US 20230317042A1

(19) **United States**

(12) **Patent Application Publication**

Khalid et al.

(10) **Pub. No.: US 2023/0317042 A1**

(43) **Pub. Date: Oct. 5, 2023**

(54) **ELECTRONIC CYMBAL AND STRIKING DETECTION METHOD**

(71) Applicant: **Roland Corporation**, Shizuoka (JP)

(72) Inventors: **Suhada Binti Khalid**, W.P. Kuala Lumpur (MY); **Nuradiza Binti Rani**, W.P. Kuala Lumpur (MY); **Syota Kobayashi**, Shizuoka (JP)

(73) Assignee: **Roland Corporation**, Shizuoka (JP)

(21) Appl. No.: **17/866,540**

(22) Filed: **Jul. 17, 2022**

(30) **Foreign Application Priority Data**

Mar. 29, 2022 (JP) 2022-054432

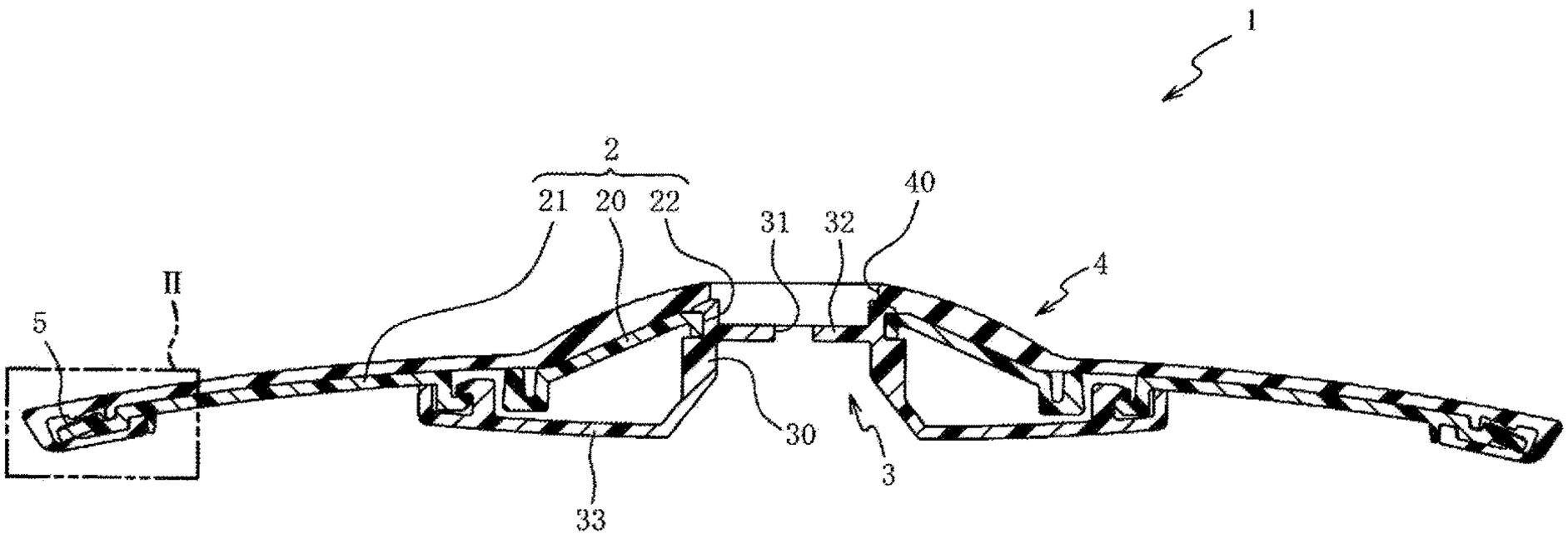
Publication Classification

(51) **Int. Cl.**
G10H 3/14 (2006.01)

(52) **U.S. Cl.**
CPC ***G10H 3/146*** (2013.01)

(57) **ABSTRACT**

By limiting deformation of an upper cover part **41** toward an inner peripheral side through catching between an outer peripheral surface of a bent part **21***b* and a stopper **46** or by forming an interval between a sensor installation part **21***d* and the upper cover part **41** to gradually increase from the inner peripheral side toward an outer peripheral side, at the time of being struck from a lateral direction, the upper cover part **41** and the lateral cover part **42** are suppressed from contacting an outer edge of the sensor installation part **21***d*. Thus, since the protrusion **45** is easily pressed to the edge sensor **5**, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.



