupled to the main block 50m, extends apart from the main block 50m.

[0082] FIG. 6 is an exploded view of the load detection sensor according to the second embodiment. FIG. 7 is a sectional view of the load detection sensor according to the second embodiment. As illustrated in FIGS. 6 and 7, the load detection sensor 5B according to the present embodiment includes a first electrode sheet 56, a second electrode sheet 57, a spacer 58, an annular member 59, adhesive layers 10 as main constituent elements. Note that, for convenience, the adhesive layers 10 are omitted in FIG. 6.

[0083] The first electrode sheet 56 includes a first insulating sheet 56s, a first electrode 56e, and a first terminal 56c.

[0084] The first insulating sheet 56s is a resin insulating sheet having flexibility. The first insulating sheet 56s includes a main block 56m and a tail block 56t connected to the main block 56m. For the shape of the tail block 56t, a leading end portion opposite to the main block 56m is narrower in width than the other portion of the tail block 56t. The main block 56m has through holes 56H. Note that the through holes 56H are part of the through holes 50H of the load detection sensor 5B. Examples of resin as the material of the first insulating sheet 56s include PET, PI, and PEN.

[0085] The first electrode 56e is provided at substantially the center on one face of the main block 56m. The first electrode 56e includes a conductive layer, for example, a substantially-circular metallic printed layer. The first terminal 56c includes a conductive layer, for example, a substantially-quadrangular metallic layer. The first terminal 56c is provided on a face of the leading end portion of the tail block 56t, the face being on the side on which the first electrode 56e is provided. The first electrode 56e and the first terminal 56c are mutually electrically connected through a first wire 56w.

[0086] The second electrode sheet 57 includes a second insulating sheet 57s, a metallic plate 60, an adhesive layer for metal 70, a second electrode 57e, and a second terminal 57c. The second electrode sheet 7 according to the first embodiment includes one layer of the second insulating sheet 71, whereas the second electrode sheet 57 according to the present embodiment includes two layers of the second insulating sheet 57s and the metallic plate 60.

[0087] The second insulating sheet 57s disposed on the seat cushion SC (FIG. 4) side with respect to the first electrode sheet 56, is a resin insulating sheet, similarly to the first insulating sheet 56s. According to the present embodiment, the second insulating sheet 57s is smaller in thickness than the first insulating sheet 56s, and is less in thickness than the metallic plate 60. The second insulating sheet 57s includes: a main block 57m identical in shape to the main block 56m of the first insulating sheet 56s; and a tail block 57t connected to the main block 57m, the tail block 57t being identical in shape to the tail block 56t of the first insulating sheet 56s except for the leading end portion. The leading end portion of the tail block 57t is narrower in width than the other portion of the tail block 57t. When the first insulating sheet 56s and the second insulating sheet 57s are superimposed, the leading end portion of the tail block 56t of the first insulating sheet 56s and the leading end portion of the tail block 57t of the second insulating sheet 57s do not overlap each other. The main block 57m has through holes 57H. Note that the through holes 57H are part of the through holes 50H of the load detection sensor 5B, similarly to the through holes 56H of the first insulating sheet 56s. Examples of resin as the material of the second insulating sheet 57s include PET, PI, and PEN. The second insulating sheet 57s may be identical in material to or different in material from the first insulating sheet 56s.

[0088] The metallic plate 60 bonds to one face of the second insulating sheet 57s through the adhesive layer for metal 70. According to the present embodiment, the metallic plate 60 bonds to the face on the seat cushion SC side of the main block 57m that is part of the second insulating sheet 57s. The metallic plate 60 has through holes 60H. Note that the through holes 60H are part of the through holes 50H of the load detection sensor 5B. Examples of the material of the metallic plate 60 include, but are not particularly limited to, copper and stainless steel.

[0089] The adhesive layer for metal 70 is disposed between the main block 57m of the second insulating sheet 57s and the metallic plate 60. The adhesive layer for metal 70 is not particularly limited as long as the second insulating sheet 57s and the metallic plate 60 bond together. Examples of the adhesive layer for metal 70 include glue, adhesive, and double-sided tape including a base material, such as PET or nonwoven fabric, having each face provided with glue or adhesive. Examples of the material of the adhesive layer for metal 70 include thermoplastic resin, thermosetting resin, and photo-curable resin. Note that the adhesive layer for metal 70 may be identical in material to or different in material from the adhesive layers 10. Here, the glass-transition temperature Tg of the adhesive layer for metal 70 is preferably 85°C or more. A glass-transition temperature Tg of 85°C or more causes the adhesive layer for metal 70 to be less likely to flow even in a high-temperature environment, such as the inside of a motor vehicle under a blazing sun, so that false detection of seating due to flowing of the adhesive layer for metal 70 can be inhibited. Note that, as long as the second insulating sheet 57s and the metallic plate 60 bond together, the adhesive layer for metal 70 may be disposed over the entire faces between the second insulating sheet 57s and the metallic plate 60 or may be dispersedly disposed at a plurality of portions between the second insulating sheet 57s and the metallic plate 60.

[0090] The second electrode 57e similar in configuration to the first electrode 56e, is provided at substantially the center on one face of the main block 57m of the second insulating sheet 57s. The position for provision of the second electrode 57e allows superimposition of the second electrode 57e on the first electrode 56e at superimposition of the first electrode sheet 56 and the second electrode sheet 57. The second terminal 57c similar in configuration to the first terminal 56c, is provided on a face of the leading end portion of the tail block 57t, the face being on the side on which the second electrode 57e is provided. As described above, when the first insulating sheet 56s and the second insulating sheet 57s are superimposed, the respective leading end portions of the insulating sheets do not overlap each other. Thus, the first terminal 56c and the second terminal 57c are exposed without being located between the first insulating sheet 56s and the second insulating sheet 57s. The second electrode 57e and the second terminal 57c are mutually electrically connected through a second wire 57w.

[0091] The spacer 58 disposed between the first electrode sheet 56 and the second electrode sheet 57, includes a resin insulating sheet having flexibility. The spacer 58 includes a main block 58m and a tail block 58t connected to the main block 58m. The main block 58m is similar in outer shape to the main blocks 56m and 57m of the first insulating sheet 56s and the second insulating sheet 57s. The tail block 58t has a shape identical to the shape in which the leading end portion narrow in width is excluded from each of the tail blocks 56t and 57t of the first insulating sheet 56s and the second insulating sheet 57s. The spacer 58 has through holes 58H, similarly to the first insulating sheet 56s and the second insulating sheet 57s. Note that the through holes 58H are part of the through holes 50H of the load detection sensor 5B. Examples of resin as the material of the spacer 58 include PET, PI, and PEN, similarly to the first insulating sheet 56s and the second insulating sheet 57s. Note that the spacer 58 may be identical in material to or different in material from the first insulating sheet 56s or the second insulating sheet 57s.

[0092] The main block 58m of the spacer 58 has an opening 58c penetrating from one face side to the other face side of the spacer 58. The first electrode 56e and the second electrode 57e are opposed to each other through the opening 58c. The circumferential-edge shape of the opening 58c is, for example, substantially circular. The opening 58c is formed smaller in diameter than the first electrode 56e and the second electrode 57e.

[0093] The opening 81 of the spacer 8 according to the first embodiment is formed larger in diameter than the first electrode 62 and the second electrode 72. In contrast to this, the opening 58c of the spacer 58 according to the present embodiment is formed smaller in diameter than the first electrode 56e and the second electrode 57e. Therefore, for the opening 58c according to the present embodiment, in a case where the spacer 58 is superimposed on the first electrode sheet 56 and the second electrode sheet 57, the opening 58c of the spacer 58 is located inside the circumferential edges of the first electrode 56e and the second electrode 57e.

[0094] Furthermore, the spacer 58 has a slit 58b through which the space in the opening 58c is in communication with the external space of the load detection sensor 5B. The slit 58b serves as an air vent with the first electrode sheet 56, the spacer 58, and the second electrode sheet 57 in superimposition on each other. The air vent is a passage for deflation of the air in the opening 58c to the outside of the load detection sensor 5B.

[0095] The annular member 59 is a member in an annular shape disposed in the opening 58c of the spacer 58. The outer diameter of the annular member 59 is smaller than the diameter of the opening 58c of the spacer 58, and is smaller than the diameters of the first electrode 56e and the second electrode 57e.

[0096] The inner diameter of the annular member 9 according to the first embodiment is larger than the diameters of the first electrode 62 and the second electrode 72, whereas the inner diameter and the outer diameter of the annular member 59 according to the present embodiment both are smaller than the diameters of the first electrode 56e and the second electrode 57e. Therefore, as illustrated in FIG. 8, the annular member 59 and the second electrode 57e according to the present embodiment overlap in plan view of a sheet face of of the second electrode sheet 57 when the spacer 58, the first electrode sheet 56, and the second electrode sheet 57 are stacked. As illustrated in FIG. 7, the sum of the height of the annular member 59, the thickness of the first electrode 56e, and the thickness of the second electrode 57e is approximately equivalent to the sum of the thickness of the adhesive layer 10 between the first insulating sheet 61 and the spacer 8, the thickness of the adhesive layer 10 between the second insulating sheet 71 and the spacer 8, and the thickness of the spacer 8. Note that the annular member 59 is preferably larger in elastic modulus than the adhesive layers 10, similarly to the first embodiment.

[0097] Examples of resin as the material of the annular member 59 include PET, PI, and PEN, similarly to the first insulating sheet 56s, the second insulating sheet 57s, and the spacer 58. Note that the annular member 59 may be identical in material to or different in material from the spacer 58, the first insulating sheet 56s, or the second insulating sheet 57s. Note that the spacer 58 and the annular member 59 are preferably identical in material in order to reduce a variation due to expansion between the height of the annular member 59 and the height of the spacer 58.

[0098] The annular member 59 has a vent 59b for deflation of the air inside the annular member 59 in the opening 58c in the spacer 58. According to the present embodiment, the vent 59b is a slit formed from one end to the other end in the height direction of the annular member 59, but may be a through hole penetrating from the outer circumferential face to the inner circumferential face of the annular member. Note that, similarly to the annular member 9 according to the first embodiment, the annular member 59 according to the present embodiment includes one break or intermittent breaks as long as a ring-like shape exists. Note that the number of breaks is preferably one or less.

[0099] The load detection sensor 5B includes the above constituent elements in combination. That is the load detection sensor 5B includes the first electrode sheet 56 adhering on the one face side of the spacer 58 through the adhesive layer 10 and the second electrode sheet 57 adhering on the other face side of the spacer 58 through the adhesive layer 10 with the annular member 59 disposed in the opening 58c of the spacer 58.

[0100] In the load detection sensor 5B, mutual superimposition of the through holes 56H, 57H, and 58H results in the through holes 50H. The first electrode 56e of the first electrode sheet 56 exposed on one opening face side of the opening 58c of the spacer 58 and the second electrode 57e of the second electrode sheet 57 exposed on the other opening face side of the opening 58c, opposed to each other, are included in the switch SW.

[0101] Furthermore, the annular member 59 is in contact with both of the first electrode 56e and the second electrode 57e. Specifically, one end of the annular member 59 is in contact with the first electrode 56e of the first electrode sheet 56 in the inner circumference of the opening 58c, and the other end of the annular member 59 is in contact with the second electrode 57e of the second electrode sheet 57 in the inner circumference of the opening 58c. Therefore, the annular member 59 can support the first electrode sheet 56 and the second electrode sheet 57. Note that the annular member 59 in contact with the first electrode 56e of the first electrode sheet 56, has no adhesion to the first electrode 56e. Similarly, the annular member 59 in contact with the second electrode 57e of the second electrode sheet 57, has no adhesion to the second electrode 57e.

[0102] In the load detection sensor 5B, the vent 59b of the annular member 59 is in communication with the outside of the load detection sensor 5B through the slit 58b of the spacer 58, with the outer circumferential face of the annular member 59 disposed apart from the spacer 58. Note that part of the outer circumferential face of the annular member 59 may be in contact with the spacer 58. That is the outer circumferential face of the annular member 59 requires at least spacing apart from part of the spacer 58.

[0103] The first terminal 56c and the second terminal 57c of the load detection sensor 5B each are connected to a signal cable 19 connected to a control device not illustrated. The first terminal 56c and the second terminal 57c are connected to the respective signal cables 19, for example, through conductive paste or by soldering.

[0104] The load detection sensor 5B having the configuration described above is disposed on the support plate 2 as illustrated in FIG. 4. Specifically, the main block 50m of the load detection sensor 5B including the switch SW is disposed on the main block mount portion 21m of the support plate 2, and the tail block 50t of the load detection sensor 5B is disposed on the tail block mount portion 21t of the support plate 2. The first terminal 56c and the second terminal 57c provided at the tail block 50t are out of the tail block mount portion 21t. Therefore, the first terminal 56c and the second terminal 57c are located in a region the support plate 2 does not overlap. Then, the respective signal cables 19 connected to the first terminal 56c and the second terminal 57c of the load detection sensor 5B are laid apart from the support plate 2.

[0105] Thus, with the load detection sensor 5B disposed on the support plate 2, the end of the tail block 50t including the first terminal 56c and the second terminal 57c connected to the signal cables 19 is covered with a protective resin 18. Note that, for example, the protective resin 18 includes thermoplastic resin or photo-curable resin including polyamide, polyimide, olefin, urethane, or acrylic.

