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

(11) EP 2 565 888 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
06.03.2013 Bulletin 2013/10

(21) Application number: **11774790.7**

(22) Date of filing: **11.04.2011**

(51) Int Cl.:
H01H 1/06 *(2006.01)* ***H01H 5/30*** *(2006.01)*
H01H 11/00 *(2006.01)* ***H01H 13/48*** *(2006.01)*
H01H 13/702 *(2006.01)*

(86) International application number:
PCT/JP2011/058975

(87) International publication number:
WO 2011/136006 (03.11.2011 Gazette 2011/44)

(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

(30) Priority: **28.04.2010 JP 2010103635**

(71) Applicant: **Alps Electric Co., Ltd.**
Tokyo 145-8501 (JP)

(72) Inventor: **HANAWA, Naoki**
Tokyo 145-8501 (JP)

(74) Representative: **Waibel, Stefan Christopher**
Klunker Schmitt-Nilson Hirsch
Patentanwälte
Destouchesstrasse 68
80796 München (DE)

(54) CONTACT MEMBER AND SWITCH DEVICE USING CONTACT MEMBER

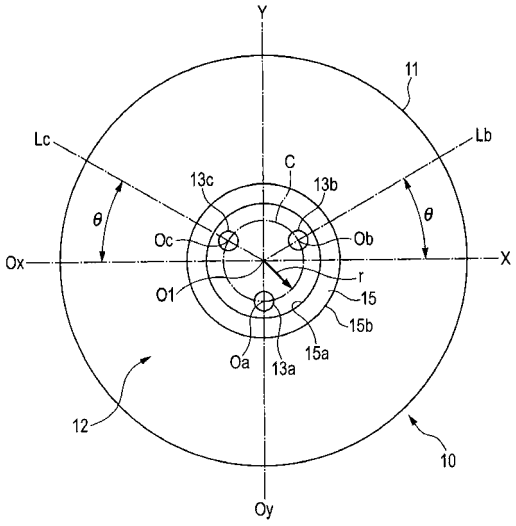
(57) PROBLEMS

In a contact member provided with a plurality of protrusions in a curved portion and a switch device using the contact member, deterioration of an operating sensation is caused not to occur even though a pressing point is deviated from the center.

SOLVING MEANS

A dome-shaped curved portion 12 is formed in a contact member 10 formed of a metal leaf spring material, and three protrusions 13a, 13b, and 13c protrude toward a substrate at the periphery of a center O1. The extension direction of the leaf spring material that forms the contact member 10 is the X direction. The protrusions 13b and 13c are disposed at positions where the circular contours thereof do not overlap with a vertical center line Ox extending in the extension direction. Therefore, the positions of the protrusions may be displaced with respect to a direction in which an operating sensation is deteriorated due to the influence of the extension direction of the material, so that when a position distant from the center 01 is pressed, an area where the operating sensation is not deteriorated may be enlarged in a wide range in the X direction and the Y direction.

FIG. 2



EP 2 565 888 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a contact member having a curved portion which is formed of a metal plate and is elastically deformed, and more particularly, to a contact member provided with a plurality of protrusions on a concave surface side of a curved portion and a switch device using the contact member.

BACKGROUND ART

[0002] In PTL 1 described below, an inversion leaf spring which is a contact member having a dome-shaped curved portion is disclosed. In the inversion leaf spring, the convex side of the curved portion is fixed to a flexible sheet via an adhesive. A peripheral fixed contact and a center fixed contact are provided on the base, and when the flexible sheet is fixed to the surface of the base, the peripheral edge portion of the inversion leaf spring abuts on the peripheral fixed contact and the concave side of the curved portion of the inversion leaf spring opposes the center fixed contact. When the inversion leaf spring is pressed by a stem or the like of the switch mechanism, the inversion leaf spring is inverted toward the base and comes in contact with the fixed contact.

[0003] The inversion leaf spring disclosed in PTL 1 is provided with three movable contact portions protruding toward the base from the concave side of the curved portion, and the three movable contacts are disposed at equal distances from the center of the curved portion and at intervals of equal angles of 120 degrees with respect to the center.

[0004] When the curved portion is inverted toward the substrate, the movable contact portions come in contact with the center fixed contact. As the movable contact portions, which are small protrusions, come in contact with the center fixed contacts, a contact area between the inversion leaf spring and the center fixed contact may be reduced, resulting in an increase in contact reliability. In addition, even though an insulating material such as dust is present on the surface of the center fixed contact, when the curved portion is inverted, the movable contact portion is operated so as to exclude the insulating portion on the surface of the center fixed contact, and thus it becomes possible to enhance the contact reliability.

CITATION LIST

PATENT LITERATURE

[0005]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2007-280848

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] In the switch mechanism using the inversion leaf spring described in PTL 1, when the center of the stem is aligned with the center of the curved portion of the inversion leaf spring, an elastic reaction is appropriately exerted when the curved portion is inverted by pressing the stem and thus an operating sensation is enhanced.

[0007] However, when the center of the stem is deviated from the center of the curved portion due to the assembly tolerance of the switch mechanism, the elastic reaction when the stem is pressed is weakened in the deviating position and at the deviating distance, so that the operating sensation may be deteriorated.

[0008] In order to solve the problem with degradation of the operating sensation, an object of the invention is to provide a contact member capable of preventing extreme deterioration of an operating sensation even though a pressing position is deviated in any direction with respect to the center of a curved portion, and a switch device using the contact member.

MEANS FOR SOLVING THE PROBLEMS

[0009] According to the invention, a contact member, includes: a curved portion which is formed of a rolled conductive metal plate and protrudes toward a first side, the curved portion being elastically deformable toward a second side; and a plurality of protrusions formed to protrude toward the second side from the curved portion, wherein all the protrusions are formed at positions that do not overlap with a vertical center line extending in parallel to a rolling direction through a center of the curved portion.

[0010] The invention is made in consideration that deterioration of an operating sensation when a pressing position is deviated from the center of a curved portion is dependent on the positional relationship between a rolling direction of a metal plate and protrusions. In the metal plate, bending rigidity and bending elastic modulus thereof in the pressing direction are lower than those in a direction orthogonal to the pressing direction. There, by setting a line connecting the center of the curved portion to the center point of the protrusion so as not to direct in the rolling direction in which the bending rigidity and the bending elastic modulus are low, appropriate elastic reaction may be present when the curved portion is pressed in the peripheries of the protrusions, so that extreme deterioration of the operating sensation may be prevented.

[0011] According to the invention, contours of all the protrusions when viewed from the second side are positioned to be distant from the center line.

[0012] It is preferable that the protrusions be positioned at equal distances from the center of the curved portion,

and it is preferable that center points of the plurality of protrusions are disposed at equal angles with respect to the center of the curved portion.

[0013] According to the invention, for example, the number of the protrusions is 3, and a center point of one of the protrusions is positioned on a horizontal center line orthogonal to the vertical center line through the center of the curved portion.

[0014] According to the invention, a raised portion is formed to protrude toward the first side from the curved portion, wherein the raised portion is provided at a position farther from the center of the curved portion than the protrusions, and the raised portion is formed continuously or intermittently along an arc with a predetermined radius from the center.

[0015] By providing the raised portion, an appropriate elastic reaction may be obtained when the curved portion is elastically deformed, so that the operating sensation may be enhanced.

[0016] According to the invention, the first side of a plurality of the metal plates having the curved portion is fixed to a flexible synthetic resin sheet.

[0017] Furthermore, a switch device according to the invention includes: a substrate having a plurality of fixed contacts on a surface, the contact member of which the second side is installed so as to face the surface of the substrate, wherein a peripheral part of the curved portion of the metal plate comes in contact with any of the fixed contacts, and the protrusions oppose the other fixed contacts.

ADVANTAGEOUS EFFECTS OF INVENTION

[0018] In the contact member and the switch device according to the invention, since the plurality of protrusions are provided in the curved portion, contact reliability between the contact member and the fixed contact may be enhanced when the curved portion is inverted. In particular, contact reliability when an insulating material such as dust is present on the surface of the fixed contact may be enhanced.

[0019] In addition, by appropriately setting the positions where the protrusions are disposed according to the relationship with the rolling direction of the metal plate, an area where appropriate elastic reaction is exhibited may be enlarged when the pressing position is deviated from the center of the curved portion, so that extreme degradation of the operating sensation may be suppressed even though the pressing position is deviated. Therefore, the contact member and the switch device with good operating sensation and high contact reliability may be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a cross-sectional view illustrating a contact member and a switch device according to an embodiment of the invention, in which Fig. 1A illustrates a non-contact state, and Fig. 1B illustrates a contact state.

Fig. 2 is a plan view of the contact member according to the embodiment of the invention.

Fig. 3 is a plan view illustrating a hoop material for forming the contact member.

Figs. 4A and 4B are explanatory views of an operating sensation when the center of a curved portion of the contact member is pressed by a stem.