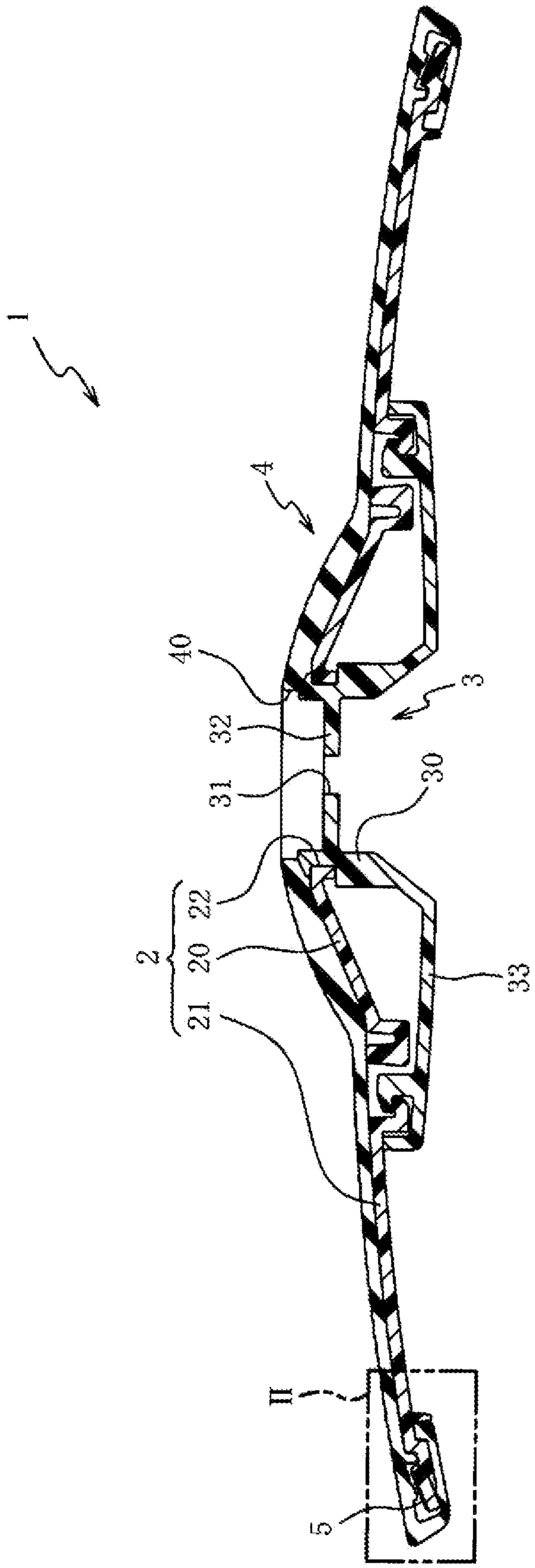


FIG. 1