[0106] As described above, with the upper case 4 covering the load detection sensor 5B mounted on the support plate 2 and the hook pieces 47 engaging with the corresponding case-locking openings 24, the leading end of the pressing portion 46 is in contact with a position overlapping the switch SW, in the metallic plate 60 of the load detection sensor 5B. In this state, each rib 49 is inserted through a through hole 50H of the load detection sensor 5B and a through hole 20H of the support plate 2. Therefore, even with no adhesion between the support plate 2 and the first insulating sheet 56s, the relative movement between the switch SW of the load detection sensor 5B and the pressing portion 46 of the upper case 4, is regulated. That is the ribs 49 can be regarded as a movement regulation member that regulates the relative movement between the load detection sensor 5B and the support plate 2 in the in-plane direction of the support plate 2.

[0107] Next, detection of a load by the load detection sensor unit 100 according to the present embodiment will be described.

[0108] FIG. 9 is a view of the ON state of the load detection sensor unit. Seating of a person on the seat device causes the lower face of the seat cushion SC to move downward, so that the lower face of the seat cushion SC presses the upper face 45S of the upper case 4 in contact with the upper face 45S. Then, as illustrated in FIG. 9, further downward movement of the lower face of the seat cushion SC causes the leading end of the pressing portion 46 to press the metallic plate 60 of the second electrode sheet 57 in the load detection sensor 5B. Then, deflection of the metallic plate 60 causes inward deflection of the main block 57m of the second insulating sheet 57s inside the annular member 59. Thus, the switch SW of the load detection sensor 5B changes to the ON state due to the second electrode 57e in contact with the first electrode 56e. Then, the seating is detected by a vehicular control unit, not illustrated, connected to the signal cables 19. In this case, according to the present embodiment, because the face on the support plate side of the main block 56m of the first insulating sheet 56s has no adhesion to the support plate 2, at least a portion on the periphery of the switch SW can deform in accordance with the degree of deflection of the metallic plate 60. Thus, the switch SW is easily turned on.

[0109] Note that, deflection of the second electrode sheet 57 causes the air in the opening of the annular member 59 and the air in the opening 58c of the spacer 58 to discharge through the slit 58b. Therefore, inhibition of deflection between the first electrode sheet 56 and the second electrode sheet 57 due to the air in the opening of the annular member 59 and the air in the opening 58c of the spacer 58 is avoided, so that the switch SW of the load detection sensor 5A changes to the ON state, properly.

[0110] As described above, the load detection sensor 5B according to the present embodiment includes: the first electrode sheet 56 including the first electrode 56e; the second electrode sheet 57 including the second electrode 57e opposed to the first electrode 56e; and the spacer 58 interposed between the first electrode sheet 56 and the second electrode sheet 57, the spacer 58 having the opening 58c between the first electrode 56e and the second electrode 57e. The load detection sensor 5B includes: the annular member 59 disposed in the opening 58c of the spacer 58; and the respective adhesive layers 10 disposed between the spacer 58 and the first electrode sheet 56 and between the spacer 58 and the second electrode sheet 57.

[0111] In the load detection sensor 5B, because the annular member 59 is disposed in the opening 81 of the spacer 8, the annular member 59 supports the inner circumferential portion exposed from the opening 81 of the first electrode sheet 56 and the inner circumferential portion exposed from the opening 81 of the second electrode sheet 57. The annular member 59 has no adhesion to both of the first electrode sheet 56 exposed at the opening 58c of the spacer 58 and the second electrode sheet 57 exposed at the opening 58c of the spacer 58.

[0112] Thus, in comparison to a case where the annular member 59 adheres to at least one of the first electrode sheet 56 and the second electrode sheet 57 through an adhesive layer 10, influence of the adhesive layer due to a variation in temperature can be inhibited.

[0113] That is the adhesive layer 10 tends to soften under a high-temperature environment and tends to harden under a low-temperature environment, easily. Thus, in a case where no annular member 59 is provided, variation of the adhesive layers 10 at the edge portion of the opening 58c of the spacer 58, corresponding to a temperature environment, causes a variation in the degree of inward deflection to the opening 58c of the spacer 58 between the first electrode sheet 56 and the second electrode sheet 57. The variation in the degree of deflection causes a variation in the load necessary for contact between the first electrode 56e and the second electrode 57e. In contrast to this, according to the present embodiment, because the annular member 59 disposed in the opening 58c of the spacer 58 has no adhesion, a variation in temperature environment due to the adhesive layers 10 does not occur at the edge portion of the opening of the annular member 59. Thus, the degree of inward deflection to the opening of the annular member 59 due to pressing of the second electrode sheet 57, substantially does not change. Therefore, in comparison to a case where the annular member 59 adheres to at least one of the first electrode sheet 56 and the second electrode sheet 57 through an adhesive layer, the load necessary for contact between the first electrode 56e and the second electrode 57e can be prevented from varying.

[0114] The presence of the annular member 59 causes less load to be applied to the adhesive layers 10, and thus the adhesive layers 10 are less likely to be creep-deformed. Even if the adhesive layers 10 are creep-deformed by long-term pressing of the load detection sensor 5B, the distance between the first electrode sheet 56 and the second electrode sheet 57 is substantially constantly retained by the annular member 59. As a result, variation in the load necessary for contact between the first electrode 56e and the second electrode 57e, along with creep deformation, is reduced.

[0115] Thus, the load detection sensor 5B according to the present embodiment can detect a load properly, similarly to the load detection sensor 5A according to the first embodiment.

[0116] The annular member 59 according to the present embodiment is in contact with both of the first electrode sheet 56 exposed at the opening 58c of the spacer 58 and the second electrode sheet 57 exposed at the opening 58c of the spacer 58, similarly to the first embodiment.

[0117] Thus, because there is no gap between the first electrode sheet 56 exposed at the opening 58c of the spacer 58, the second electrode sheet 57 exposed at the opening 58c of the spacer 58, and the annular member 59, the annular member 59 can support the first electrode sheet 56 and the second electrode sheet 57, more stably. Therefore, variation in the load necessary for contact between the first electrode 56e and the second electrode 57e, can be further reduced.

[0118] The outer circumferential face of the annular member 59 according to the present embodiment is spaced apart from the spacer 58, similarly to the first embodiment. Thus, even when the adhesive layer 10 between the spacer 58 and the first electrode sheet 56 and the adhesive layer 10 between the spacer 58 and the second electrode sheet 57 soften and flow into the opening 58c due to the load detection sensor 5B under a high-temperature environment, the adhesive layers 10 can be stored in the gap between the annular member 59 and the spacer 58. Therefore, flowing of the softened adhesive layers 10 between the annular member 59, the first electrode sheet 56, and the second electrode sheet 57, is avoided. As a result, variation in the load necessary for contact between the first electrode 56e and the second electrode 57e, can be further reduced.

[0119] The annular member 59 according to the present embodiment has the vent 59b for deflation of the air inside the annular member 59 in the opening 81 of the spacer 8, similarly to the first embodiment. Thus, when inward deflection of the second electrode sheet 57 inside the annular member 59 causes contact between the first electrode 56e and the second electrode 57e, the air inside the annular member 59 in the opening 81 of the spacer 8 discharges from the vent 59b. Therefore, inhibition of deflection of the second electrode sheet 57 due to the air in the opening 81 of the spacer 8 is avoided, so that the load detection sensor 5B can be prevented from performing false detection.

[0120] As described above, the opening 81 of the spacer 8 according to the first embodiment is formed larger in diameter than the first electrode 62 and the second electrode 72, whereas the opening 58c of the spacer 58 according to the present embodiment is formed smaller in diameter than the first electrode 56e and the second electrode 57e. Thus, the opening 58c of the spacer 58 according to the present embodiment is located inside the circumferential edges of the first electrode 56e and the second electrode 57e. The annular member 59 having no adhesion is in contact with the first electrode 56e in the first electrode sheet 56 exposed at the opening 58c of the spacer 58 and the second electrode 57e in the second electrode sheet 57 exposed at the opening 58c. Therefore, in the load detection sensor 5B according to the present embodiment, in a case where the sheet face of the first electrode sheet 56 is viewed in plan view, the annular member 59 overlaps the first electrode 56e and the second electrode 57e. The first electrode 56e and the second electrode 57e may have respective dummy electrodes not connected to the first wire 56w and the second wire 57w. The dummy electrodes may overlap the annular member 59.

[0121] The annular member 59 is interposed between the first electrode 56e and the second electrode 57e. Thus, even when the first electrode 56e itself and the second electrode 57e itself each have variation in thickness, the distance between the first electrode 56e and the second electrode 57e is substantially constantly retained by the annular member 59. Therefore, the variation in distance between the first electrode 56e and the second electrode 57e between a plurality of load detection sensors 5B can be reduced by the annular member 59. As a result, the variation in the load necessary for contact between the first electrode 56e and the second electrode 57e between the plurality of load detection sensors 5B can be reduced.

[0122] The sum of the thickness of the spacer 58 and the thicknesses of the adhesive layers 10 is approximately equivalent to the sum of the height of the annular member 59, the thickness of the first electrode 56e, and the thickness of the second electrode 57e.

[0123] Thus, even when the annular member 59 has no adhesion to the first electrode sheet 56 and the second electrode sheet 57, the annular member 59 is inhibited from moving in the opening 58c of the spacer 58. Under no load in which no load is applied to the load detection sensor 5B, stress can be prevented from occurring in a direction in which the spacer 58, the first electrode sheet 56, and the second electrode sheet 57 adhering through the adhesive layers 10 peel off.

[0124] According to the present embodiment, the second electrode sheet 57 includes the metallic plate 60. The metallic plate 60 adheres to the resin second insulating sheet 57s through the adhesive layer for metal 70. Metal varies less in flexibility than resin, in response to a variation in environmental temperature, and thus creep is less likely to occur and the idiosyncrasy of pressing is less likely to occur. However, according to the present embodiment, because the metallic plate 60 adheres to the resin second insulating sheet 57s through the adhesive layer for metal 70, when release of pressing from the second electrode sheet 57 causes the metallic plate 60 to return to the position in no pressing, the metallic plate 60 enables the resin second insulating sheet 57s to return to the position. Therefore, even in a case where the ambient environmental temperature of the load detection sensor 5B varies, the idiosyncrasy of pressing is less likely to occur in the resin second insulating sheet 57s. Thus, false detection of a load applied in response to, for example, seating, due to the idiosyncrasy of pressing, can be inhibited. As a result, a load applied in response to, for example, seating can be detected properly. Note that use in combination with the annular member 59 enables further proper detection of a load applied properly in response to, for example, seating.

[0125] According to the present embodiment, because the second insulating sheet 57s is less in thickness than the metallic plate 60, the amount of deformation of the resin second insulating sheet 57s can be reduced, in comparison to a case where the second insulating sheet 57s is identical in thickness to or more in thickness than the metallic plate 60. That is close to a case where a second electrode sheet includes only the metallic plate 60 with no second insulating sheet 57s. Therefore, variation in the load necessary for contact between the first electrode 56e and the second electrode 57e, due to a variation in temperature, can be reduced.

[0126] According to the present embodiment, the second insulating sheet 57s is less in thickness than the first insulating sheet 56s. Thus, with the load detection sensor 5B thinner, false detection of a load due to a variation in temperature, can be inhibited.

(3) Third Embodiment

[0127] Next, a load detection sensor unit will be described as a third embodiment. Note that configurations similar to the configurations described above are denoted with the same reference signs. Unless otherwise specified, the duplicate descriptions will be omitted.

[0128] FIG. 10 is a sectional view of a load detection sensor according to the third embodiment. As illustrated in FIG. 10, the load detection sensor 5C according to the present embodiment has difference in terms of adoption of a metallic sheet 101 instead of the second insulating sheet 71 of the second electrode sheet 7 in the first embodiment.

[0129] The metallic sheet 101 that is a thin metallic sheet having flexibility, adheres to a spacer 8 through an adhesive layer 10. Examples of the material of the metallic sheet 101 include, but are not particularly limited to as long as the material is metal, copper and stainless steel.

[0130] According to the present embodiment, a portion opposed to a first electrode 62 through an opening 81 of the spacer 8, in the metallic sheet 101, serves as a second electrode 72. That is part of the metallic sheet 101 doubles as the second electrode 72. Note that, for example, a metallic layer identical in material to or different in material from the metallic sheet 101, may be disposed as the second electrode 72 at the portion opposed to the first electrode 62 through the opening 81 of the spacer 8, in the metallic sheet 101.

[0131] Even the load detection sensor 5C has an effect similar to the above-described respective effects of the load detection sensor 5A according to the first embodiment and the load detection sensor 5B according to the second embodiment. Furthermore, according to the present embodiment, the metallic sheet 101 is adopted instead of the second insulating sheet 71.

[0132] As described above, metal varies less in flexibility than resin, in response to a variation in environmental temperature, and thus creep is less likely to occur and the idiosyncrasy of pressing is less likely to occur. Therefore, in the load detection sensor 5C, false detection of a load applied in response to, for example, seating, due to creep or the idiosyncrasy of pressing, can be inhibited. As a result, a load applied in response to, for example, pressing can be detected properly.

(4) Fourth Embodiment

[0133] Next, a load detection sensor unit will be described as a fourth embodiment. Note that configurations similar to the configurations described above are denoted with the same reference signs. Unless otherwise specified, the duplicate descriptions will be omitted.

[0134] FIG. 11 is an exploded view of the configuration of a load detection sensor according to the fourth embodiment. FIG. 12 is a view of the load detection sensor in plan view from the second electrode sheet side. As illustrated in FIGS. 11 and 12, the load detection sensor 5D according to the present embodiment includes a first electrode sheet 66, a second electrode sheet 67, a spacer 68, a plurality of annular members 9A to 9D, a communication member 80, and adhesive layers 10 as main constituent elements. Note that, for convenience, the adhesive layers 10 are omitted in FIG. 11.