Figs. 5A and 5B are explanatory views of an operating sensation when a position deviated from the center of the curved portion of the contact member is pressed by the stem.

Fig. 6 is a plan view illustrating a contact member according to a comparative example.

Fig. 7A is an explanatory view illustrating a distribution of elastic reaction when the contact member according to the embodiment is used, and Fig. 7B is an explanatory view illustrating a distribution of elastic reaction when the contact member according to the comparative example is used.

Figs. 8A and 8B are explanatory views for explaining characteristics of the elastic reaction of the contact member according to the embodiment.

Figs. 9A and 9B are explanatory views for explaining characteristics of the elastic reaction of the contact member according to the comparative example.

Fig. 10 is a plan view illustrating a contact member according to another embodiment of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0021] A plurality of switch devices 1 are arranged to be lined up on a substrate 2, and only the single switch device 1 is illustrated in Fig. 1.

[0022] On a surface 2a of the substrate 2, an outside fixed contact 3 and a center fixed contact 4 are formed of a low-resistance conductive material such as gold or silver. A contact member 10 has a first side 10a and a second side 10b, and the first side 10a is fixed to a flexible sheet 5. The flexible sheet 5 is a synthetic resin sheet with insulating properties, and on a rear surface 5a thereof, an adhesive layer is formed, such that the contact member 10 is fixed to the rear surface 5a of the flexible sheet 5 by the adhesive layer. In a part where the contact member 10 is not provided, the rear surface 5a of the flexible sheet 5 is fixed to the surface2a of the substrate 2 via the adhesive layer.

[0023] As illustrated in Fig. 2, the outer peripheral edge 11 of the contact member 10 is circular, and in the switch device 1 illustrated in Fig. 1, the outer peripheral edge 11 comes in contact with the outside fixed contact 3. In the contact member 10, substantially the entire region of the inside of the outer peripheral edge 11 is a curved portion 12, and the curved portion 12 is formed in a dome shape so that the convex side thereof faces the first side

10a. When the curved portion 12 is pressed against the substrate 2, as illustrated in Fig. 1B, the contact member 10 is inverted and is elastically deformed.

[0024] The contact member 10 is formed of a leaf spring material made of a rolled stainless steel. The rolling direction of the leaf spring material is the X direction illustrated in Fig. 2. In Fig. 2, the vertical center line extending in the X direction parallel to the rolling direction through the center (center of gravity: centroid) O1 of the curved portion 12 is represented by Ox. In addition, the horizontal center line extending in the Y direction orthogonal to the rolling direction through the center O1 is represented by Oy.

[0025] The contact member 10 illustrated in Figs. 1 and 2 is cut from a hoop material 20 illustrated in Fig. 3. In general, regarding the hoop material 20, the rolling direction of the stainless steel is directed to the longitudinal direction (the X direction). The hoop material 20 has feeding holes 23 provided at a predetermined pitch and is intermittently sent in the X direction while the feeding holes 23 are held by a traverse apparatus. Semicircular arc holes 21 are opened by a press apparatus, and inside the semicircular arc holes 21 and 21 which oppose each other, the contact member 10 is connected by connection pieces 22 and 22 so as to be formed. Moreover, after the curved portion 12 and the like are press-formed, the connection pieces 22 and 22 are cut, such that the individual contact members 10 are separated from the hoop material 20. The rolling direction of the contact members 10 cut from the hoop material 20 is the X direction.

[0026] On the curved portion 12 of the contact member 10, three protrusions 13a, 13b, and 13c are formed which protrude from a rear surface 12a thereof toward the second side 10b (a direction to the substrate 2). The protrusions 13a, 13b, and 13c are processed by the press apparatus in the state of the hoop material 20 illustrated in Fig. 3.

[0027] In Fig. 2, although the protrusions 13a, 13b, and 13c are illustrated as circles with the same diameters, the contours of the circles when the protrusions 13a, 13b, and 13c are seen from the second side 10b (the substrate 2 side) are illustrated by being seen through the first side 10a. That is, the contours of the circles illustrated in Fig. 2 are boundary lines between the protrusions 13a, 13b, and 13c and the rear surface 12a of the curved portion 12.

[0028] As illustrated in Fig. 2, when a virtual circle C with a predetermined radius r from the center O1 of the curved portion 12 of the contact member 10 is drawn, the center point Oa of the protrusion 13a, the center point Ob of the protrusion 13b, and the center point Oc of the protrusion 13c are positioned on the virtual circle C. That is, the center points Oa, Ob, and Oc thereof are positioned at positions of equal distances r from the center O1 of the curved portion 12. The radius r is equal to or smaller than 0.5 mm and is, for example, 0.3 mm. The center points Oa, Ob, and Oc of the protrusions 13a, 13b, and 13c are disposed at equal angles with respect to the center O1 of the curved portion 12, and the disposition angle intervals of the center points Oa, Ob, and OC are 120 degrees.

[0029] Regarding all the protrusions 13a, 13b, and 13c, the contours (the contours when viewed from the second side 10b) thereof are distant from the vertical center line Ox extending in the rolling direction of the metal plate. In the embodiment illustrated in Fig. 2, the protrusions 13a, 13b, and 13c are arranged so that the contours of both the two protrusions 13b and 13c are most distant from the vertical center line Ox. That is, the center point Oa of the protrusion 13a is positioned on the horizontal center line Oy, an angle θ between a virtual line Lb connecting the center point Ob of the protrusion 13b and the center O1 and the vertical center line Ox is 30 degrees, and an angle θ between a virtual line Lc connecting the center point Oc of the protrusion 13c and the center O1 and the vertical center line Ox is 30 degrees.

[0030] In the curved portion 12 of the contact member 10, a raised portion 15 raised from a surface 12b toward the first side 10a is formed. The raised portion 15 is processed by the press apparatus in the state of the hoop material 20 illustrated in Fig. 3. The raised portion 15 is formed so as to be raised from the surface 12b between an inner peripheral contour 15a and an outer peripheral contour 15b. The inside contour 15a is positioned outside the protrusions 13a, 13b, and 13c and is formed along a circle with a constant radius from the center 01. In the example illustrated in Fig. 2, the raised portion 15 is formed in a 360-degree continuous ring shape. However, the raised portion 15 may be formed in an intermittent ring shape which is separated at each of the predetermined angles.

[0031] The radius of the outer peripheral contour 15b of the raised portion 15 from the center O1 is in a range of 0.5 to 1.0 mm, and is, for example, 0.75 mm.

[0032] As illustrated in Fig. 1, in the switch device 1, an operating body 8 is provided. The operation body 8 is provided so as to be elevated in the case of an electronic device and is pressed and operated as an operating portion 8a is pressed by a finger. A stem 8b is provided at the lower portion of the operating body 8, and the stem 8b opposes the raised portion 15 of the contact member 10 via the flexible sheet 5. The lower surface of the stem 8b is circular, and the diameter thereof is slightly greater than the diameter of the outer peripheral contour 15b of the raised portion 15.

[0033] In the switch device 1, as illustrated in Fig. 1B, when the operating body 8 is pressed, the raised portion 15 of the contact member 10 is pressed down by the stem 8b via the flexible sheet 5. When the raised portion 15 is pressed, the curved portion 12 is elastically deformed toward the substrate 2. When the curved portion 12 is deformed halfway, the curved portion 12 is inverted toward the substrate 2, and the protrusions 13a, 13b, and 13c come in contact with the center fixed contact 4, so that the outside fixed contact 3 and the center fixed contact 4 are electrically connected to each other with the contact member 10. As illustrated in Fig. 1B, at a time

point when the protrusions 13a, 13b, and 13c come in contact with the center fixed contact 4, the curved portion 12 has an elastic restoring force in a direction away from the substrate 2. Therefore, when the pressing force against the operating body 8 is released, the contact member 10 is returned to a non-contact state illustrated in Fig. 1A.

[0034] Since the ring-shaped raised portion 15 is formed in the contact member 10 and the raised portion 15 is pressed by the stem 8b, unnecessary deformation is less likely to occur at the center portion of the contact member 10, and thus the center portion thereof having the raised portion 15 and the protrusions 13a, 13b, and 13c is more likely to be elastically deformed toward the substrate 2 in a stable posture. Since the protrusions 13a, 13b, and 13c come in contact with the center fixed contact 4 in small areas, reliability of contact is enhanced. In addition, even though an insulating material such as dust is present on the surface of the center fixed contact 4, when the protrusions 13a, 13b, and 13c come in contact with the center fixed contact 4, the insulating material is removed, so that reliability of electrical connection between the contact member 10 and the center fixed contact 4 is enhanced.

[0035] Fig. 4A illustrates an operation when the curved portion 12 is pressed while the center of the stem 8b is aligned with the center O1 of the curved portion 12, and Fig. 4B illustrates a change in elastic reaction imparted to the operating body 8 from the contact member 10 at this time.