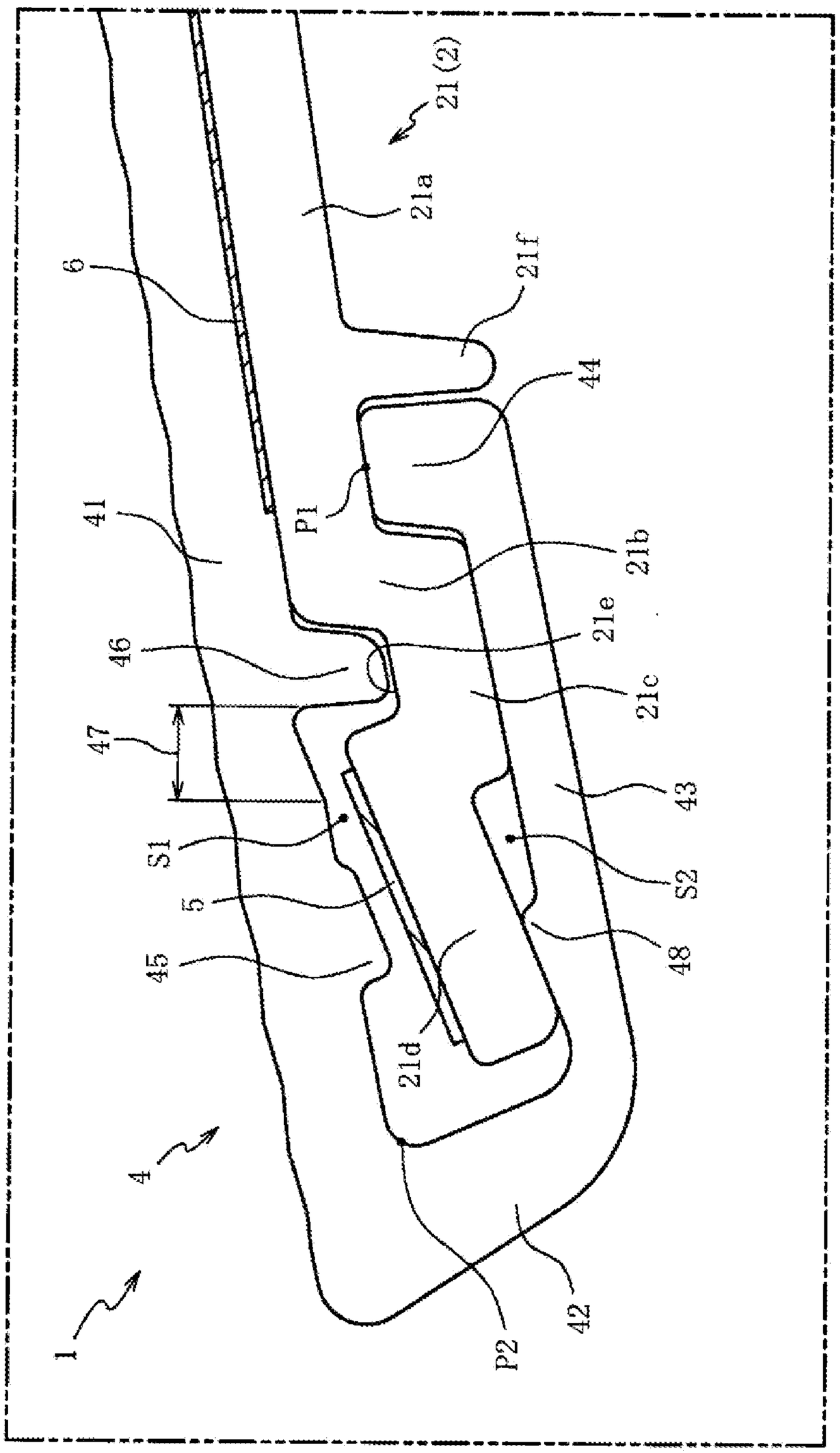
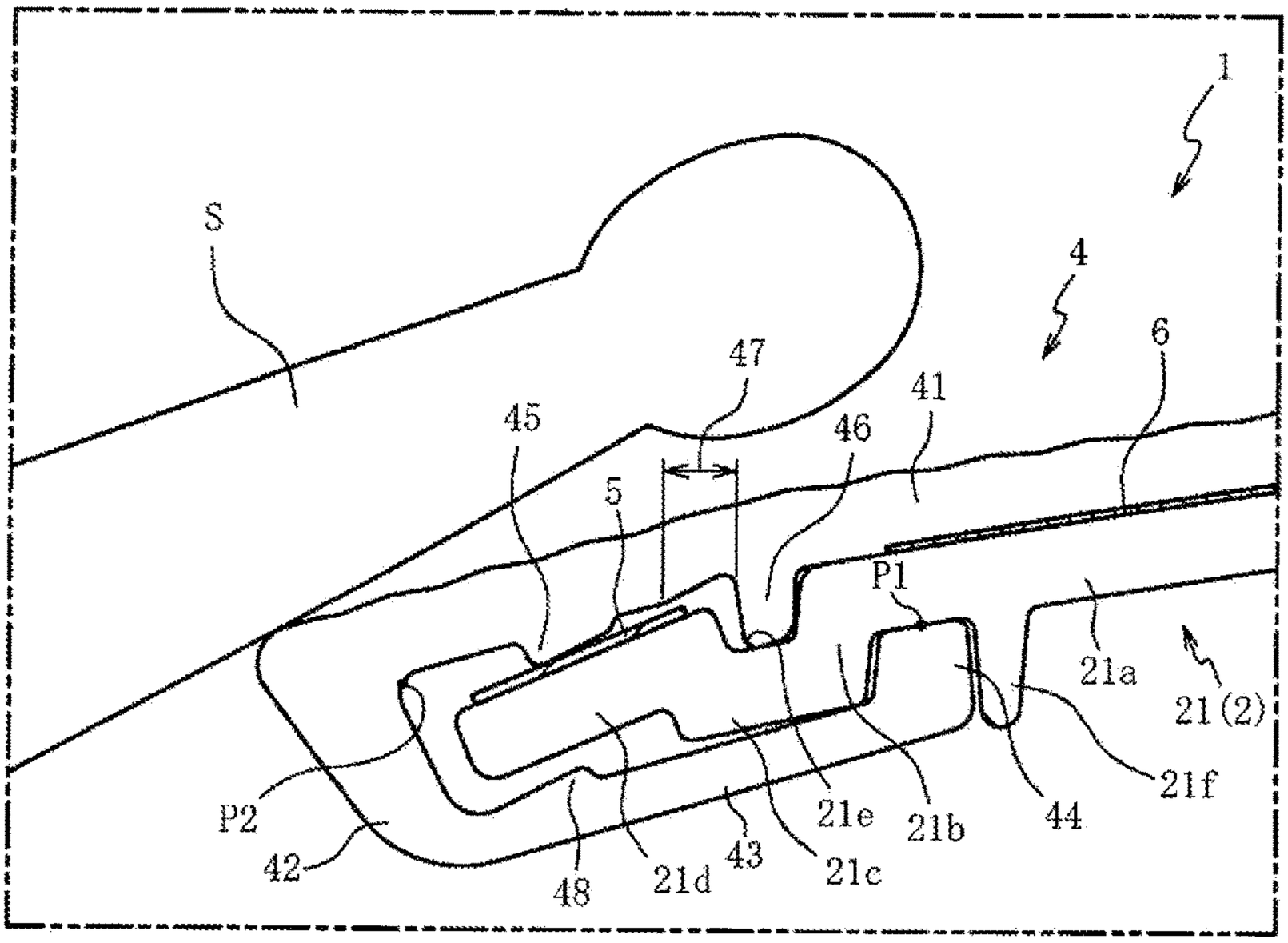