[0135] The first electrode sheet 66 includes a first insulating sheet 66s, first electrodes 66e1 to 66e4, a first terminal 66c1, and a second terminal 66c2.

[0136] The first insulating sheet 66s that is a resin insulating sheet having flexibility, has, for example, an H shape. The first insulating sheet 66s includes a first main block B1, a second main block B2, a coupling block B3 coupling the first main block B1 and the second main block B2, and a tail block B4 extending from the coupling block. The first main block B1 and the second main block B2 each are a belt-shaped block. The coupling block B3 is a belt-shaped block coupling intermediate portions in the longitudinal directions of the first main block B1 and the second main block B2. The tail block B4 smaller than the coupling block B3, is a substantially-rectangular block protruding from an end of an intermediate portion in the longitudinal direction of the coupling block B3. Examples of resin as the material of the first insulating sheet 56s include PET, PI, and PEN.

[0137] The first electrodes 66e1 to 66e4 each include a conductive layer, for example, a substantially-circular metallic printed layer. The first electrode 66e1 and the first electrode 66e2 disposed on one surface of the first main block B1, are arranged collinearly, according to the present embodiment. The first electrode 66e3 and the first electrode 66e4 disposed on a surface identical to the face on which the first electrode 66e1 and the first electrode 66e2 are disposed, in the second main block B2, are arranged collinearly, according to the present embodiment.

[0138] The first terminal 66c1 and the second terminal 66c2 each include a conductive layer, for example, a substantially-quadrangular metallic sheet. The first terminal 66c1 and the second terminal 66c2 are disposed on a surface identical to the faces on which the first electrodes 66e1 to 66e4 are disposed, in the tail block B4.

[0139] The first electrode 66e1 and the first electrode 66e2 are electrically connected through a first wire 66w1, and the first electrode 66e3 and the first electrode 66e4 are electrically connected through a first wire 66w2. The first wire 66w1 and the first terminal 66c1 are electrically connected through a first wire 66w3, and the first wire 66w2 and the second terminal 66c2 are electrically connected through a first wire 66w4.

[0140] The second electrode sheet 67 includes a second insulating sheet 67s and a plurality of second electrodes 67e1 to 67e4.

[0141] The second insulating sheet 67s that is a film-shaped insulating sheet having flexibility, has, for example, an H shape. According to the present embodiment, the second insulating sheet 67s includes a first main block B11, a second main block B12, and a coupling block B13 coupling the first main block B11 and the second main block B12. The first main block B11 is identical in shape and size to the first main block B1 in the first insulating sheet 66s, and the second main block B12 is identical in shape and size to the second main block B2 in the first insulating sheet 66s. The coupling block B13 is identical in shape and size to the coupling block B3 in the first insulating sheet 66s. Examples of resin as the material of the second insulating sheet 67s include PET, PI, and PEN, similarly to the first insulating sheet 66s. Note that the second insulating sheet 67s may be identical in material to or different in material from the first insulating sheet 66s.

[0142] The second insulating sheet 67s has an air outlet 67op penetrating from one face side to the other face side of the second insulating sheet 67s. The air outlet 67op that is an opening for deflation of the air in the openings of the annular members 9A to 9D to the outside of the load detection sensor 5D, is provided at a position the second electrodes 67e1 to 67e4 do not overlap in a case where the sheet face of the second electrode sheet 67 is viewed in plan view. For example, the air outlet 67op is provided at the coupling block B3.

[0143] The second electrodes 67e1 to 67e4 each include a conductive layer, for example, a substantially-circular metallic printed layer. The second electrode 67e1 and the second electrode 67e2 are disposed on one surface of the first main block B11. The second electrode 67e3 and the second electrode 67e4 are disposed on a surface identical to the face on which the second electrodes 67e1 and 67e2 are disposed, in the second main block B12. According to the present embodiment, the second electrodes 67e1 to 67e4 are identical in size to the first electrodes 66e1 to 66e4. The disposed positions of the second electrodes 67e1 and 67e2 are relatively identical in position to the disposed positions of the first electrodes 66e1 and 66e2 in the first main block B1. The disposed positions of the second electrodes 67e3 and 67e4 are relatively identical in position to the disposed positions of the first electrodes 66e3 and 66e4 in the second main block B2.

[0144] The second electrode 67e1 and the second electrode 67e2 are electrically connected through a second wire 67w1, the second electrode 67e3 and the second electrode 67e4 are electrically connected through a second wire 67w2, and the second wire 67w1 and the second wire 67w2 are electrically connected through a second wire 67w3.

[0145] The spacer 68 disposed between the first electrode sheet 66 and the second electrode sheet 67, is a resin insulating sheet having flexibility. According to the present embodiment, the spacer 68 having, for example, an H shape, includes a first main block B21, a second main block B22, and a coupling block B23 coupling the first main block B21 and the second main block B22. The first main block B21 is identical in shape and size to the first main block B1 in the first insulating sheet 66s, and the second main block B22 is identical in shape and size to the second main block B2 in the first insulating sheet 66s. The coupling block B23 is identical in shape and size to the coupling block B3 in the first insulating sheet 66s. Examples of resin as the material of the spacer 68 include PET, PI, and PEN, similarly to the first insulating sheet 66s and the second insulating sheet 67s. The spacer 68 may be identical in material to or different in material from the first insulating sheet 66s or the second insulating sheet 67s.

[0146] The first main block B21 of the spacer 68 has openings 68A and 68B penetrating from one face side to the other face side of the spacer 68. The first electrode 66e1 and the second electrode 67e1 are opposed to each other through the opening 68A, and the first electrode 66e2 and the second electrode 67e2 are opposed to each other through the opening 68B. Similarly, the second main block B22 of the spacer 68 has openings 68C and 68D penetrating from the one face side to the other face side of the spacer 68. The first electrode 66e3 and the second electrode 67e3 are opposed to each other through the opening 68C, and the first electrode 66e4 and the second electrode 67e4 are opposed to each other through the opening 68D. The circumferential-edge shapes of the openings 68A to 68D are, for example, substantially circular. The openings 68A to 68D are formed larger in diameter than the first electrodes 66e1 to 66e4. Therefore, the openings 68A to 68D according to the present embodiment are located outside the circumferential edges of the corresponding first electrodes 66e1 to 66e4 in plan view of the spacer 68 when the spacer 68, the first electrode sheet 66, and the second electrode sheet 67 are stacked.

[0147] Furthermore, the spacer 68 has a slit 68b connected to the openings 68A to 68D, the slit 68b allowing communication between the openings 68A to 68D. The slit 68b is located inside the edge of the spacer 68 without opening across the edge. According to the present embodiment, the slit 68b has, for example, an H shape.

[0148] The annular members 9A to 9D identical in configuration to the annular member 9 according to the first embodiment, have vents 91A to 91D, respectively.

[0149] The communication member 80 that is a member allowing communication between the respective vents 91A to 91D of the annular members 9A to 9D and the air outlet 67op provided at the second electrode sheet 67, is disposed in the slit 68b of the spacer 68. The communication member 80 having, for example, an H shape, similarly to the slit 68b, is connected to the annular members 9A to 9D through the respective vents 91A to 91D of the annular members 9A to 9D. Note that the communication member 80 may be connected to each of the annular members 9A to 9D by integral molding or may be connected to each of the annular members 9A to 9D by a predetermined fixture. According to the present embodiment, the communication member 80 includes a pair of flat plates disposed in parallel and has a passage allowing communication between the annular members 9A to 9D and the air outlet 67op, between the flat plates. However, the communication member 80 may have a grooved passage or a tubular passage.

[0150] In a case where the spacer 68 is superimposed on the first electrode sheet 66 and the second electrode sheet 67 with the communication member 80 disposed in the slit 68b of the spacer 68, the communication member 80 is in communication with the air outlet 67op provided at the second insulating sheet 67s of the second electrode sheet 67.

Therefore, the openings of the annular members 9A to 9D are in communication with the air outlet 67op through the communication member 80. That is the communication member 80 serves as an air vent.

[0151] The load detection sensor 5D includes the above constituent elements in combination. That is the annular member 9A to 9D are disposed in the corresponding openings 68A to 68D of the spacer 68, and the communication member 80 is disposed in the slit 68b of the spacer 68. In this state, the first electrode sheet 66 adheres to the one face side of the spacer 68 through the adhesive layer 10, and the second electrode sheet 67 adheres to the other face side of the spacer 68 through the adhesive layer 10, so that the load detection sensor 5D is provided.

[0152] In the load detection sensor 5D, the annular member 9A to 9D have no adhesion in contact with both of the first insulating sheet 66s exposed on one opening face side of the openings 68A to 68D of the spacer 68 and the second insulating sheet 67s exposed on the other opening face side of the openings 68A to 68D. As described above, the openings 68A to 68D of the annular members 9A to 9D are in communication with the air outlet 67op provided at the second insulating sheet 67s of the second electrode sheet 67 through the communication member 80, resulting in communication with the outside of the load detection sensor 5D.

[0153] Furthermore, in the load detection sensor 5D, the first electrodes 66e1 to 66e4 are located inside one opening ends of the annular members 9A to 9D, and the second electrodes 67e1 to 67e4 are located inside the other opening ends of the annular members 9. The first electrodes 66e1 to 66e4 are opposed to the second electrodes 67e1 to 67e4 through the openings 68A to 68D of the annular members 9A to 9D, resulting in formation of switches SW1 to SW4, respectively.

[0154] As described above, the load detection sensor 5D has also an effect similar to the above-described respective effects of the load detection sensor 5A according to the first embodiment and the load detection sensor 5B according to the second embodiment. Furthermore, according to the present embodiment, a plurality of switches is provided, each including a set of a first electrode and a second electrode. The openings 68A to 68D of the spacer 68 and the annular members 9A to 9D are provided for the switches SW1 to SW4, respectively. The spacer 68 has the slit 68b through which the openings 68A to 68D are in communication, and the second electrode sheet 67 has the air outlet 67op. The load detection sensor 5D according to the present embodiment includes the communication member 80 disposed in the slit 68b, the communication member 80 allowing communication between the annular members 9A to 9D and the air outlet 67op.

[0155] In the load detection sensor 5D, when inward deflection of the second electrode sheet 67 inside the annular member 9A causes contact between the first electrode 66e1 and the second electrode 67e1, the air inside the annular member 9A in the openings 68A to 68D of the spacer 68 discharges from the air outlet 67op to the outside of the load detection sensor 5D through the communication member 80. Similarly, inward deflection of the second electrode sheet 67 inside the annular members 9B to 9D causes the air inside the annular members 9B to 9D in the openings 68A to 68D of the spacer 68, to discharge from the air outlet 67op to the outside of the load detection sensor 5D through the communication member 80.

[0156] Therefore, inhibition of deflection of the second electrode sheet 67 due to the air inside the annular members 9A to 9D in the openings 68A to 68D of the spacer 68 is avoided, so that the load detection sensor 5D can be prevented from performing false detection.

(5) Fifth Embodiment

[0157] Next, a load detection sensor unit will be described as a fifth embodiment. Note that configurations similar to the configurations described above are denoted with the same reference signs. Unless otherwise specified, the duplicate descriptions will be omitted.

[0158] FIG. 13 is an exploded view of the configuration of a load detection sensor according to the fifth embodiment. As illustrated in FIG. 13, the load detection sensor 5E according to the present embodiment includes second electrodes 67e1 to 67e4 provided with air discharge slits 67s1 to 67s4, respectively. Annular members 9A to 9D according to the present embodiment have no vents 91A to 91D, respectively. The annular members 9A to 9D each circle in a ring shape with no break.

[0159] The load detection sensor 5E according to the present embodiment includes pairs of wires PW1 to PW3, each pair of wires being mutually adjacently spaced apart, instead of the second wires 67w1 to 67w3 according to the fourth embodiment. The load detection sensor 5E according to the present embodiment includes a communicating-passage formation member 85, instead of the communication member 80 according to the fourth embodiment.

[0160] The pairs of wires PW1 to PW3 are disposed on one face of a second electrode sheet 67 with each pair of wires mutually adjacently spaced apart. One end of the pair of wires PW1 electrically connected to the second electrode 67e1, is located inside the annular member 9A. The other end of the pair of wires PW1 electrically connected to the second electrode 67e2, is located inside the annular member 9B. One end of the pair of wires PW2 electrically connected to the second electrode 67e3, is located inside the annular member 9C. The other end of the pair of wires PW2 electrically connected to the second electrode 67e4, is located inside the annular member 9D. The pair of wires PW3 electrically connects one of the pair of wires PW1 to the adjacent one of the pair of wires PW2. In the example illustrated in FIG. 13, each of the pairs of wires PW1 to PW3 is disposed in parallel, but each pair of wires is not necessarily parallel as long as the pair of wires is mutually adjacently spaced apart in relationship.

[0161] The communicating-passage formation member 85 including, for example, an H-shaped beam, is connected to the annular members 9A to 9D. FIG. 14 is a sectional view of the load detection sensor 5E taken along line X-X of FIG. 13. As illustrated in FIG. 14, in a case where a spacer 68 is superimposed on a first electrode sheet 66 and the second electrode sheet 67, the communicating-passage formation member 85 abuts on the pair of wires PW1 and closes a gap AR between the pair of wires PW1 from the side opposite to the one face of the second electrode sheet 67. Similarly, in the case where the spacer 68 is superimposed on the first electrode sheet 66 and the second electrode sheet 67, the communicating-passage formation member 85 abuts on the pairs of wires PW2 and PW3 and closes respective gaps AR between the pairs of wires PW2 and PW3 from the side opposite to the one face of the second electrode sheet 67. Note that the communicating-passage formation member 85 has no adhesion to the pairs of wires PW1 to PW3, the first electrode sheet 66, and the second electrode sheet 67.