[0036] The horizontal axis of Fig. 4B represents a pressing stroke (a displacement of the curved portion 12) of the operating body 8, and the vertical axis thereof represents a load needed to deform the curved portion 12, that is, a reaction exerted on the operating body 8. When the curved portion 12 is pressed by the operating body 8, the reaction is gradually increased and reaches the maximum value W1, the curved portion 12 is thereafter inverted toward the substrate 2, and the reaction becomes the minimum value W2. Thereafter, when the pressing force against the operating body 8 is released, the curved portion 12 is returned to its base curved state.

[0037] Fig. 5A illustrates an operation when the curved portion 12 is pressed while the center of the stem 8b is deviated from the center O1 of the curved portion 12, and Fig. 5B illustrates a change in elastic reaction exerted on the operating body 8 at this time. W3 denotes the maximum value of the load, and W4 denotes the minimum value.

[0038] In Fig. 4B, a difference $\Delta W1$ between the maximum value W1 and the minimum value W2 of the reaction is high, and the value of $\Delta W1/W1$ is increased. This means that the operating sensation (a so-called clicking sensation) in the finger pressing the operating body 8 is good. Conversely, in Fig. 5B, a difference $\Delta W2$ between the maximum value W3 and the minimum value W4 of the reaction is relatively small, and the value of $\Delta W2/W3$ is smaller than that of Fig. 4. This means that the operating sensation (the so-called clicking sensation) in the finger pressing the operating body 8 is slightly deteriorated compared to that of Fig. 4.

[0039] As illustrated in Figs. 1 and 2, the ring-shaped raised portion 15 is formed in the curved portion 12, and the raised portion 15 is pressed by the stem 8b. When the raised portion 15 is pressed by the stem 8b, the entirety of the ring-shaped raised portion 15 of which the rigidity is increased is more likely to move toward the substrate 2. Therefore, even though the center of the stem 8b is deviated from the center O1 of the curved portion 12, a structure in which extreme deterioration of the operating sensation is less likely to occur. However, the part thereof where the protrusions 13a, 13b, and 13c are formed is a substantially rigid body and may not have a sufficient elastic function. Therefore, when the vicinity of the protrusion is pressed, it becomes difficult for the curved portion 12 to be inverted. Therefore, as illustrated in Figs. 5A and 5B, it is difficult to avoid degradation of a contact sensation.

[0040] Here, in the contact member 10 of this embodiment, the three protrusions 13a, 13b, and 13c are disposed in different directions from those according to the related art. Therefore, even though a force pressing the curved portion 12 is exerted while being deviated from the center O1 in any direction, excessive degradation of the operating sensation is less likely to occur.

[0041] Fig. 7A shows simulation results of calculation of $\Delta W2/W3$ of Fig. 5B by moving the center of the stem 8b from the center 01 of the curved portion 12 by a distance of 0.1 mm so as to be distant in both the X and Y directions. During the simulation, the diameter of the virtual circle C on which the protrusions 13a, 13b, and 13c are arranged was set to 0.3 mm, the diameter of the outer peripheral contour 15b of the raised portion 15 was set to 1.5 mm, and the diameter of the stem 8b was set to 1.7 mm.

[0042] α shown in Fig. 7A represents an area where $\Delta W2/W3 \times 100$ is equal to or greater than 45% when the curved portion 12 is pressed while the center of the stem 8b is placed in the area, β represents an area where $\Delta W2/W3 \times 100$ is less than 45% when the curved portion 12 is pressed while the center of the stem 8b is placed in the area. γ represents an area where $\Delta W2/W3 \times 100$ is less than 35%.

[0043] Fig. 6 illustrates a contact member 110 of a comparative example. The shape and the diameter of an outer peripheral edge 11 of the contact member 110 and the curvature of a curved portion 12 are the same as those of the contact member 10 of the embodiment. The shape and the size of a raised portion 15 of the contact member 110 are also the same as those of the contact member 10.

[0044] Protrusions 13d, 13e, and 13f are formed in the contact member 110 toward a second side 10b. The shapes of the protrusions 13d, 13e, and 13f and the sizes of the contours thereof viewed from the substrate 2 side are the same as those of the protrusions 13a, 13b, and

13c of the contact member 10. The radius r of a virtual circle C where the center points Od, Oe, and Of the protrusions 13d, 13e, and 13f is also the same as that of the contact member 10.

[0045] In the contact member 110 of this example, the center point Od of the protrusion 13d is positioned on the vertical center line Ox extending in the rolling direction of a metal plate. A virtual line Le in which the center point Oe of the protrusion 13e is positioned has an angle of θ=30 degrees from the horizontal center line Oy, and a virtual line Lf in which the center point Of of the protrusion 13f is positioned has an angle of θ=30 degrees from the horizontal center line Oy.

[0046] In the comparative example illustrated in Fig. 6, a change in the operating sensation when the center of a stem 8b with a diameter of 1.7 mm is pressed against the curved portion 12 while being displaced from the center O1 of the curved portion 12 in the X and Y directions, is shown in Fig. 7B. α, β, and y of Fig. 7B represent areas where $\Delta W2/W3\times100$ determined when the center of a stem 8b is placed in the areas is equal to or greater than 45%, less than 45%, and less than 35%, respectively, as in Fig. 7A.

[0047] As illustrated in Fig. 7A, when the contact member 10 of this embodiment is used, even when the center of the stem 8b is pressed at a position displaced from the center 01 of the curved portion 12 in each of the X and Y directions, the ratio of $\Delta W2/W3$ is not significantly reduced, and a good operating sensation may be obtained. Particularly, even when the center of the stem 8b is displaced to the position of the virtual circle C or a position slightly on the outside, extreme deterioration of the operating sensation is less likely to occur.

[0048] As illustrated in Fig. 7B, in the case where the contact member 110 of the comparative example is used, when the center of the stem 8b is pressed against the curved portion 12 while being placed in the vicinity of the protrusion 13d, it can be seen that $\Delta W2/W3\times100$ becomes less than 45% and thus the operating sensation is extremely degraded.

[0049] In the contact member 10 of this embodiment illustrated in Fig. 2, since the contours (the contours viewed from the substrate 2 side) of all the protrusions 13a, 13b, and 13c are deviated from the vertical center line Ox, even though the center of the stem 8b is deviated to the vicinities of the protrusions 13a, 13b, and 13c, the ratio of $\Delta W2/W3$ is not significantly reduced. In addition, since the center point Oa of the protrusion 13a is positioned on the horizontal center line Oy, the contours of the other two protrusions 13b and 13c may be most distant from the vertical center line Ox. Accordingly, deterioration of the operating sensation when the curved portion 12 is pressed in the vicinities of the protrusions 13b and 13c is suppressed to a minimum.

[0050] Conversely, the contact member 110 of the comparative example illustrated in Fig. 6, the protrusion 13d is positioned immediately on the vertical center line Ox. Therefore, when the center of the stem 8b is positioned in the vicinity of the protrusion 13d and the curved portion 12 is pressed, the operating sensation in this part is locally deteriorated.

[0051] Figs. 8 and 9 are explanatory views for explaining the reason.

Fig. 8A is a diagram for explaining the operating sensation of the curved portion 12 where the protrusions 13a, 13b, and 13c are not present and only the raised portion 15 is provided.

[0052] Since the rolling direction of the metal leaf spring material from which the contact member 10 is made is the X direction, bending rigidity and bending elastic modulus when the leaf spring material is bent in the X direction (bent around the axis extending in the Y direction) are low, and compared to this, bending rigidity and bending elastic modulus when the leaf spring material is bent in the Y direction (bent around the axis extending in the X direction) are increased.

[0053] The inversing operation of the curved portion 12 being pressed is influenced by the bending rigidity and the bending elastic modulus in a direction along the line connecting the pressing point and the center 01. As the bending rigidity and the bending elastic modulus in the direction along the line connecting the pressing point and the center O1 are increased, the center O1 of the curved portion 12 is more likely to be inversed toward the substrate 2, the difference between the maximum value W3 and the minimum value W4 of the reaction is increased, and thus the operating sensation (the so-called clicking sensation) is enhanced.

[0054] As illustrated in Fig. 8A, when the rolling direction of the leaf spring material is the X direction, an area A where the operating sensation is not significantly changed when the pressing point is displaced from the center O1 is short in the X direction and is lengthened in the Y direction. As shown by reference numeral A1, on the vertical center line Ox, an area where the operating sensation is deteriorated when the pressing point is displaced approaches the center O1.

[0055] In addition, anisotropy of the operating sensation caused by the rolling direction illustrated in Fig. 8A is also the same in a contact member where the raised portion 15 is not provided.

[0056] Fig. 8B is a diagram for explaining the relationship between the arrangement direction of the protrusions 13a, 13b, and 13c formed in the curved portion 12 and the operating sensation.