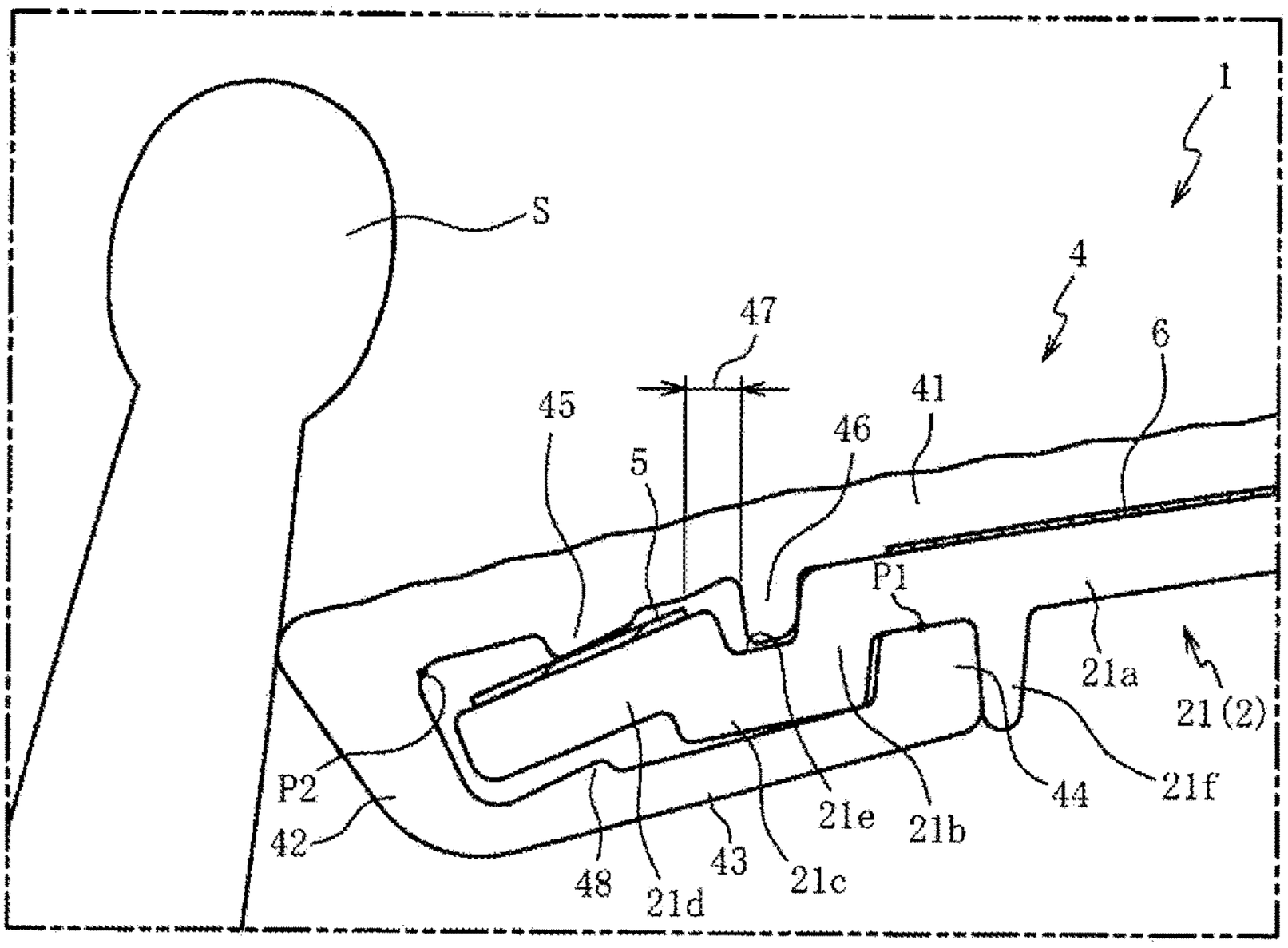