[0162] Therefore, in the case where the spacer 68 is superimposed on the first electrode sheet 66 and the second electrode sheet 67, the communicating-passage formation member 85 forms the respective gaps between the pairs of wires PW1 to PW3 as a communicating passage through which the air discharge slits 67s1 to 67s4 of the second electrodes 67e1 to 67e4 located inside the annular members 9A to 9D are in communication with an air outlet 67op.

[0163] Thus, in the load detection sensor 5E according to the present embodiment, when inward deflection of the second electrode sheet 67 inside the annular member 9A causes contact between the first electrode 66e1 and the second electrode 67e1, the air inside the annular member 9A in the openings 68A to 68D of the spacer 68, flows in the air discharge slit 67s1 of the second electrode 67e1. Then, the air flows into the respective gaps AR between the pairs of wires PW1 and PW3 formed by the communicating-passage formation member 85, and discharges from the air outlet 67op to the outside of the load detection sensor through the gaps AR.

[0164] Therefore, in the load detection sensor 5E according to the present embodiment, similarly to the fourth embodiment, inhibition of deflection of the second electrode sheet 67 due to the air inside the annular members 9A to 9D in the openings 68A to 68D of the spacer 68 is avoided, so that the load detection sensor 5E can be prevented from performing false detection. In addition, according to the present embodiment, because the annular members 9A to 9D require no vents 91A to 91D, respectively, the annular members 9A to 9D each itself improve in durability. Therefore, the annular members 9A to 9D can support the first electrode sheet 66 and the second electrode sheet 67, more stably. As a result, variation in the load necessary for contact between the first electrodes 66e1 to 66e4 and the second electrodes 67e1 to 67e4, can be reduced.

[0165] In the load detection sensor 5E according to the present embodiment, the communicating-passage formation member 85 itself has no adhesion to the pairs of wires PW1 to PW3, the first electrode sheet 66, and the second electrode sheet 67. Thus, filling of the respective gaps AR between the pairs of wires PW1 and PW3 formed by the communicating-passage formation member 85, with an adhesive layer, can be avoided. The communicating-passage formation member 85 itself is capable of supporting the first electrode sheet 66 and the second electrode sheet 67 with no adhesion to the pairs of wires PW1 to PW3 and the first electrode sheet 66, and thus an adhesive layer 10 between the first electrode sheet 66 and the spacer 68 and an adhesive layer 10 between the second electrode sheet and the spacer 68, can be reduced.

(6) Sixth Embodiment

[0166] Next, a load detection sensor unit will be described as a sixth embodiment. Note that configurations similar to the configurations described above are denoted with the same reference signs. Unless otherwise specified, the duplicate descriptions will be omitted.

[0167] FIG. 15 is an exploded view of the configuration of a load detection sensor according to the sixth embodiment. As illustrated in FIG. 15, the load detection sensor 5F according to the present embodiment includes a first electrode sheet 110, a second electrode sheet 120, a spacer 130, and an engagement member 140 as main constituent elements.

[0168] The first electrode sheet 110 includes a first insulating sheet 110s and a first conductive layer 110e.

[0169] The first insulating sheet 110s is a resin insulating sheet having flexibility. The first insulating sheet 110s includes a main block 110m and a tail block 110t connected to the main block 110m. The tail block 110t is narrower in width than the main block 110m. An air outlet 110h is formed near the center of the main block 110m. Examples of resin as the material of the first insulating sheet 110s include PET, PI, and PEN.

[0170] The first conductive layer 110e including a first electrode 111, a first terminal 113, and a first wire 112, is provided on one face of the first insulating sheet 110s. Referring to FIG. 15, for easy understanding, the disposed position of the first conductive layer 110e is indicated with broken lines on the first insulating sheet 110s with the first conductive layer 110e and the first insulating sheet 110s exploded.

[0171] The first electrode 111 is provided on the end side of the main block 110m. The first electrode 111 includes a conductive layer, for example, a metallic printed layer. The first electrode 111 according to the present embodiment includes a substantially-circular central electrode portion 111p and a substantially-circular ring-shaped outer electrode portion 111r surrounding the outer circumference of the central electrode portion 111p, with a gap llls formed between the central electrode portion 111p and the outer electrode portion 111r. The first terminal 113 includes a conductive layer, for example, a substantially-quadrangular metallic layer. The first terminal 113 is provided at the tail block 110t. The first electrode 111 and the first terminal 113 are mutually electrically connected through the first wire 112.

[0172] The first wire 112 includes a pair of wires spaced apart from each other. A slit-shaped gap 112s is formed between the pair of wires. The pair of wires is connected by a ring portion 112r formed in a substantially ring shape. An opening 112h is formed by the ring portion 112r, and the opening 112h is in communication with the gap 112s. The first wire 112 including the pair of wires, extends to the central electrode portion 111p of the first electrode 111, and the gap 112s extends to the central electrode portion 111p.

[0173] As indicated with the broken lines in FIG. 15, with the first conductive layer 110e disposed on the one face of the first insulating sheet 110s, the opening 112h of the first conductive layer 110e overlaps the air outlet 110h of the first insulating sheet 110s. That is the ring portion 112r of the first wire 112 surrounds the air outlet 110h of the first insulating sheet 110s in plan view of the first electrode sheet 110.

[0174] The second electrode sheet 120 includes a second insulating sheet 120s and a second conductive layer 120e.

[0175] The second insulating sheet 120s is a resin insulating sheet, similarly to the first insulating sheet 110s. The second insulating sheet 120s includes: a main block 120m identical in shape to the main block 110m of the first insulating sheet 110s; and a tail block 120t connected to the main block 120m, the tail block 120t being identical in shape to the tail block 110t of the first insulating sheet 110s. Note that, when the first insulating sheet 110s and the second insulating sheet 120s are superimposed, the tail block 110t of the first insulating sheet 110s and the tail block 120t of the second insulating sheet 120s do not overlap each other. Examples of the material of the second insulating sheet 120s are identical to the examples of the material of the first insulating sheet 110s. The second insulating sheet 120s may be identical in material to or different in material from the first insulating sheet 110s.

[0176] The second conductive layer 120e including a second electrode 121, a second terminal 123, and a second wire 122, is provided on one face of the second insulating sheet 120s. The one face of the second insulating sheet 120s is opposed to the one face of the first insulating sheet 110s provided with the first conductive layer 110e. Referring to FIG. 15, for easy understanding, similarly to the first electrode sheet 110, the disposed position of the second conductive layer 120e is indicated with broken lines on the second insulating sheet 120s with the second conductive layer 120e and the second insulating sheet 120s exploded.

[0177] The second electrode 121 provided on the end side of the main block 120m, is opposed to the first electrode 111 mutually when the first electrode sheet 110 and the second electrode sheet 120 are superimposed. The second electrode 121 includes a conductive layer similar to that of the first electrode 111. Similarly to the first electrode 111, the second electrode 121 according to the present embodiment includes a substantially-circular central electrode portion 121p and a substantially-circular ring-shaped outer electrode portion 121r surrounding the outer circumference of the central electrode portion 121p, with a slit 121s formed between the central electrode portion 121p and the outer electrode portion 121r. The second terminal 123 includes a conductive layer, for example, a substantially-quadrangular metallic layer. The second terminal 123 is provided at the tail block 120t. The second electrode 121 and the second terminal 123 are mutually electrically connected through the second wire 122. The second wire 122 extends to the central electrode portion 121p.

[0178] The spacer 130 disposed between the first electrode sheet 110 and the second electrode sheet 120, includes a resin insulating sheet having flexibility. The spacer 130 is similar in outer shape to the first insulating sheet 110s and the main block 120m of the second insulating sheet 120s. Examples of the material of the spacer 130 are similar to the examples of the material of the first insulating sheet 110s and the examples of the material of the second insulating sheet 120s. Note that the spacer 130 may be identical in material to or different in material from the first insulating sheet 110s or the second insulating sheet 120s. An adhesive layer not illustrated is disposed on each face of the spacer 130, the adhesive layers adhering to the first insulating sheet 110s and the second insulating sheet 120s.

[0179] The spacer 130 has an opening 130h. The opening 130h has a first opening portion 131 that is a substantially-circular opening and a second opening portion 132 connected to the first opening portion 131, the second opening portion 132 being a substantially-oblong slit. Thus, the opening 130h having the circular opening and the slit connected to the opening, has a substantially keyhole shape.

[0180] The engagement member 140 is a member that engages with the opening 130h of the spacer 130. The engagement member 140 includes an annular member 141 and a communicating-passage formation member 142 connected to the annular member 141, the annular member 141 and the communicating-passage formation member 142 being integrally formed.

[0181] The annular member 141 is formed in a ring shape, and an opening 140h is surrounded by the annular member 141. The annular member 141 is circular in outer shape, similarly to the first opening portion 131 of the opening 130h. The outer diameter thereof is slightly smaller than the diameter of the first opening portion 131 so that the annular member 141 can engage with the first opening portion 131. The inner diameter of the annular member 141 is larger than the central electrode portion 111p of the first electrode 111 and the central electrode portion 121p of the second electrode 121.

[0182] The communicating-passage formation member 142 is substantially identical in shape to the second opening portion 132 in the opening 130h of the spacer 130. Note that the communicating-passage formation member 142 is formed slightly smaller than the second opening portion 132 so that the communicating-passage formation member 142 can engage with the second opening portion 132.

[0183] Examples of the material of the engagement member 140 are similar to the examples of the material of the first insulating sheet 110s, the examples of the material of the second insulating sheet 120s, and the examples of the material of the spacer 130. Note that the engagement member 140 may be identical in material to or different in material from the spacer 130, the first insulating sheet 110s, and the second insulating sheet 120s. Note that the spacer 130 and the engagement member 140 are preferably identical in material in order to reduce a relative variation due to expansion of the spacer 130 between the height of the spacer 130 and the height of the engagement member 140. No adhesive layer is disposed on each face of the engagement member 140.

[0184] In plan view of the annular member 141 when the first electrode sheet 110, the spacer 130, and the second electrode sheet 120 are superimposed and the engagement member 140 engages with the opening 130h of the spacer 130, the central electrode portion 111p of the first electrode 111 and the central electrode portion 121p of the second electrode 121 are located inside the opening 140h of the annular member 141. The portion including the pair of wires, in the first wire 112 of the first electrode sheet 110 is in contact with the communicating-passage formation member 142, up to the ring portion 112r. Therefore, similarly to the fifth embodiment, according to the present embodiment, an air channel is formed by the pair of wires of the first wire 112, the first insulating sheet 110s, and the communicating-passage formation member 142. As described above, because no adhesive layer is disposed on each face of the engagement member 140, the air channel is inhibited from being filled with adhesive. As described above, the gap 112s between the pair of wires included in the first wire 112 extends to the central electrode portion 111p of the first electrode 111. Therefore, the gap 112s is in communication with the opening 140h. Furthermore, as described above, the ring portion 112r of the first wire 112 surrounds the air outlet 110h of the first insulating sheet 110s. Therefore, the air outlet 110h and the gap 112s are in communication. Thus, the opening 140h and the air outlet 110h are in communication through the air channel.

[0185] Therefore, in the load detection sensor 5F according to the present embodiment, when inward deflection of at least one of the first electrode sheet 110 and the second electrode sheet 120 inside the opening 140h of the annular member 141 causes contact between the first electrode 111 and the second electrode 121, the air in the opening 140h of the annular member 141 discharges from the air outlet 110h to the outside of the load detection sensor 5F through the air channel formed by the first wire 112, the first insulating sheet 110s, and the communicating-passage formation member 142 enveloping the gap 112s.

[0186] Therefore, similarly to the fourth embodiment and the fifth embodiment, in the load detection sensor 5F according to the present embodiment, inhibition of deflection of at least one of the first electrode sheet 110 and the second electrode sheet 120 due to the air inside the opening 140h of the annular member 141 is inhibited, so that the load detection sensor 5E can be prevented from performing false detection.

(7) Modification

[0187] According to the embodiments, the adhesive layer 10 is disposed both between the first electrode sheet and the spacer and between the second electrode sheet and the spacer, but may be disposed either between the first electrode sheet and the spacer or between the second electrode sheet and the spacer. Note that, in a case where no adhesive layer is disposed either between the first electrode sheet and the spacer or between the second electrode sheet and the spacer, for example, curing of curable resin provided to the first electrode sheet or the second electrode sheet can cause formation of a spacer, resulting in direct joining of the spacer to the first electrode sheet or the second electrode sheet. Note that curing of curable resin provided to the first electrode sheet or the second electrode sheet can cause formation of an annular member, resulting in direct joining of the annular member to the first electrode sheet or the second electrode sheet.

[0188] According to the embodiments, the annular member is in contact with both of the first electrode sheet and the second electrode sheet, but may be in contact with either the first electrode sheet or the second electrode sheet. In other words, the annular member requires contact with at least one of the first electrode sheet and the second electrode sheet.

[0189] According to the embodiments, the first electrode sheet is a resin insulating sheet having flexibility as a sheet. However, for example, the first electrode sheet may be a substrate having no flexibility or a metallic sheet, or may include two layers of an insulating sheet and a metallic sheet.

[0190] The load detection sensor according to the present invention has availability as long as the load detection sensor detects the presence or absence of load to a detection target to be detected in load. For example, there is a mode in which the load detection sensor is disposed under the seat cushion of an invalid bed. Even in the mode, the load detection sensor can detect load, so that information indicating whether a person is present on the seat cushion, can be acquired, on the basis of a detected result of the load detection sensor. The load detection sensor may be used as a switch for an electronic device, to detect the presence or absence of load.