[0057] The parts where the protrusions 13a, 13b, and 13c are formed are in a state in which the rigidity of the metal plate is locally high and is close to a rigid body. Therefore, when the pressing point pressing the curved portion 12 is set to the vicinities of the protrusions 13a, 13b, and 13c, the curved portion 12 is less likely to be elastically deformed, and the ratio of $\Delta W2/W3$ when the curved portion 12 is inverted is reduced. Conversely, an area between the adjacent protrusions 13a and 13b is less likely to be influenced by the protrusions, and thus a good operating sensation may be maintained when the

area is pressed at a position distant from the center 01. This is similar to an area between the adjacent protrusions 13b and 13c and an area between the protrusions 13c and 13a.

[0058] As illustrated in Fig. 8B, focusing on the influence of the protrusions 13a, 13b, and 13c, when the curved portion 12 is pressed while the position thereof is displaced from the center O1, an area B where the operating sensation is high and is not deteriorated becomes a substantially triangular area.

[0059] In the contact member 10 of this embodiment, since the contours of the protrusions 13b and 13c are separated from the vertical center line Ox, as illustrated in Fig. 8B, a part B1 (the center portion of the side of the triangular area B) in the area B where the operating sensation is more likely to be degraded is distant from a part A1 where the operating sensation is more likely to be degraded due to the rolling direction illustrated in Fig. 8B. As a result, as illustrated in Fig. 7A, in a wide range from the center O1 in each of the X and Y directions, even though the center of the stem 8b is deviated, deterioration of the operating sensation is less likely to occur.

[0060] Conversely, as in the contact member 110 of the comparative example, when the protrusion 13d is disposed on the vertical center line Ox, as illustrated in Fig. 9B, the direction of a triangular area E where the operating sensation is high and is not deteriorated becomes different from that of Fig. 8B. As illustrated in Fig. 9B, the periphery of the protrusion 13d positioned on the vertical center line Ox is a part E1 where the operating sensation is degraded when the position of the periphery is pressed. As illustrated in Fig. 9A, since the part E1 overlaps with the part A1 where the operating sensation is degraded due to the extension direction of the metal plate, as illustrated in Fig. 7B, the operating sensation of the periphery of the protrusion 13d when the curved portion 12 is pressed at the position of the periphery is locally degraded.

[0061] Fig. 10 illustrates a contact member 30 of another embodiment of the invention.

In the contact member 30, the shape and the size of a raised portion 15 formed in a curved portion 12 are the same as those of the contact member 10 illustrated in Figs. 1 and 2. Protrusions 13g, 13h, and 13i are formed at equal distances from the center O1, and the radius r of a virtual circle C on which the center points thereof are positioned is the same as that of the contact member 10. Opening angles between virtual lines Lg, Lh, and Li passing through the center O1 and the center points of the respective protrusions are 120 degrees.

[0062] In Fig. 10, an angle $\theta 1$ between the virtual line Lg and the vertical center line Ox is less than 30 degrees, and an angle $\theta 2$ between the virtual line Lh and the vertical center line Ox exceeds 30 degrees. Therefore, the protrusion 13g approaches the vertical center line Ox. However, the circular contour of the protrusion 13g viewed from the substrate 2 side is distant from the vertical center line Ox. Therefore, the part E1 where the operating sensation is deteriorated due to the presence of the protrusion illustrated in Figs. 9A and 9B may be prevented from overlapping with or approaching the part A1 where the operating sensation is deteriorated due to the influence of the extension direction. Therefore, unlike the contact member 110 of the comparative example, an area where the operating contact is deteriorated may be prevented from being locally generated.

[0063] In addition, the invention is not limited to the embodiments. For example, the number of protrusions may be equal to or greater than 4, and the contours of the individual protrusions viewed from the substrate side may not be circular.

REFERENCE NUMERALS

[0064]

1	switch device
2	substrate
3	outside fixed contact
4	center fixed contact
5	flexible sheet
8	operating body
8b	stem
10	contact member
10a	first side
10b	second side
12	curved portion
13a, 13b, 13c	protrusion
15	raised portion
20	hoop material
O1	center of curved portion
Ox	vertical center line
Oy	horizontal center line

Claims

1. A contact member, comprising:

a curved portion which is formed of a rolled conductive metal plate and protrudes toward a first side, the curved portion being elastically deformable toward a second side; and
a plurality of protrusions formed to protrude toward the second side from the curved portion,
wherein all the protrusions are formed at positions that do not overlap with a vertical center line extending in parallel to a rolling direction through a center of the curved portion.

2. The contact member according to claim 1, wherein contours of all the protrusions when viewed from the second side are positioned to be distant from the center line.

3. The contact member according to claim 1, wherein

the protrusions are positioned at equal distances from the center of the curved portion.

4. The contact member according to claim 2, wherein the protrusions are positioned at equal distances from the center of the curved portion.

5. The contact member according to claim 3, wherein center points of the plurality of protrusions are disposed at equal angles with respect to the center of the curved portion.

6. The contact member according to claim 4, wherein center points of the plurality of protrusions are disposed at equal angles with respect to the center of the curved portion.

7. The contact member according to claim 5, wherein the number of the protrusions is 3, and a center point of one of the protrusions is positioned on a horizontal center line orthogonal to the vertical center line through the center of the curved portion.

8. The contact member according to claim 6, wherein the number of the protrusions is 3, and a center point of one of the protrusions is positioned on a horizontal center line orthogonal to the vertical center line through the center of the curved portion.

9. The contact member according to any one of claims 1 to 8, further comprising a raised portion formed to protrude toward the first side from the curved portion, wherein the raised portion is provided at a position farther from the center of the curved portion than the protrusions, and
the raised portion is formed continuously or intermittently along an arc with a predetermined radius from the center.

10. The contact member according to any one of claims 1 to 8, wherein the first side of a plurality of the metal plates having the curved portion is fixed to a flexible synthetic resin sheet.

11. The contact member according to claim 9, wherein the first side of a plurality of the metal plates having the curved portion is fixed to a flexible synthetic resin sheet.

12. A switch device comprising:

a substrate having a plurality of fixed contacts on a surface,
the contact member according to any one of claims 1 to 8 of which the second side is installed so as to face the surface of the substrate,
wherein a peripheral part of the curved portion of the metal plate comes in contact with any of the fixed contacts, and
the protrusions oppose the other fixed contacts.

13. A switch device comprising:

a substrate having a plurality of fixed contacts on a surface,
the contact member according to claim 9 of which the second side is installed so as to face the surface of the substrate,
wherein a peripheral part of the curved portion of the metal plate comes in contact with any of the fixed contacts, and
the protrusions oppose the other fixed contacts.

14. A switch device comprising:

a substrate having a plurality of fixed contacts on a surface,
the contact member according to claim 10 of which the second side is installed so as to face the surface of the substrate,
wherein a peripheral part of the curved portion of the metal plate comes in contact with any of the fixed contacts, and
the protrusions oppose the other fixed contacts.

15. A switch device comprising:

a substrate having a plurality of fixed contacts on a surface,
the contact member according to claim 11 of which the second side is installed so as to face the surface of the substrate,
wherein a peripheral part of the curved portion of the metal plate comes in contact with any of the fixed contacts, and
the protrusions oppose the other fixed contacts.