FIG. 2

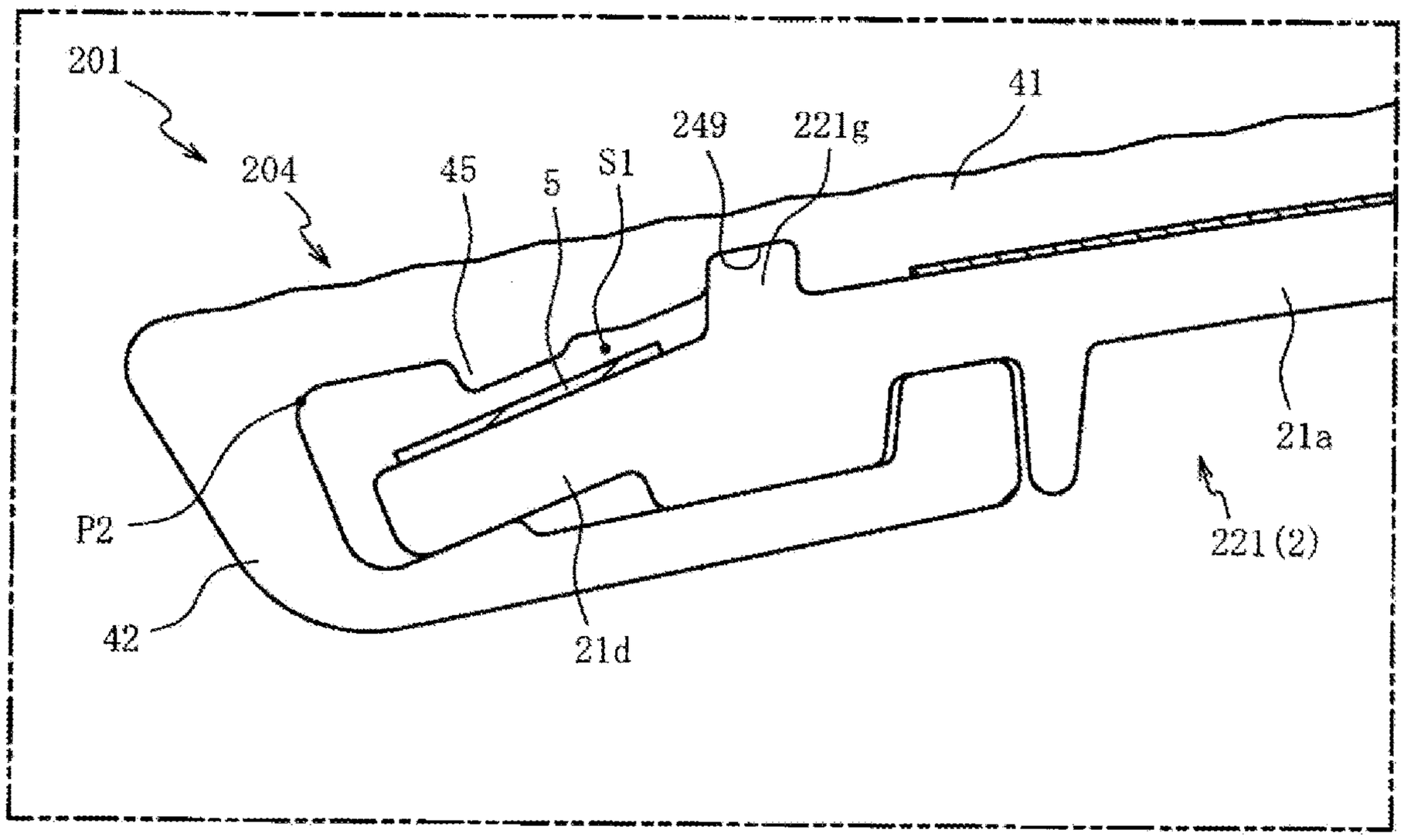

1
S
4
47
6
41
45
46
5
P1
21a
21(2)
21f
P2
42
48
21d
43
21e
21c
21b
44

(a)