[Examples]

[0191] Next, conducted experiments will be described with examples and comparative examples related to the embodiments. Note that the present invention is not limited to the examples and the comparative examples below.

[0192] A load detection sensor according to Comparative Example 1, a load detection sensor according to Example 1, and a load detection sensor according to Example 2 were prepared, and experiments were conducted in applying load to each load detection sensor under different temperature environments.

[0193] As the load detection sensor according to Comparative Example 1, prepared was a load detection sensor having a configuration in which the annular member 9 was omitted from the load detection sensor 5A according to the first embodiment. As the load detection sensor according to Example 1, prepared was a load detection sensor including the second electrode sheet 7 according to the first embodiment including two layers of the second insulating sheet 57s and the metallic plate 60 according to the second embodiment, with the other constituent elements identical to the constituent elements according to the first embodiment. As the load detection sensor according to Example 2, prepared was a load detection sensor corresponding to the load detection sensor 5C according to the third embodiment.

[0194] The load detection sensor according to Comparative Example 1, the load detection sensor according to Example 1, and the load detection sensor according to Example 2, each had a sheet including PET with a thickness of 75 μm as a first insulating sheet and a sheet including PET with a thickness of 50 μm as a spacer. An adhesive layer on the first insulating sheet side was an acrylic adhesive layer with a thickness of 25 μm, and an adhesive layer on the second insulating sheet side was an acrylic adhesive layer with a thickness of 25 μm. The load detection sensor according to Comparative Example 1 and the load detection sensor according to Example 1 each had a sheet including PET with a thickness of 100 μm as a second insulating sheet. The load detection sensor according to Example 1 and the load detection sensor according to Example 2 each had a sheet including SUS301 with a thickness of 0.1 mm as a metallic plate and an acrylic adhesive layer with a thickness of 24 μm as an adhesive layer between the metallic plate and the insulating sheet.

[0195] Furthermore, FIG. 16 indicates the diameter of the spacer of each of the load detection sensor according to Comparative Example 1, the load detection sensor according to Example 1, and the load detection sensor according to Example 2, and the inner diameter and the material of the annular member of each of the load detection sensor according to Example 1 and the load detection sensor according to Example 2. Note that the spacer opening diameter indicated in FIG. 16 means the diameter of the spacer, the ring diameter indicated in FIG. 16 means the inner diameter of the annular member, and the ring material indicated in FIG. 16 means the material of the annular member.

(Experiment 1)

[0196] The load detection sensor according to Comparative Example, the load detection sensor according to Example 1, and the load detection sensor according to Example 2 each were disposed under temperature environments at -40°C, 25°C, and 85°C, and then a load being applied (on-load) was measured at contact between a pair of electrodes due to pressing of each load detection sensor from the second electrode sheet side. Note that, referring to FIG. 16, the increase and decrease of the on-load measured under the temperature environment at -40°C and the on-load measured under the temperature environment at 85°C to the on-load measured under the temperature environment at 25°C, are indicated on a percentage basis.

[0197] As indicated in FIG. 16, even with a variation to-40°C and a variation to 85°C with respect to ordinary temperature, Example 1 and Example 2 in which the annular member was provided, are smaller in on-load variation at the temperatures than Comparative Example 1 in which no annular member was provided. That is, it was found that provision of the annular member enables load detection equivalent to that under the ordinary temperature environment even when variation occurs from the ordinary temperature to high temperature or low temperature.

(Experiment 2)

[0198] The load detection sensor according to Comparative Example 1, the load detection sensor according to Example 1, and the load detection sensor according to Example 2 each were disposed under a temperature environment at 80°C, and then each load sensor was pressed from the second electrode sheet side by a pressure of 20 N for 144 hours. After that, on-load was measured at ordinary temperature, and the rate of change to on-load measured at ordinary temperature before the pressing was acquired as the rate of on-load change after a high-temperature constant-load test. This result is indicated in FIG. 16

[0199] As indicated in FIG. 16, even with the continuously long-term pressing under the high-temperature environment, Example 1 and Example 2 in which the annular member was provided, are smaller in the rate of on-load change than Comparative Example 1 in which no annular member was provided. That is, it was found that provision of the annular member enables load detection equivalent to that under the ordinary temperature environment even with the continuously long-term pressing under the high-temperature environment.

[0200] A load detection sensor according to Comparative Example 2 and a load detection sensor according to Example 3 were prepared, and then experiments were conducted in applying load to each load detection sensor under different temperature environments.

[0201] As the load detection sensor according to Comparative Example 2, prepared was a load detection sensor having a configuration in which the annular member 9 was omitted from the load detection sensor 5A according to the first embodiment. As the load detection sensor according to Example 3, prepared was a load detection sensor corresponding to the load detection sensor 5A according to the first embodiment.

[0202] The load detection sensor according to Comparative Example 2 and the load detection sensor according to Example 3 each had a sheet including PET with a thickness of 100 μm as a first insulating sheet and a sheet including PET with a thickness of 50 μm as a spacer. The load detection sensor according to Comparative Example 2 and the load detection sensor according to Example 3 each had an acrylic adhesive layer with a thickness of 25 μm as an adhesive layer on the first insulating sheet side and an acrylic adhesive layer with a thickness of 25 μm as an adhesive layer on the second insulating sheet side. The load detection sensor according to Comparative Example 2 and the load detection sensor according to Example 3 each had a sheet including PET with a thickness of 100 μm as a second insulating sheet.

[0203] Furthermore, FIG. 17 indicates the diameter of the spacer of each of the load detection sensor according to Comparative Example 2 and the load detection sensor according to Example 3 and the inner diameter and the material of the annular member. The spacer opening diameter indicated in FIG. 17 means the diameter of the spacer, the ring diameter indicated in FIG. 16 means the inner diameter of the annular member, and the ring material indicated in FIG. 16 means the material of the annular member. Note that the outer diameter of the annular member was 11 mm and the height of the annular member was 100 μm.

[0204] The load detection sensor according to Comparative Example 2 and the load detection sensor according to Example 3 were disposed under temperature environments at-40°C, 25°C, and 85°C, and then a load being applied (on-load) was measured at contact between a pair of electrodes due to pressing of each load detection sensor from the second electrode sheet side. Note that, referring to FIG. 17, the increase and decrease of the on-load measured under the temperature environment at -40°C and the on-load measured under the temperature environment at 85°C to the on-load measured under the temperature environment at 25°C, are indicated on a percentage basis.

[0205] As indicated in FIG. 17, even with a variation to - 40°C and a variation to 85°C with respect to ordinary temperature, Example 3 in which the annular member was provided, is smaller in on-load variation at the temperatures than Comparative Example 2 in which no annular member was provided. That is, it was found that provision of the annular member enables load detection equivalent to that under the ordinary temperature environment even when variation occurs from the ordinary temperature to high temperature or low temperature.

Reference Sings List

[0206]

5A to 5F ...	load detection sensor
6, 56, 66, 110 ...	first electrode sheet
7, 57, 67, 120 ...	second electrode sheet
8, 58, 68, 130 ...	spacer
9, 9A to 9D, 59, 141 ...	annular member
10 ...	adhesive layer
80 ...	communication member
85, 142 ...	communicating-passage formation member
101 ...	metallic sheet
SW, SW1 to SW4 ...	switch

Claims

1. A load detection sensor comprising:

a first electrode sheet including a first electrode;
a second electrode sheet including a second electrode opposed to the first electrode;
a spacer interposed between the first electrode sheet and the second electrode sheet, the spacer having an opening between the first electrode and the second electrode;
an annular member disposed in the opening; and
an adhesive layer disposed at least either between the spacer and the first electrode sheet or between the spacer and the second electrode sheet,
wherein the annular member is in contact with at least one of the first electrode sheet exposed at the opening and the second electrode sheet exposed at the opening, and has no adhesion to both of the first electrode sheet and the second electrode sheet.

2. The load detection sensor according to claim 1,
wherein the annular member is in contact with both of the first electrode sheet and the second electrode sheet.

3. The load detection sensor according to claim 1 or 2,
wherein at least part of an outer circumferential face of the annular member is spaced apart from the spacer.

4. The load detection sensor according to any one of claims 1 to 3,
wherein the annular member is identical in material to the spacer.

5. The load detection sensor according to any one of claims 1 to 4,
wherein the annular member has a vent for deflation of air in the opening of the spacer.

6. The load detection sensor according to claim 5, comprising:

a communication member,
wherein the spacer has a slit connected to the opening,
at least one of the first electrode sheet and the second electrode sheet has an air outlet, and
the communication member is disposed in the slit, the communication member allowing communication between the vent of the annular member and the air outlet.

7. The load detection sensor according to any one of claims 1 to 4, comprising:

a communicating-passage formation member,
wherein the spacer has a slit connected to the opening,
at least one of the first electrode sheet and the second electrode sheet includes a pair of wires mutually adjacently spaced apart and an air outlet,
an end of the pair of wires is located inside the annular member, and
the communicating-passage formation member is disposed in the slit, the communicating-passage formation member forming a gap between the pair of wires as a communicating passage allowing communication between an inside of the annular member in the opening of the spacer and the air outlet.

8. The load detection sensor according to any one of claims 1 to 7,
wherein, in a case where a sheet face of the first electrode sheet is viewed in plan view, the annular member overlaps the first electrode and the second electrode.

9. The load detection sensor according to claim 8,
wherein a sum of a thickness of the spacer and a thickness of the adhesive layer is approximately equivalent to a sum of a height of the annular member, a thickness of the first electrode, and a thickness of the second electrode.

10. The load detection sensor according to any one of claims 1 to 7,
wherein, in a case where a sheet face of the first electrode sheet is viewed in plan view, the annular member does not overlap the first electrode and the second electrode.

11. The load detection sensor according to claim 10,
wherein a sum of a thickness of the spacer and a thickness of the adhesive layer is approximately equivalent to a height of the annular member.