FIG. 1A

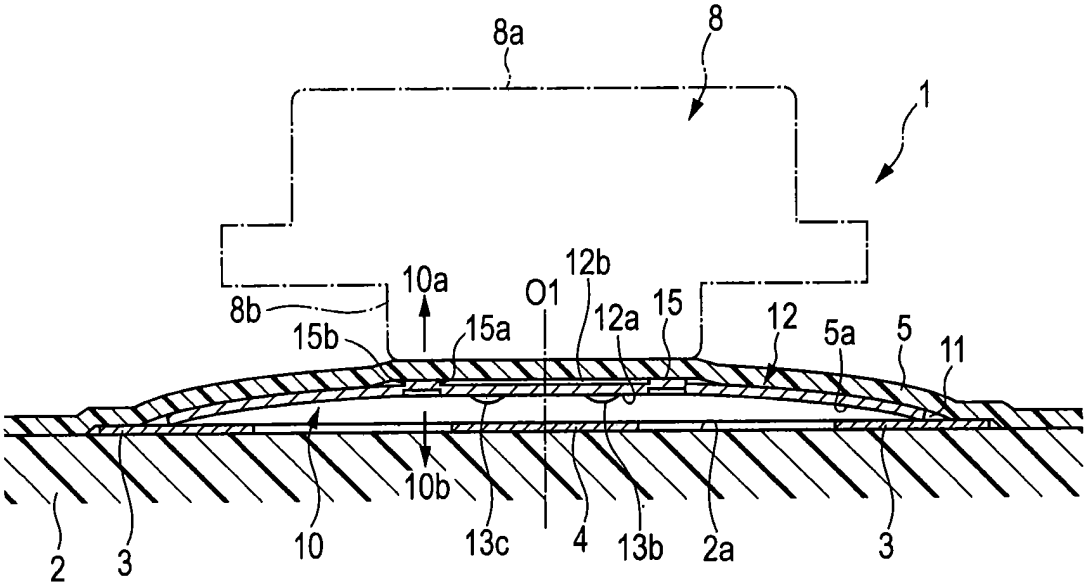

8a
8
1
10a
12b
8b
O1
12a
15
12
5a
5
11
15b
15a
10b
2
3
10
13c
4
13b
2a
3

FIG. 1B

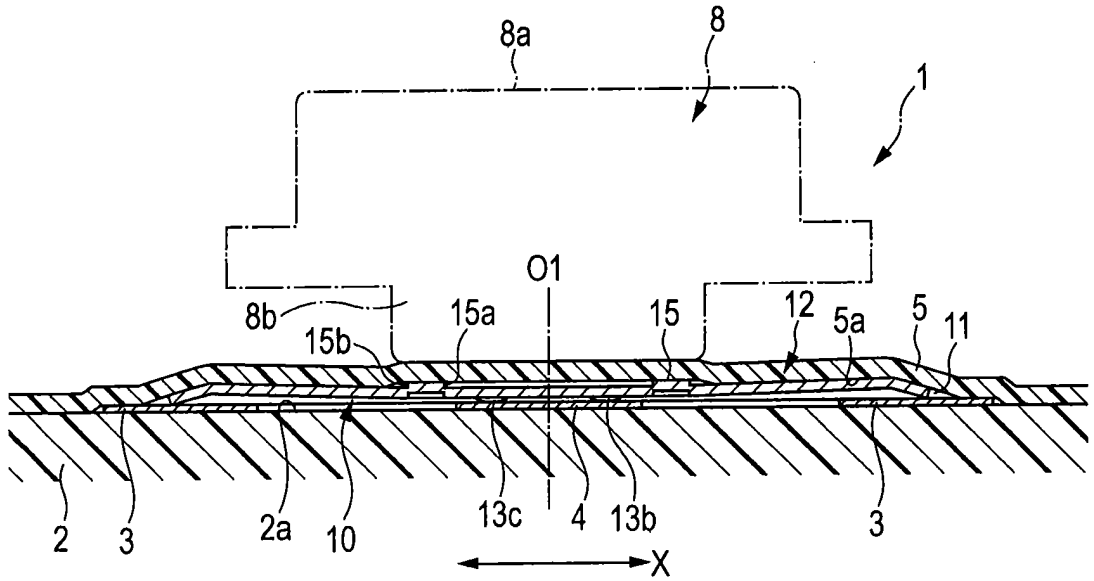

8a
8
1
O1
8b
15a
15
12
5a
5
11
15b
2
3
2a
10
13c
4
13b
3
X

FIG. 2

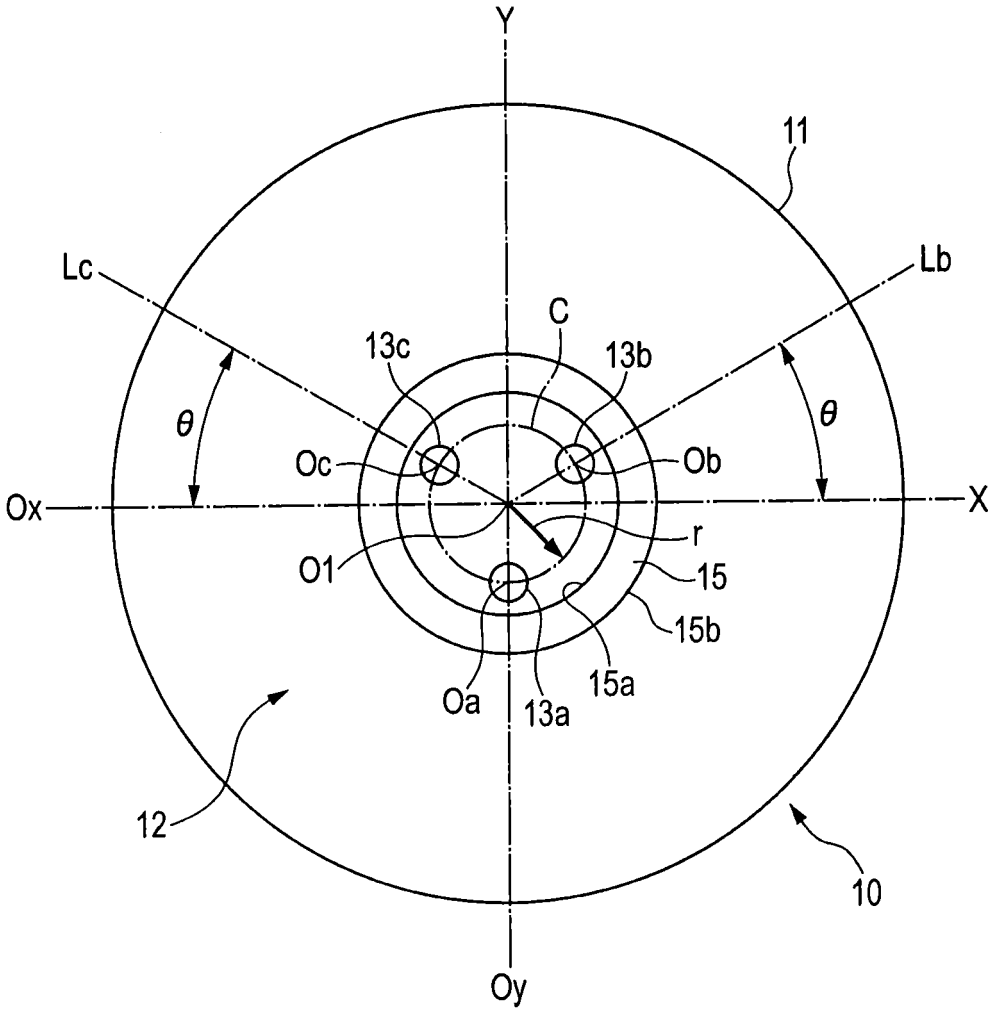


FIG. 3

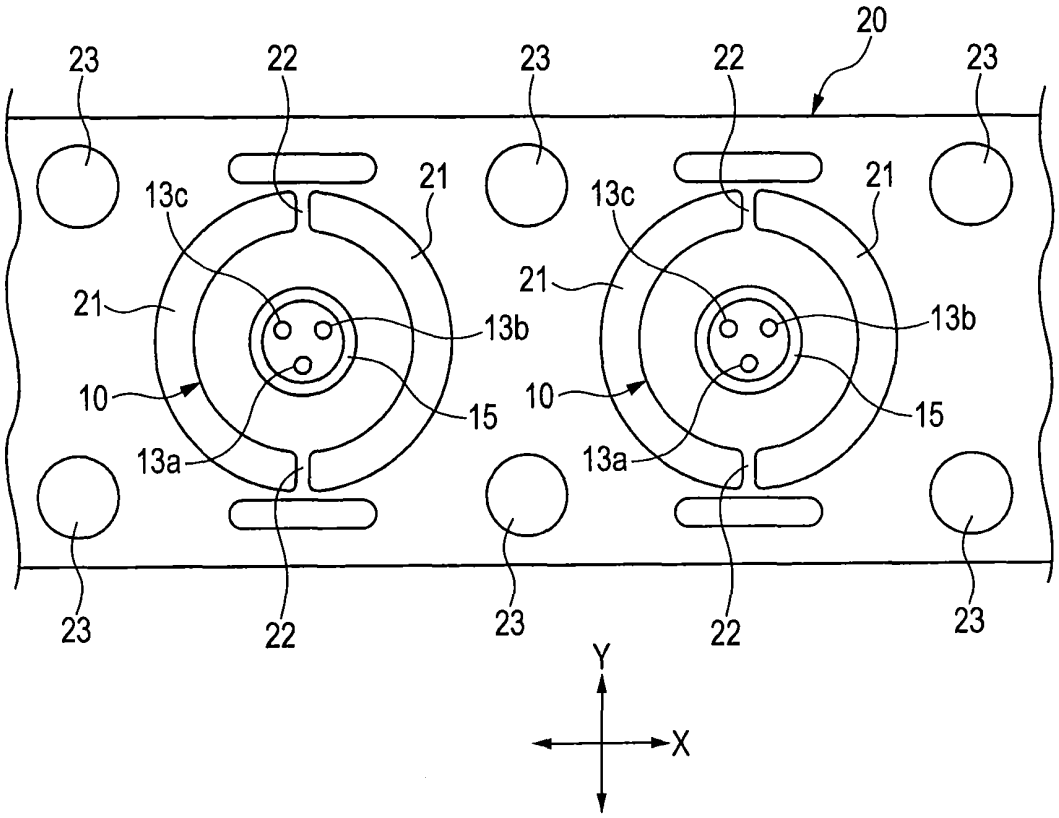

20
23
22
23
22
23
13c
21
13c
21
21
21
13b
13b
10
10
15
15
13a
13a
23
22
23
22
23
Y
X