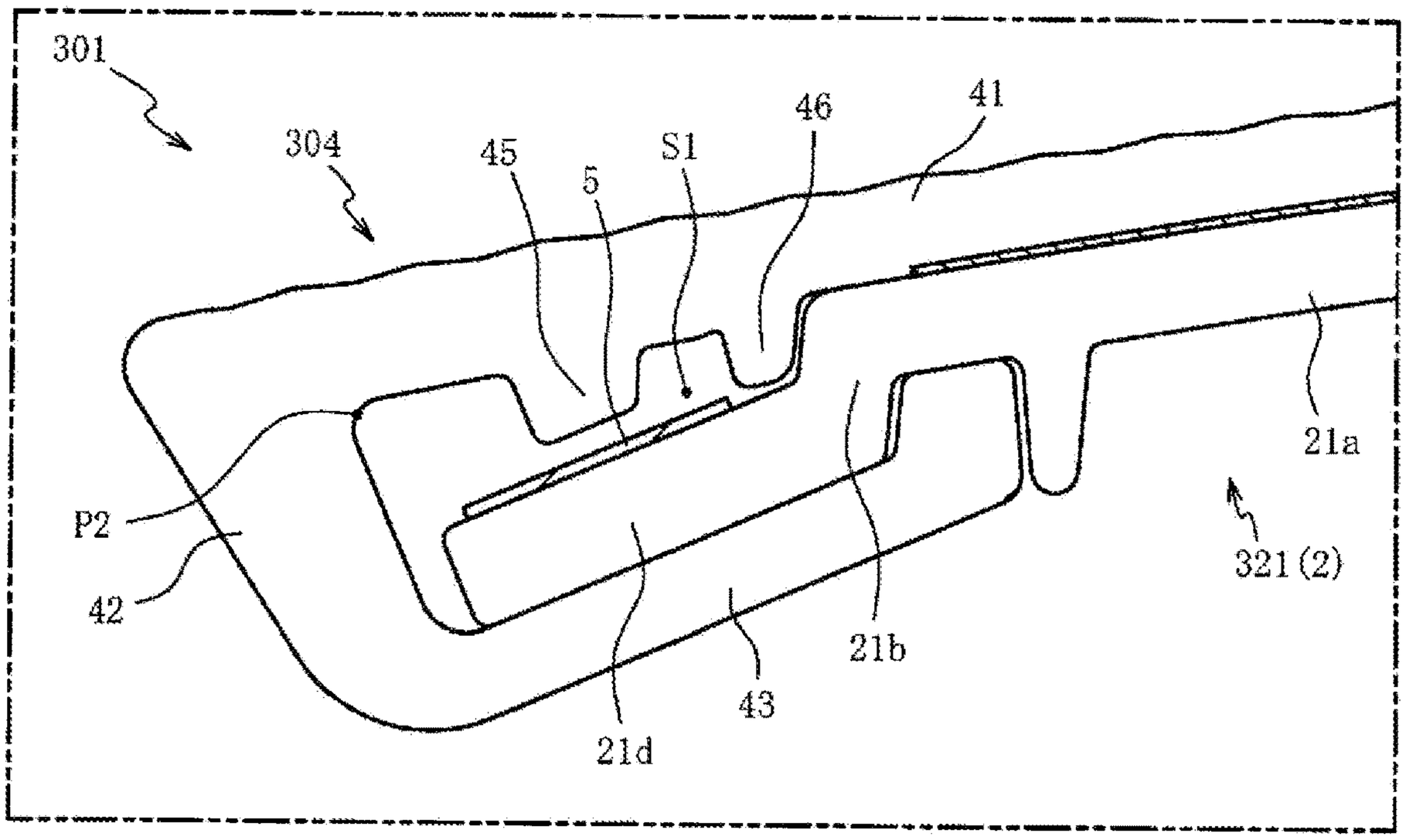

1
S
4
47
6
45
41
46
5
P1
21a
21(2)
21f
P2
42
48
21d
43
21e
21c
21b
44

(b)

FIG. 3


201
204
45
5
S1
249
221g
41
P2
42
21d
21a
221 (2)

(a)


301
304
45
5
S1
46
41
P2
42
21d
43
21b
21a
321 (2)

(b)

FIG. 4

ELECTRONIC CYMBAL AND STRIKING DETECTION METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of Japan application serial no. 2022-054432 filed on Mar. 29, 2022. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

[0002] The invention relates to an electronic cymbal and a striking detection method, and particularly relates to an electronic cymbal and a striking detection method capable of facilitating the sensor sensitivity with respect to striking from a lateral direction.

Description of Related Art

[0003] An electronic cymbal including a frame, an edge sensor installed to an upper surface on an outer edge side of the frame, and a cover covering an upper surface of the frame in a state in which a space is formed between the edge sensor and the cover and detecting striking to an outer edge portion of the cover (frame) by the edge sensor is known.

[0004] For example, Patent Document 1 recites an electronic cymbal including an upper cover part **5***b***1** covering an upper surface of a frame **4** and a lower cover part **5***b***2** with coverage from an outer edge (outer peripheral surface) of the frame **4** to an edge part of a lower surface. In such technique, a protrusion part **5***b***3** protruding toward an edge sensor **7***b* is formed in the upper cover part **5***b***1**, and when the performer strikes an outer edge portion of the upper cover part **5***b***1** from the top