FIG. 1

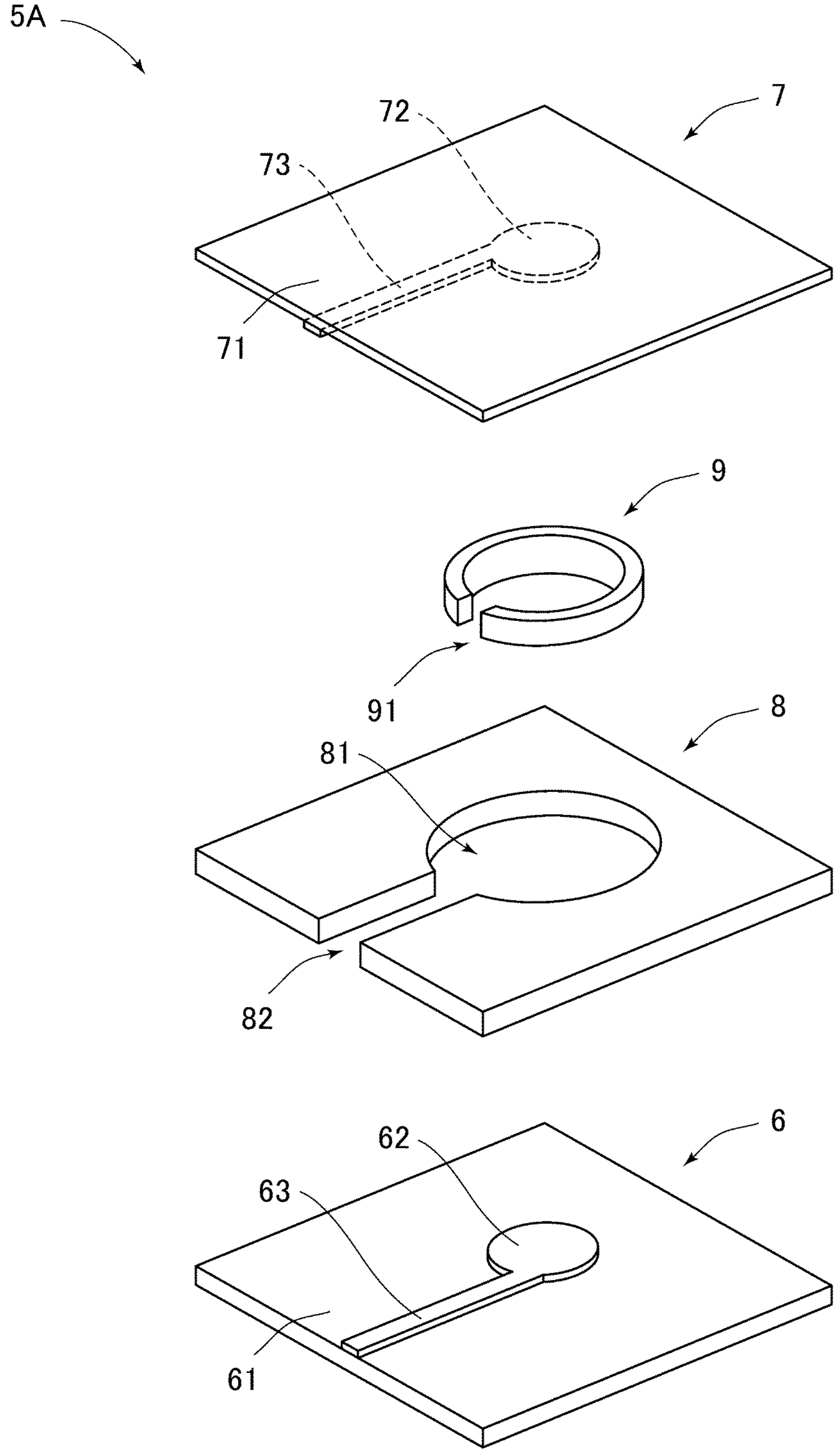


FIG. 2

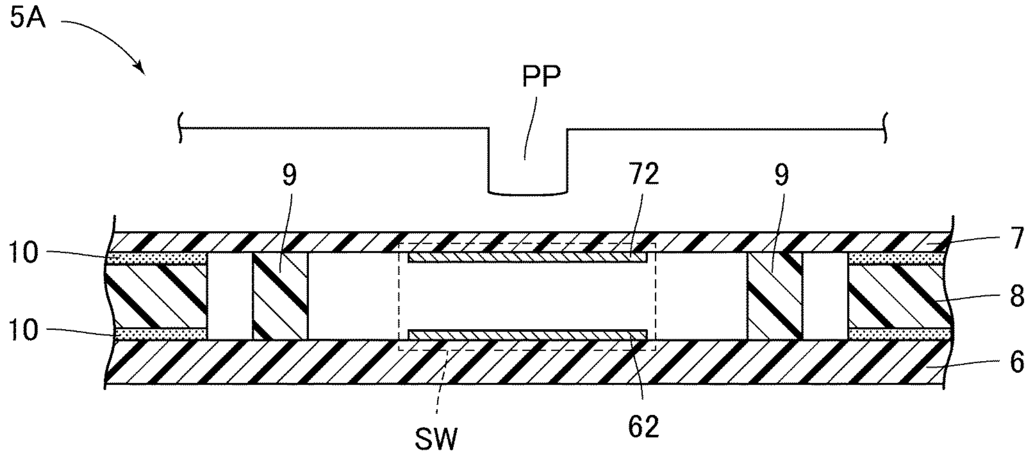


FIG. 3

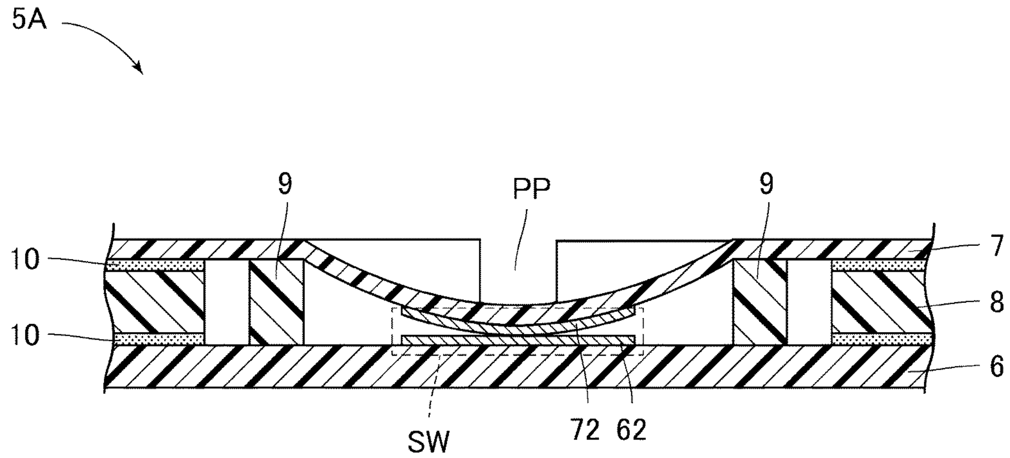


FIG. 4

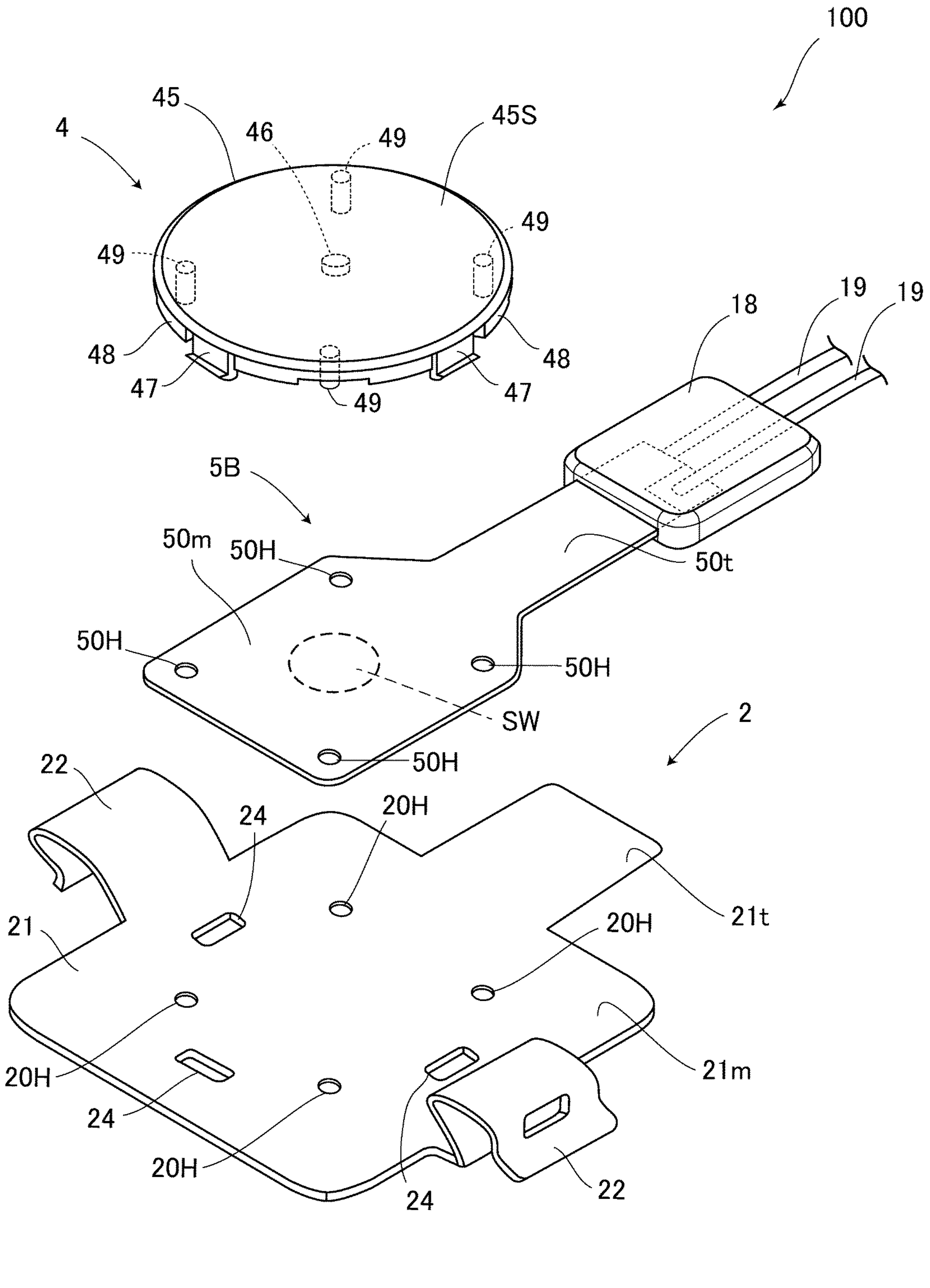

100
4
45
46
49
45S
49
49
48
48
47
49
47
18
19
19
5B
50m
50H
50t
50H
50H
SW
50H
2
22
24
20H
21t
21
20H
21m
20H
24
20H
24
22

FIG. 5

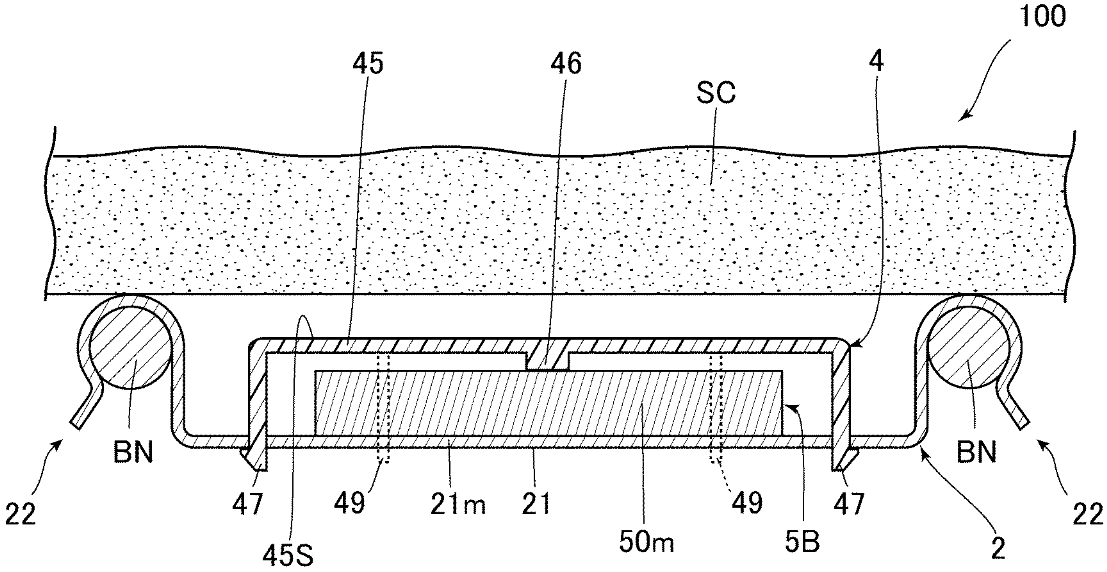


FIG. 6

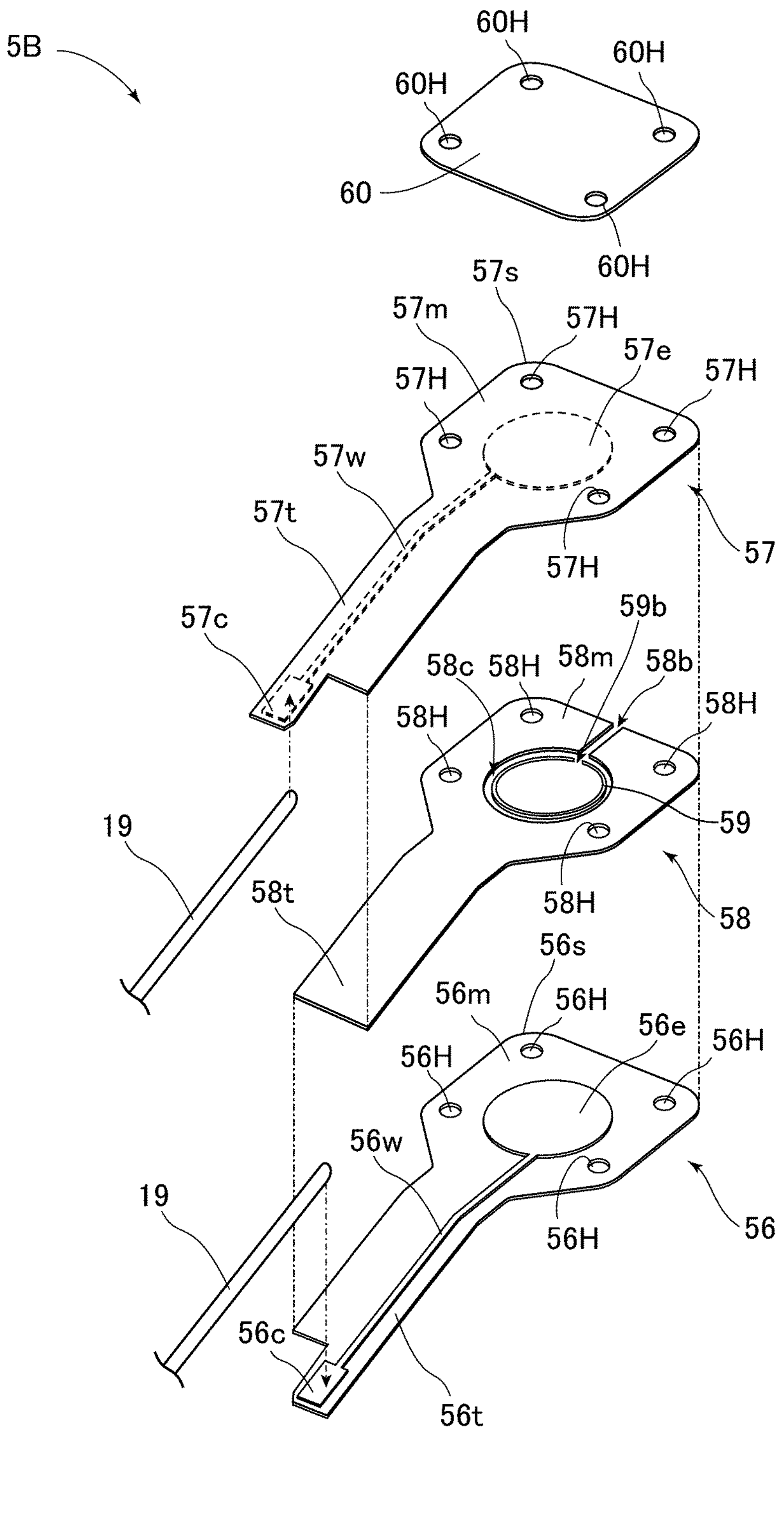

5B
60H
60H
60H
60
60H
57s
57m
57H
57e
57H
57H
57w
57t
57
57H
57c
59b
58c
58H
58m
58b
58H
58H
19
59
58t
58H
58
56s
56m
56H
56e
56H
56H
56w
19
56
56H
56c
56t