FIG. 4A

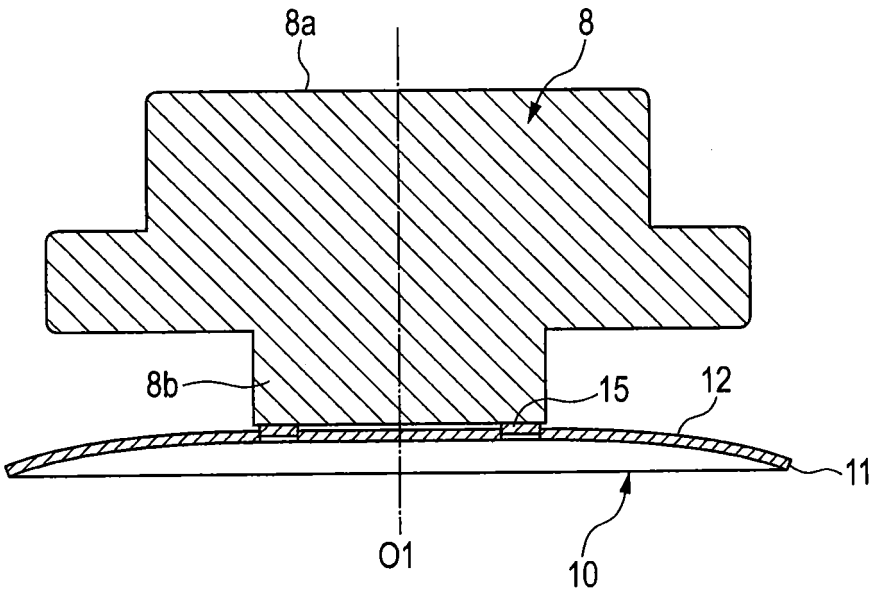


FIG. 4B

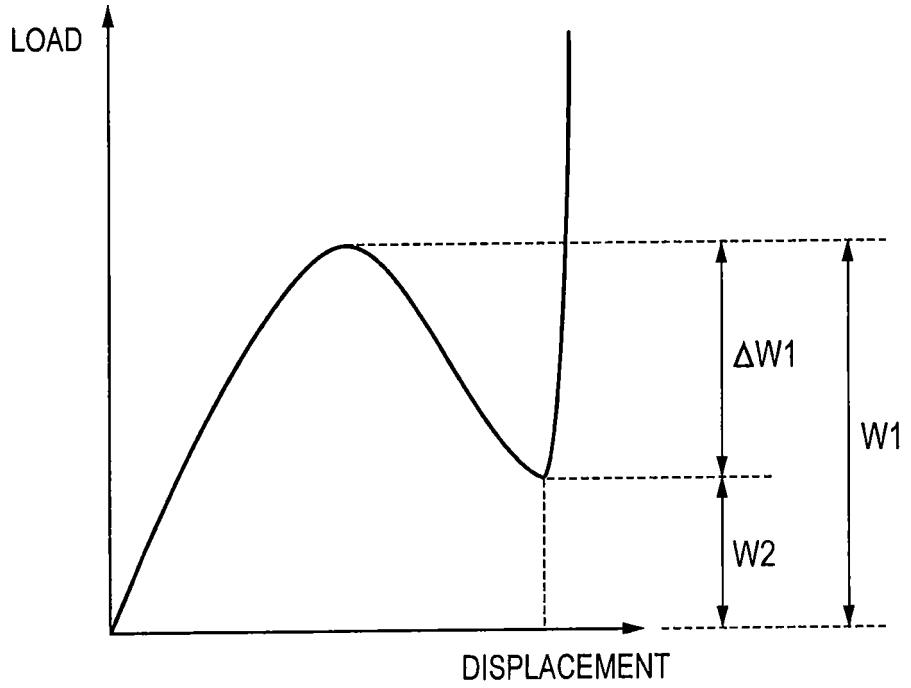


FIG. 5A

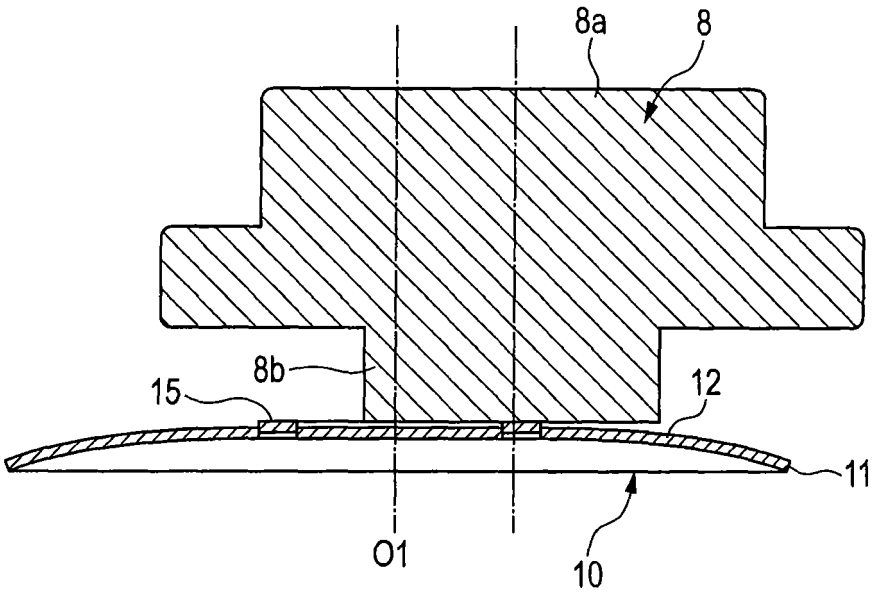


FIG. 5B

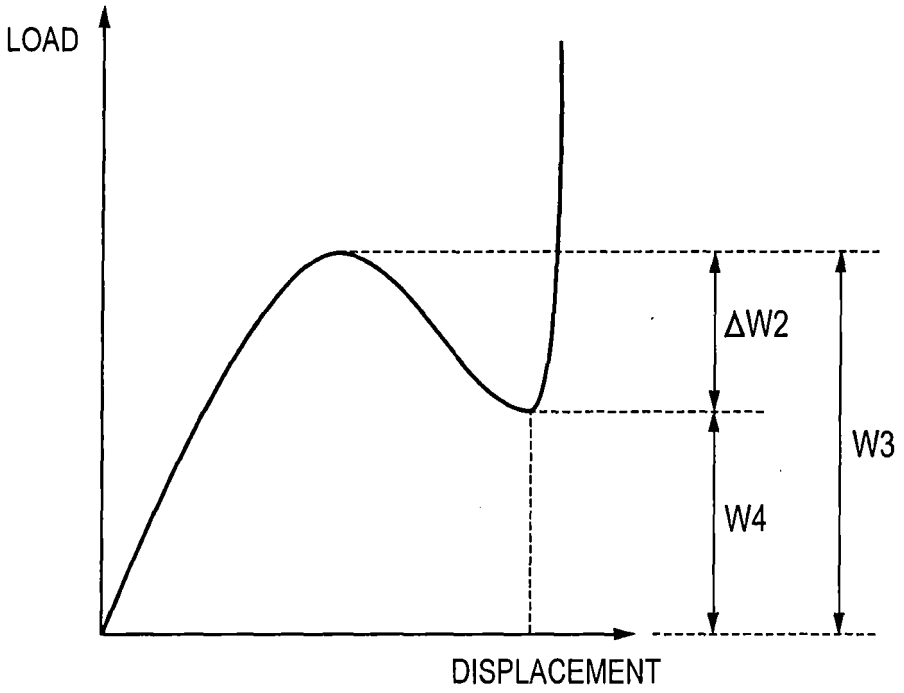


FIG. 6

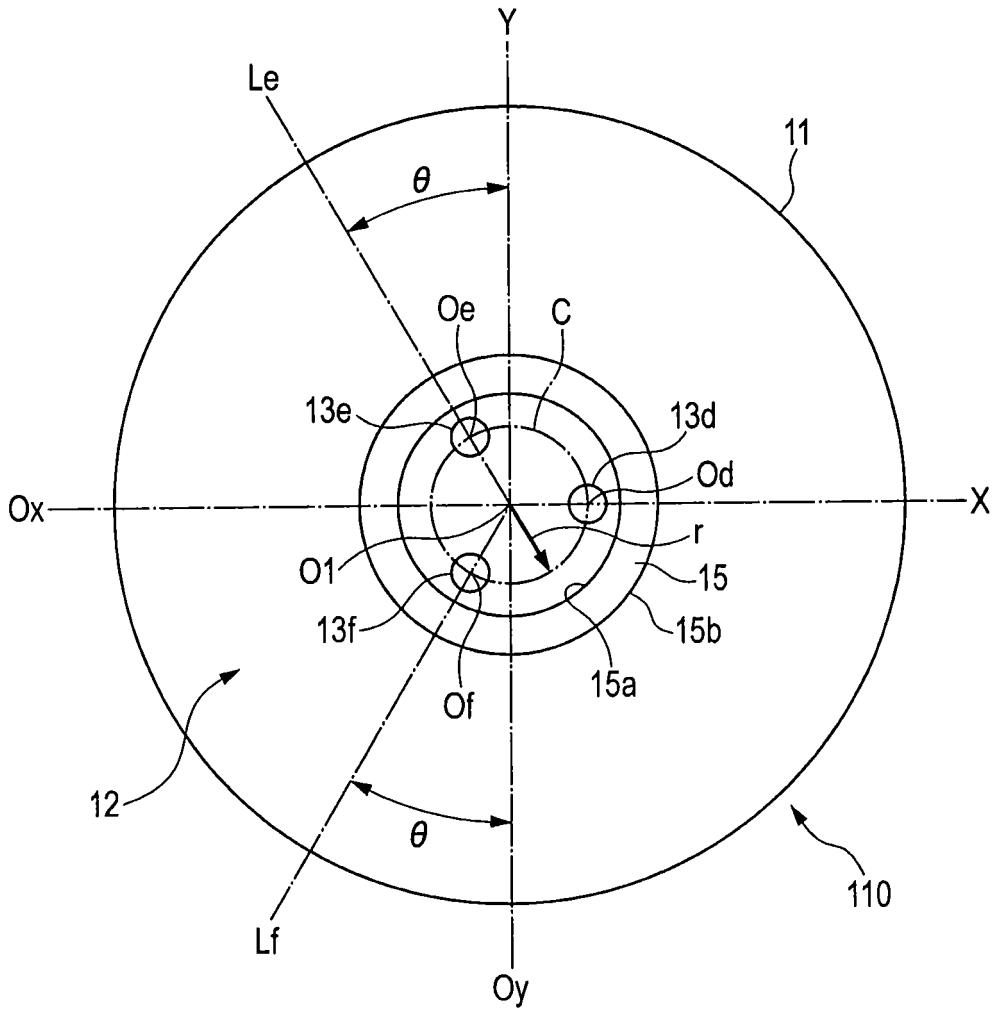


FIG. 7A

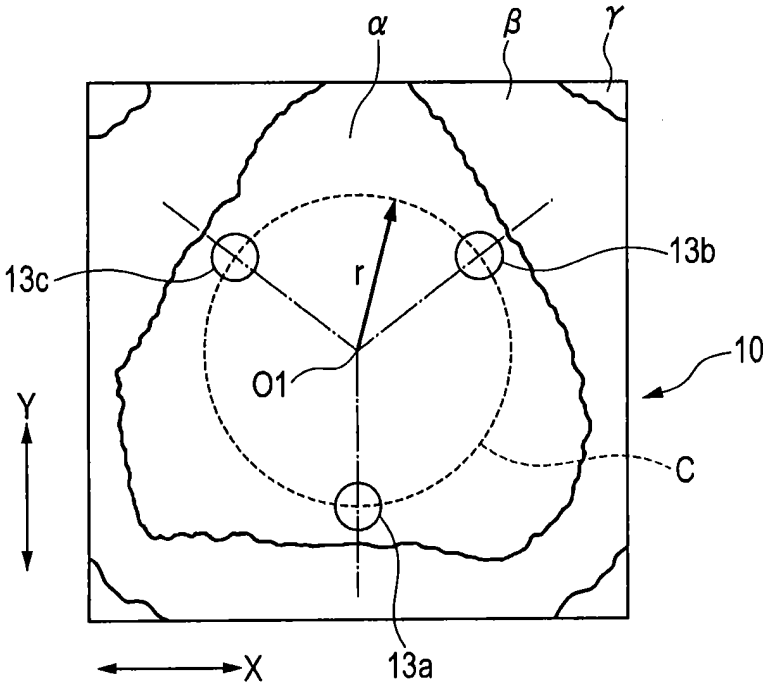


FIG. 7B

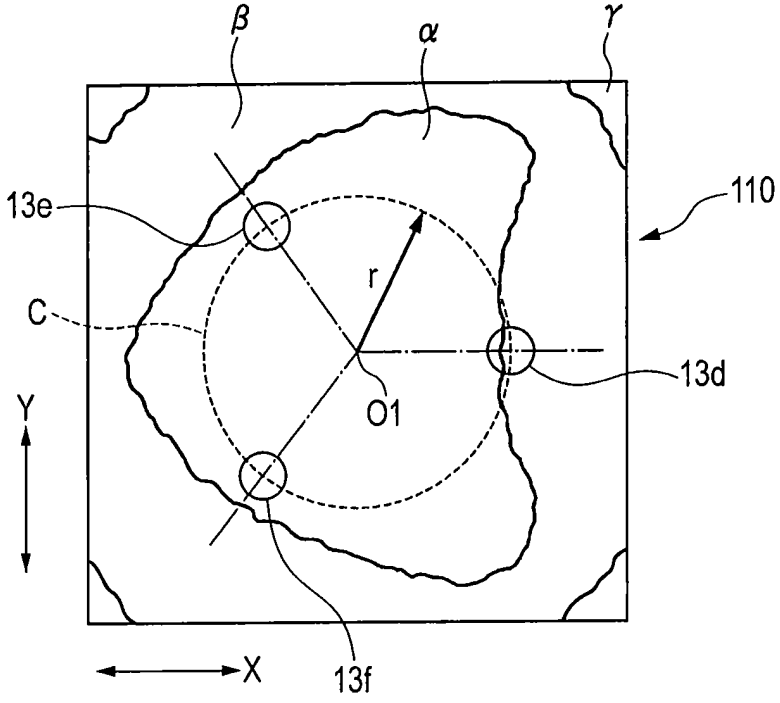


FIG. 8A

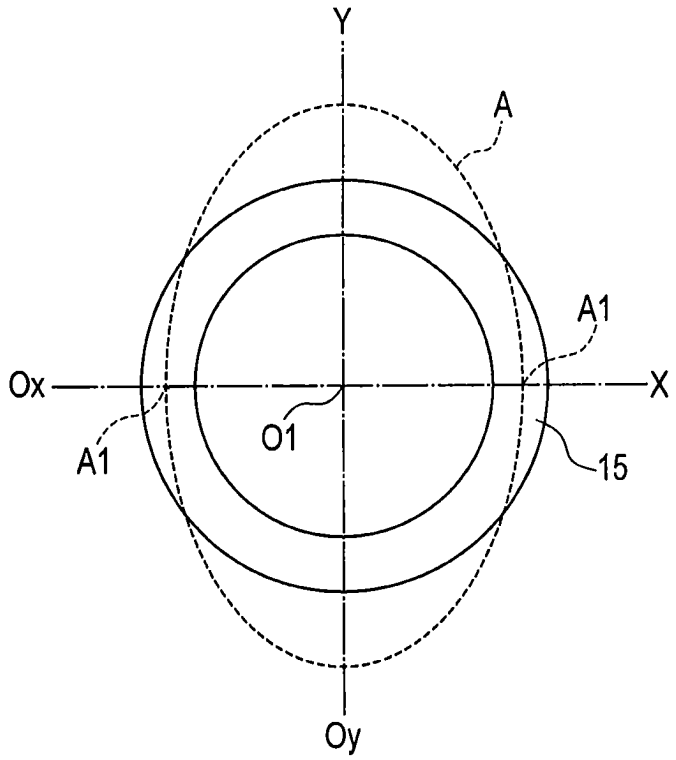


FIG. 8B

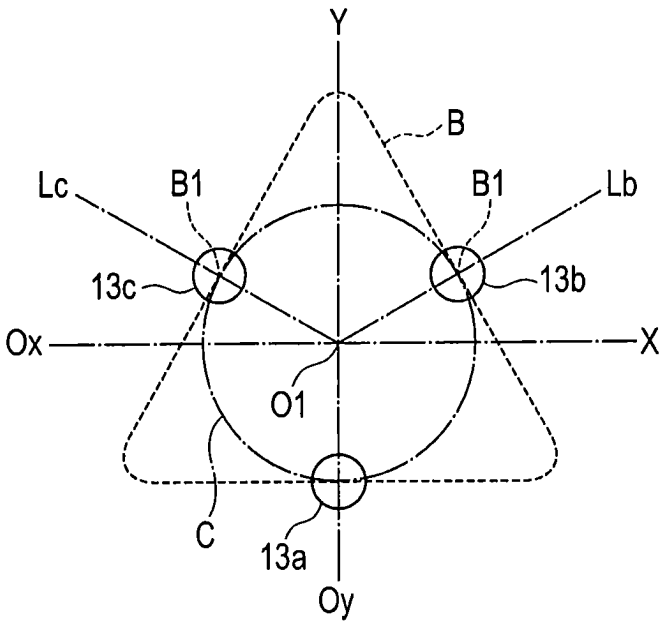


FIG. 9A

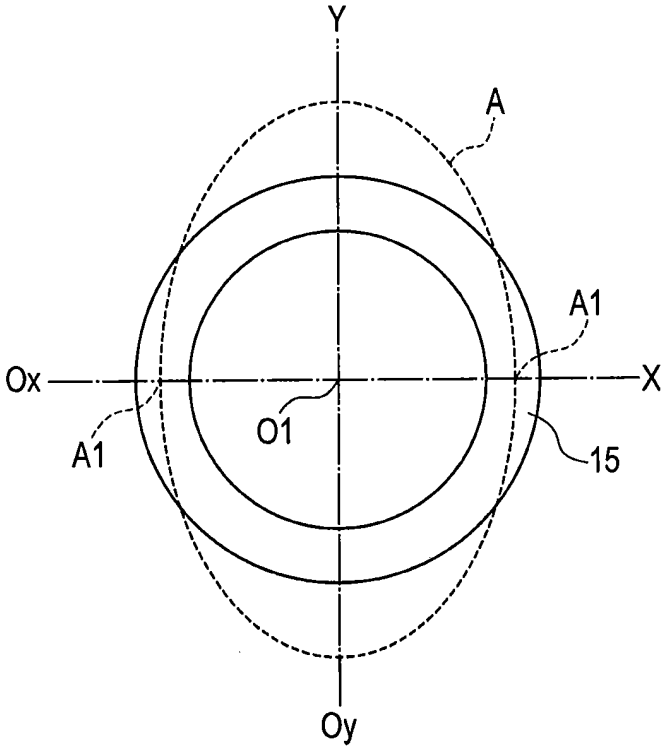


FIG. 9B

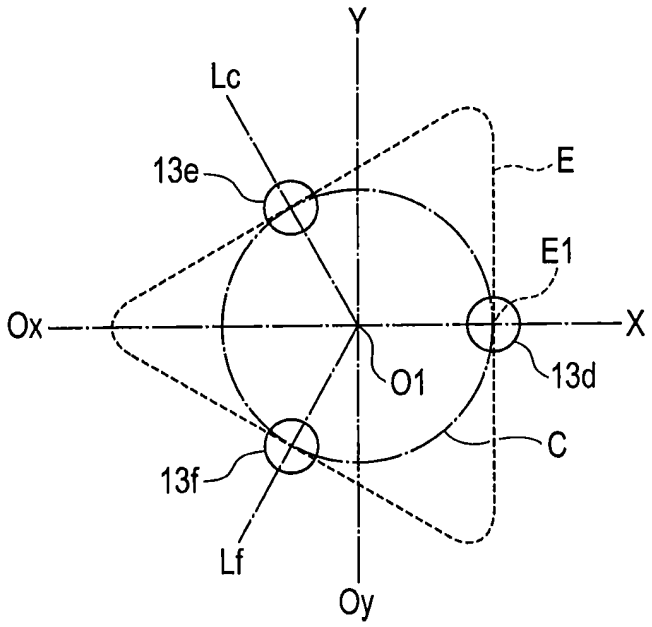
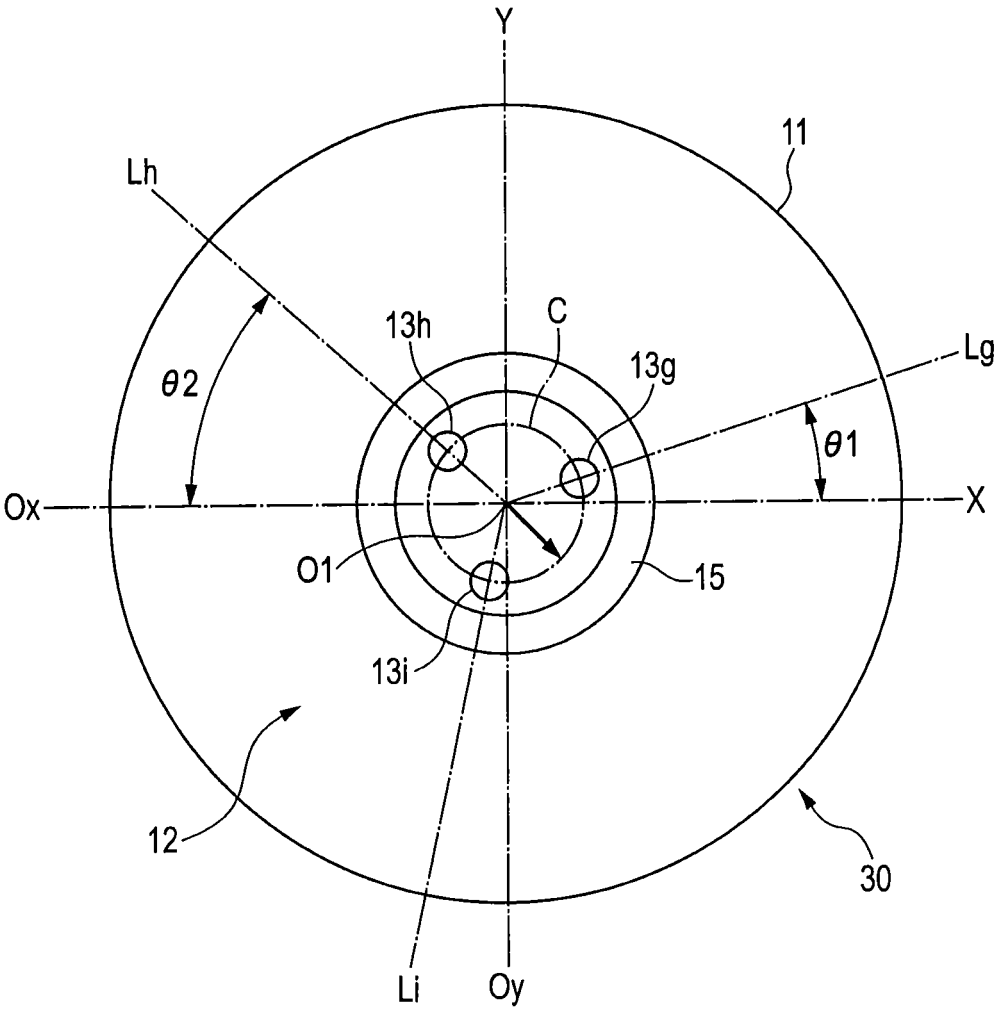


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058975

A. CLASSIFICATION OF SUBJECT MATTER
H01H1/06(2006.01)i, *H01H5/30*(2006.01)i, *H01H11/00*(2006.01)i, *H01H13/48*(2006.01)i, *H01H13/702*(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)
H01H1/06, H01H5/30, H01H11/00, H01H13/48, H01H13/702

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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.