by a stick, etc., due to elastic deformation (bending) of the upper cover part **5***b***1**, the protrusion part **5***b***3** is pressed to the edge sensor **7***b*. Accordingly, the striking to the outer edge portion of the cover **5** (the frame **4**) is detected by the edge sensor **7***b*.

PRIOR ART DOCUMENT

Patent Document

[0005] [Patent Document 1] Japanese Laid-open No. 2021-026077 (e.g., para. 0040, 0041, FIG. 4)

[0006] However, in the conventional technology, when the outer edge portion of the cover **5** is struck in a state in which the stick is upright (referred to striking from the lateral direction), before the protrusion part **5***b***3** is pressed to the edge sensor **7***b*, the upper cover **5***b***1** or the lower cover part **5***b***2** may contact the outer edge of the frame **4**. When such contact occurs, since the pressing of the edge sensor **7***b* due to the protrusion part **5***b***3** is insufficient, an issue that the sensitivity of the edge sensor **7***b* with respect to the striking from the lateral direction may be low arises.

SUMMARY

[0007] An electronic cymbal according to an aspect of the invention includes: a plate-like frame; a sensor installed to an upper surface on an outer edge side of the frame; and a cover covering upper surfaces of the sensor and the frame. The cover includes an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor; a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame. The upper cover part or the frame comprises a stopper facing the space between the upper cover part and the sensor and limits deformation of the upper cover part toward an inner peripheral side.