FIG. 7

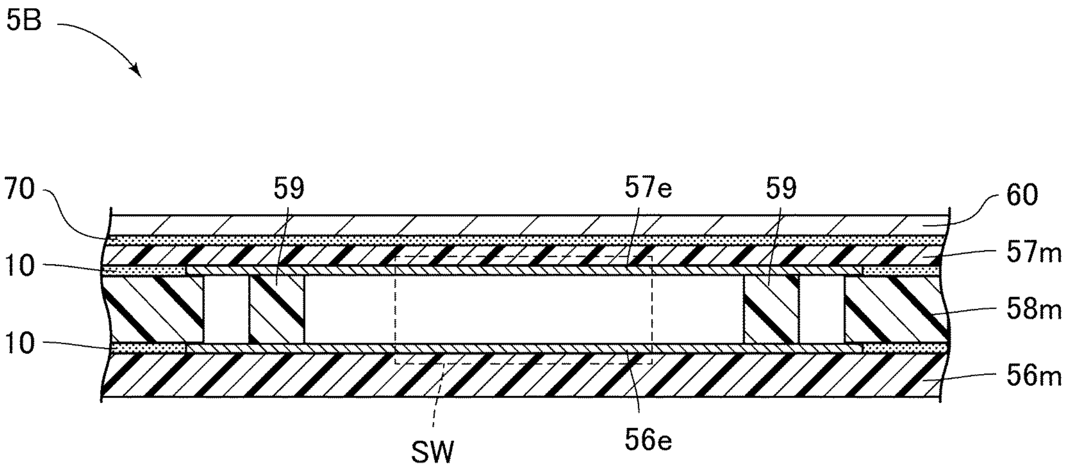


FIG. 8

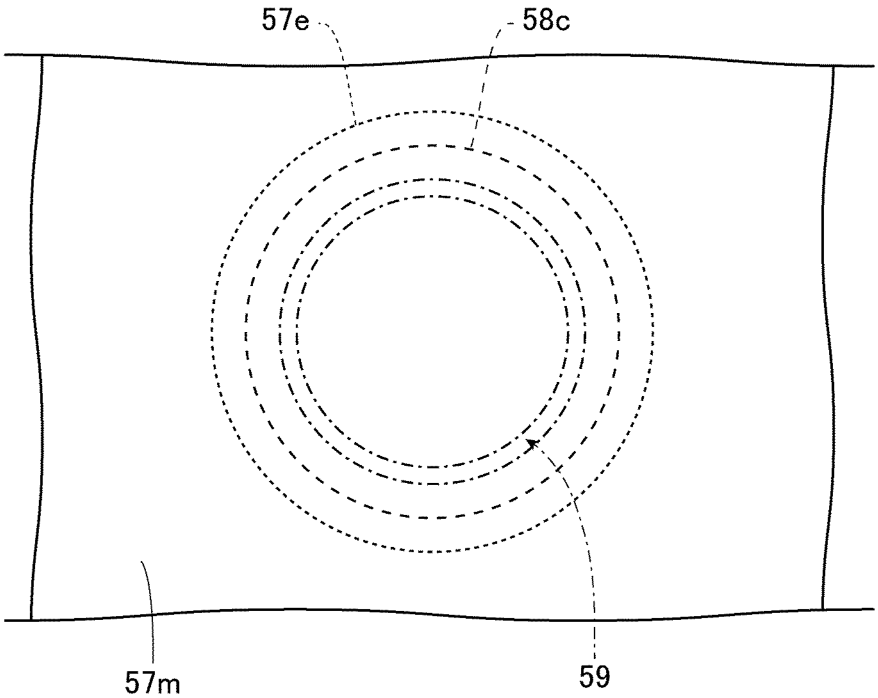


FIG. 9

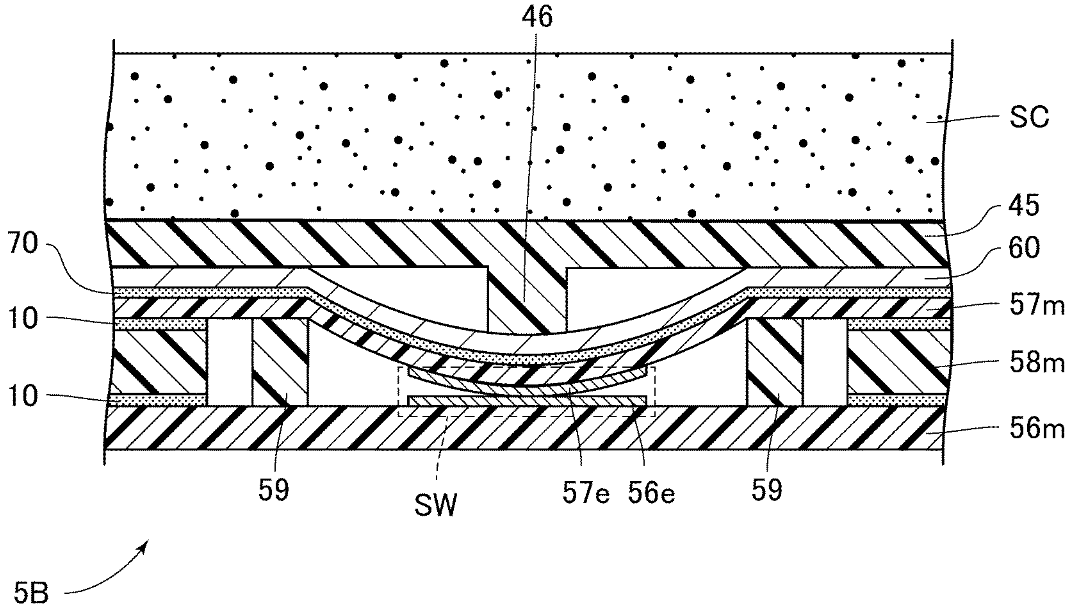

46
SC
45
70
60
10
57m
58m
10
56m
59
SW
57e
56e
59
5B

FIG. 10

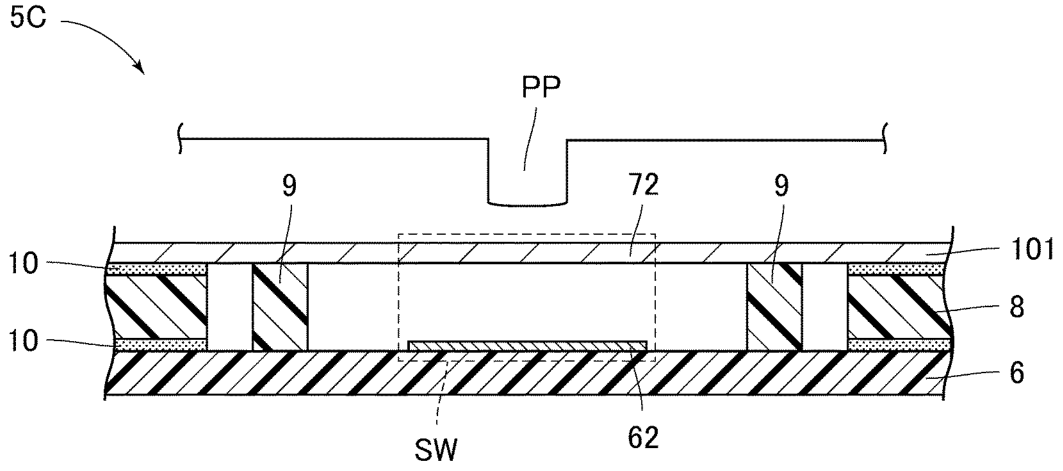

5C
PP
9
72
9
10
101
8
10
6
SW
62

FIG. 11

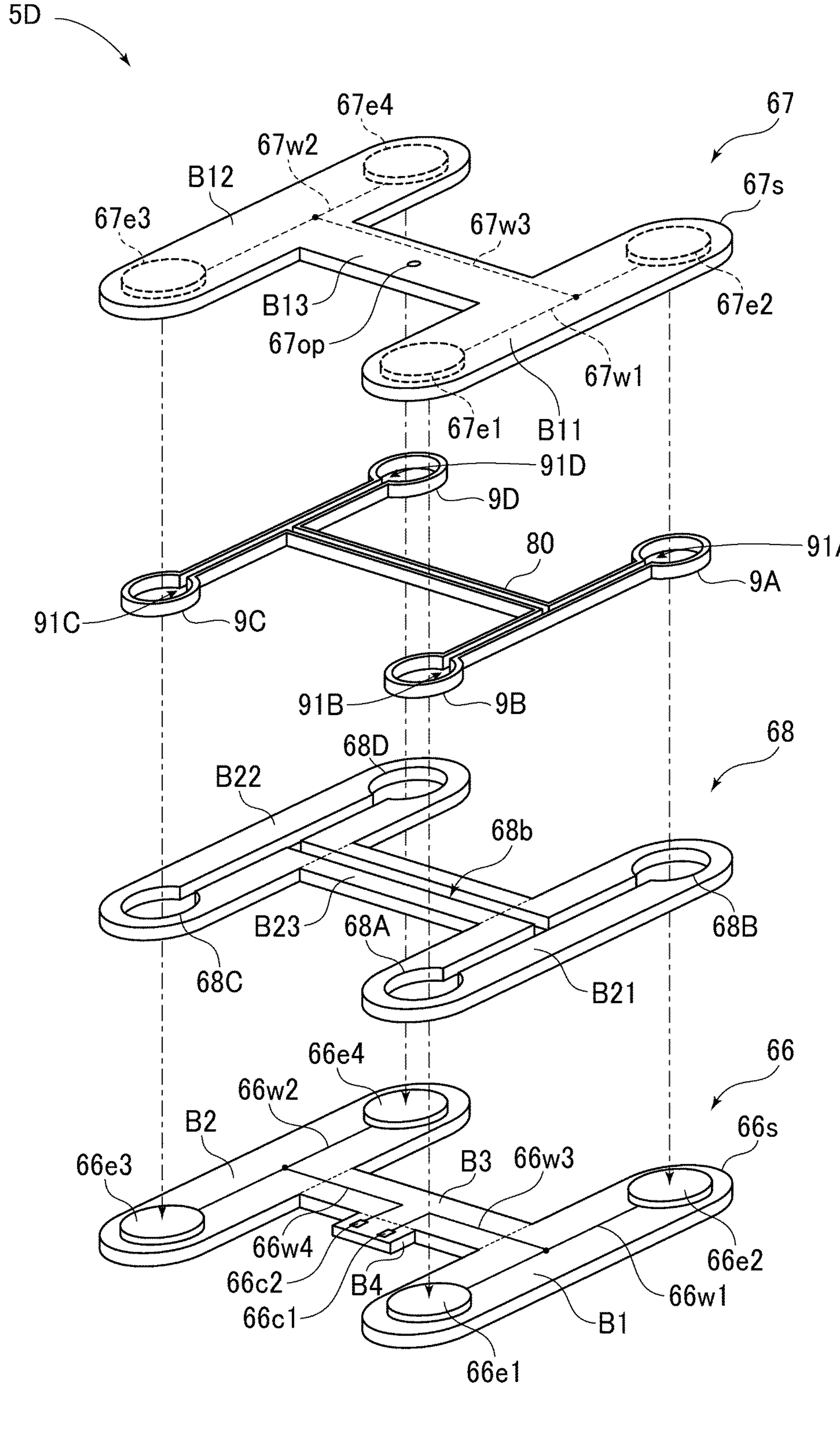

5D
67
67e4
67w2
B12
67s
67e3
67w3
B13
67e2
67op
67w1
67e1
B11
91D
9D
80
91A
9A
91C
9C
91B
9B
68
68D
B22
68b
B23
68A
68B
68C
B21
66
66e4
66w2
B2
66s
66e3
B3
66w3
66w4
66e2
66c2
B4
66w1
66c1
B1
66e1