X Y A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 036443/1992(Laid-open No. 094919/1993) (Mitsumi Electric Co., Ltd.), 24 December 1993 (24.12.1993), entire text; fig. 1, 6 (Family: none)	1-6 9-11 7,8,12-15
Y A	JP 2003-077366 A (Seiko Precision Inc.), 14 March 2003 (14.03.2003), paragraphs [0011] to [0015], [0023]; fig. 5, 6 (Family: none)	9-11 7,8,12-15

☒ 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
04 July, 2011 (04.07.11)	19 July, 2011 (19.07.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058975

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 2009-152119 A (Alps Electric Co., Ltd.), 09 July 2009 (09.07.2009), entire text; all drawings (Family: none)	1-15
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 061758/1993(Laid-open No. 027033/1995) (Teikoku Tsushin Kogyo Co., Ltd.), 19 May 1995 (19.05.1995), entire text; all drawings (Family: none)	9
A	JP 2004-139997 A (Alps Electric Co., Ltd.), 13 May 2004 (13.05.2004), fig. 3 (Family: none)	10,11
A	JP 2001-286905 A (Toyo Seihaku Kabushiki Kaisha), 16 October 2001 (16.10.2001), paragraphs [0001], [0015] (Family: none)	1
A	JP 2007-173099 A (Alps Electric Co., Ltd.), 05 July 2007 (05.07.2007), fig. 11 & CN 1988088 A & KR 10-2007-0066891 A	1
A	JP 2006-216329 A (Alps Electric Co., Ltd.), 17 August 2006 (17.08.2006), fig. 17 (Family: none)	1

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058975

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The invention in claim 1 is disclosed in the document 1, and therefore, the invention in claim 1 cannot be considered to be novel in the light of the invention described in the document 1 and does not have a special technical feature. Consequently, the invention in claim 1 and the inventions in claims 2 - 15 are not relevant to a group of inventions which comply with the requirement of unity of invention.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2007280848 A **[0005]**