FIG. 12

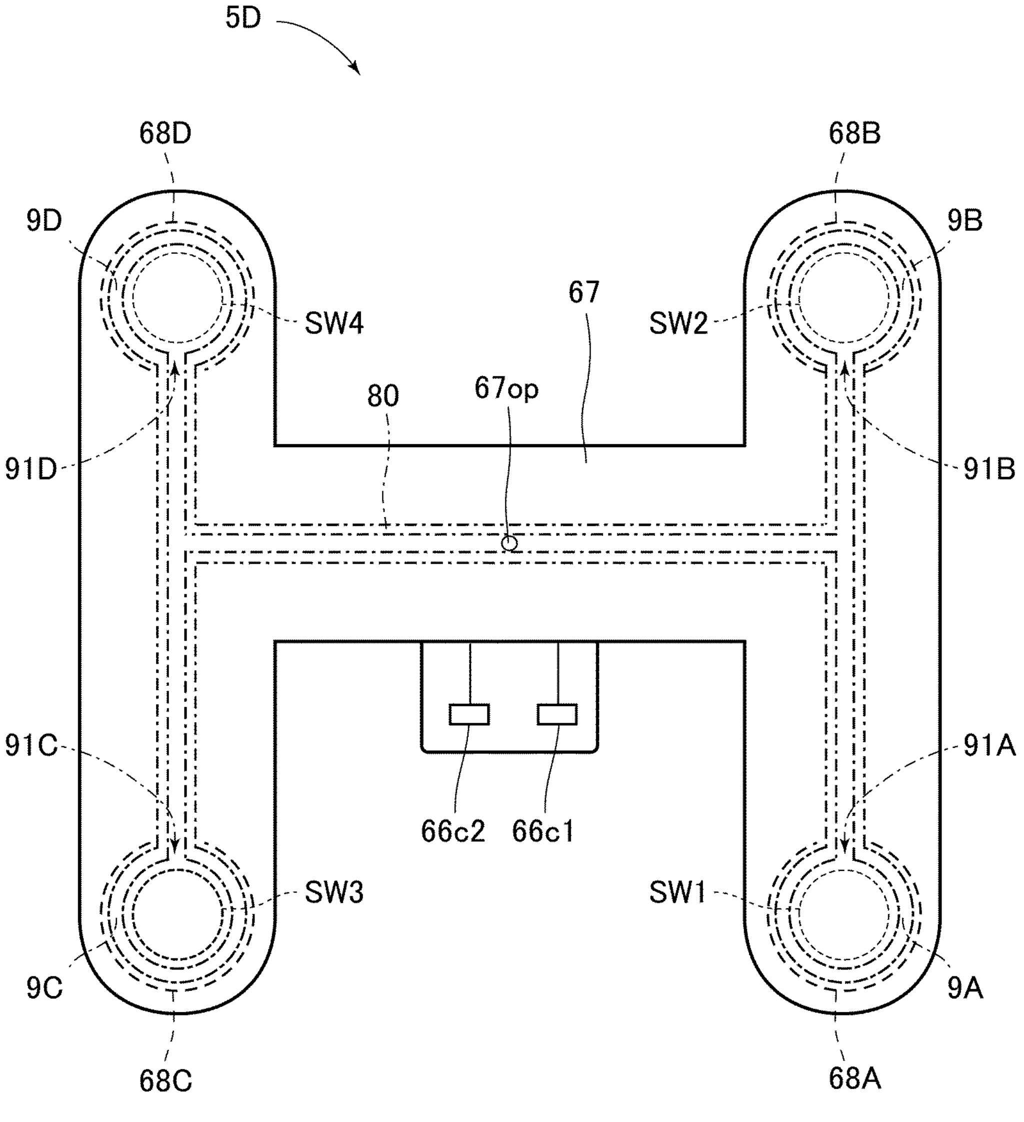

5D
68D
68B
9D
9B
67
SW4
SW2
80
67op
91D
91B
91C
91A
66c2
66c1
SW3
SW1
9C
9A
68C
68A

FIG. 13

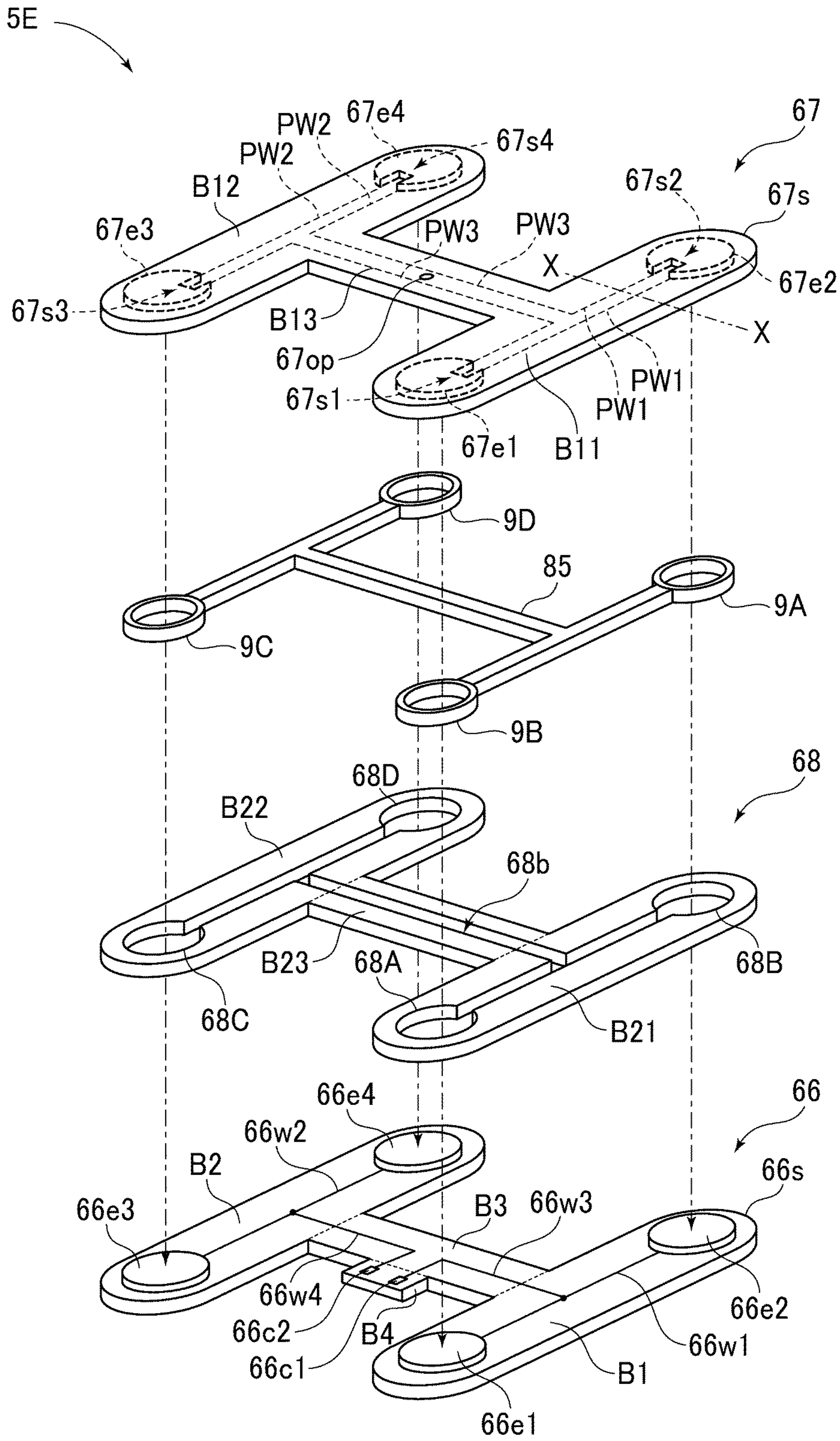

5E
67
67e4
PW2
PW2
67s4
B12
67s2
67s
67e3
PW3
PW3
X
67e2
67s3
B13
X
67op
PW1
67s1
PW1
67e1
B11
9D
85
9A
9C
9B
68
68D
B22
68b
B23
68A
68B
68C
B21
66
66e4
66w2
66s
B2
B3
66w3
66e3
66w4
66c2
B4
66e2
66c1
66w1
B1
66e1

FIG. 14

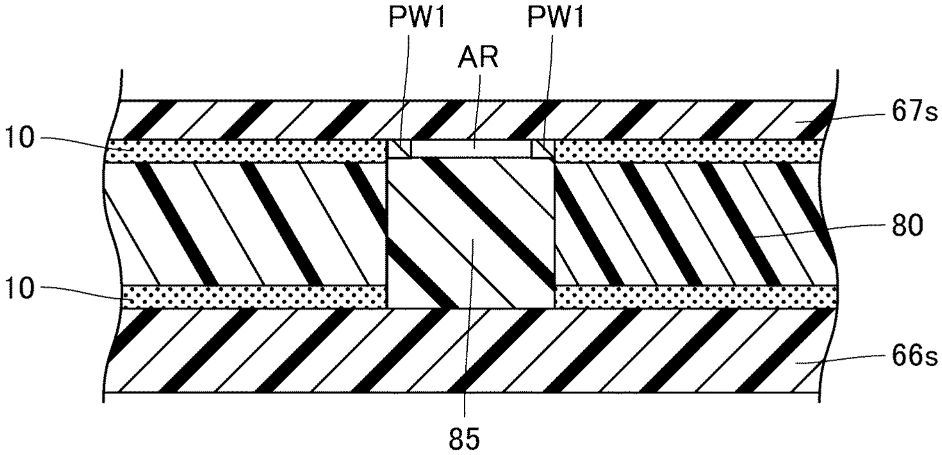
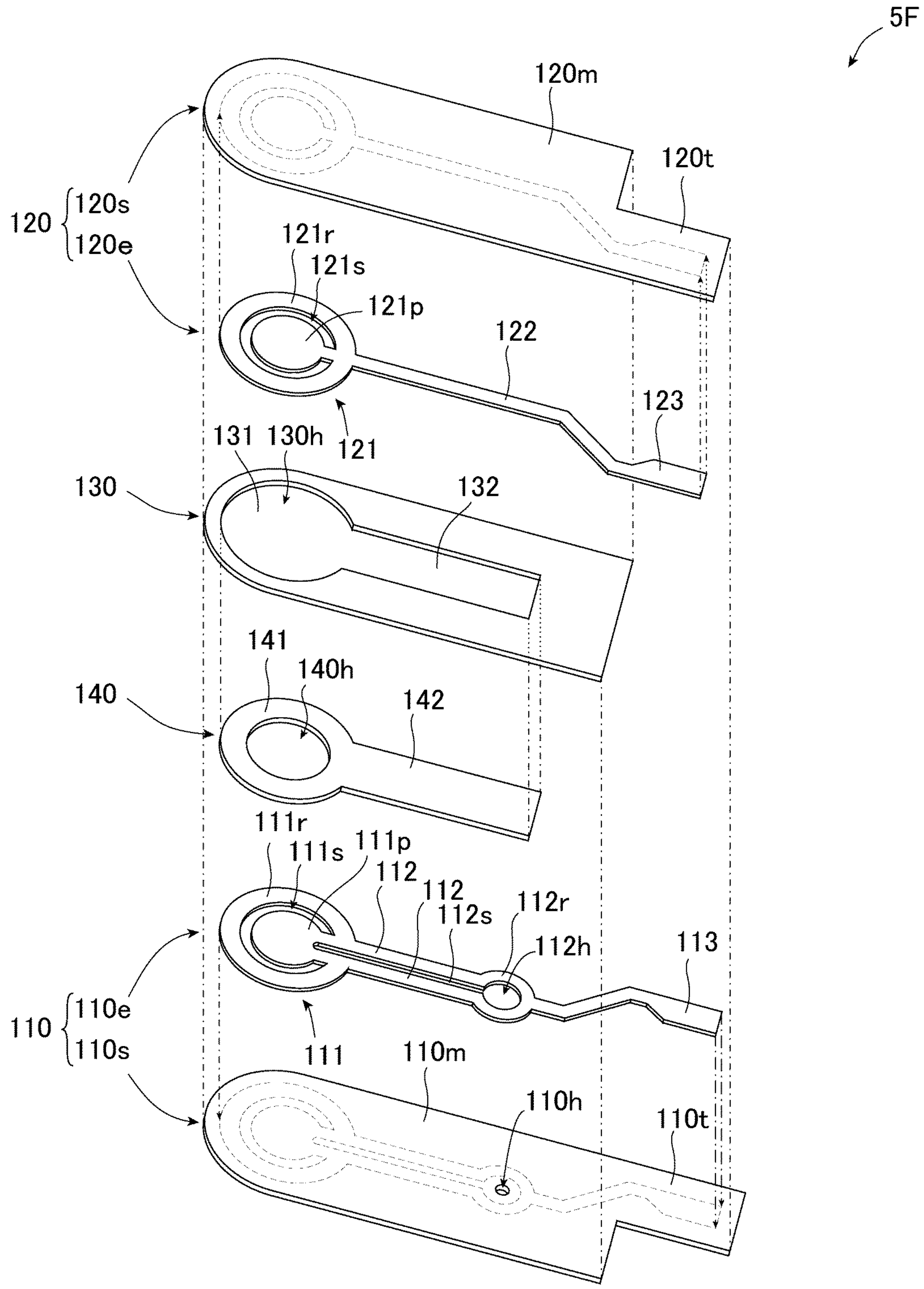


FIG. 15



5F
120m
120t
120
120s
120e
121r
121s
121p
122
123
121
131
130h
130
132
141
140h
140
142
111r
111s
111p
112
112
112s
112r
112h
113
110
110e
110s
111
110m
110h
110t

FIG. 16

		COMPARATIVE EXAMPLE 1	EXAMPLE 1	EXAMPLE 2
SPACER OPENING DIAMETER [mm]		10	15	15
RING DIAMETER [mm]		—	10	10
RING MATERIAL		—	PET	THERMOSETTING RESIN
ON-LOAD TEMPERATURE CHARACTERISTICS (NORMALIZATION WITH ON-LOAD AT 25℃)	−40℃	136.9	53.6	67.0
	25℃	0.0	0.0	0.0
	85℃	−22.7	−19.7	−20.1
RATE OF ON-LOAD CHANGE AFTER HIGH-TEMPERATURE CONSTANT-LOAD TEST [%]		−15.9	−5.4	−3.0

FIG. 17

		COMPARATIVE EXAMPLE 2	EXAMPLE 3
SPACER OPENING DIAMETER [mm]		10	12.5
RING DIAMETER [mm]		—	10
RING MATERIAL		—	PET
ON-LOAD TEMPERATURE CHARACTERISTICS (NORMALIZATION WITH ON-LOAD AT 25℃)	−40℃	46.1	11.9
	25℃	0.0	0.0
	85℃	−75.3	−50.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/007590

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. H01H13/16(2006.01)i, A47C7/62(2006.01)i, H01H35/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. H01H13/16, A47C7/62, H01H35/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-233441 A (TOYOTA BOSHOKU CORP.) 17 November 2011, entire text, all drawings (Family: none)	1-11
A	JP 2002-358852 A (FUJIKURA LTD.) 13 December 2002, entire text, all drawings & US 2003/0000821 A1, entire text, all drawings	1-11
A	JP 2010-175312 A (AISIN SEIKI CO., LTD.) 12 August 2010, entire text, all drawings (Family: none)	1-11
A	JP 2013-166532 A (AISIN SEIKI CO., LTD.) 29 August 2013, entire text, all drawings (Family: none)	1-11

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24.04.2018	15.05.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/007590

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2017-033780 A (FUJIKURA LTD.) 09 February 2017, entire text, all drawings (Family: none)	1-11

Form PCT/ISA/210 (continuation of second sheet) (January 2015)