[0008] An electronic cymbal according to another aspect of the invention includes: a plate-like frame; a sensor installed to an upper surface on an outer edge side of the frame; and a cover covering upper surfaces of the sensor and the frame. The cover includes an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor; a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame. The frame includes: a covered part covered in a state of being contacted by the upper cover part; and a sensor installation part which is located on an outer peripheral side with respect to the covered part and to which the sensor is installed. The upper cover part includes a protrusion which protrudes toward the sensor and in which a lower surface is parallel to an upper surface of the sensor installation part. The upper surface of the sensor installation part tilts downward toward an outer peripheral side at a slope greater than that of an upper surface of the covered part, and an interval between the upper surface of the sensor installation part and the lower surface of the upper cover part is formed to gradually increase from an inner peripheral side toward the outer peripheral side.

[0009] Another aspect of the invention provides a striking detection method for an electronic cymbal. The electronic cymbal includes: a plate-like frame; a sensor installed to an upper surface on an outer edge side of the frame; and a cover covering upper surfaces of the sensor and the frame. The cover includes: an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor; a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame. The upper cover part or the frame includes a stopper facing the space between the upper cover part and the sensor. The striking detection method includes: at the time of striking an outer edge of the cover, limiting deformation of the upper cover part toward an inner peripheral side by the stopper and detecting striking to the cover by pressing the sensor by the upper cover part deformed with the stopper as a fulcrum.

[0010] Another aspect of the invention provides a striking detection method for an electronic cymbal. The electronic

cymbal includes: a plate-like frame; a sensor installed to an upper surface on an outer edge side of the frame; and a cover covering upper surfaces of the sensor and the frame. The cover includes: an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor; a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame. The frame includes: a covered part covered in a state of being contacted by the upper cover part; and a sensor installation part which is located on an outer peripheral side with respect to the covered part and to which the sensor is installed. The upper cover part includes a protrusion which protrudes toward the sensor and in which a lower surface is parallel to an upper surface of the sensor installation part. The upper surface of the sensor installation part tilts downward toward an outer peripheral side at a slope greater than that of an upper surface of the covered part, and an interval between the upper surface of the sensor installation part and the lower surface of the upper cover part is formed to gradually increase toward the outer peripheral side. The striking detection method includes: at the time of striking the outside of the cover, suppressing the upper cover part and the lateral cover part from contacting an outer edge of the sensor installation part, and detecting striking to the cover by pressing the sensor by the protrusion displaced together with deformation of the upper cover part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a cross-sectional view illustrating an electronic cymbal according to a first embodiment.

[0012] FIG. **2** is a partially enlarged cross-sectional view of the electronic cymbal in which a portion II of FIG. **1** is enlarged.

[0013] In FIG. **3**, (a) is a partially enlarged cross-sectional view of the electronic cymbal illustrating a state in which an edge portion is struck by normal striking, and (b) is a partially enlarged cross-sectional view of the electronic cymbal illustrating a state in which the edge portion is struck by striking from a lateral direction.

[0014] In FIG. **4**, (a) is a cross-sectional view illustrating an electronic cymbal according to a second embodiment, and (b) is a cross-sectional view illustrating an electronic cymbal according to a third embodiment.

DESCRIPTION OF THE EMBODIMENTS

[0015] The invention provides an electronic cymbal and a striking detection method capable of facilitating the sensor sensitivity with respect to the striking from the lateral direction.

[0016] Hereinafter, several embodiments will be described with reference to the accompanying drawings. Firstly, the overall configuration of an electronic cymbal **1** is described with reference to FIG. **1**. FIG. **1** is a cross-sectional view illustrating an electronic cymbal **1** according to a first embodiment. FIG. **1** illustrates an end surface cut at a plane along a central axis of a frame **2** that is disc-shaped (the same applies to FIG. **2** and subsequent drawings). In addition, in the following description, the description is made by setting the direction along the central axis of the disc-shaped frame **2** as upper-lower direction and a direction (radial direction) orthogonal to the upper-lower direction as a left-right direction.

[0017] As shown in FIG. **1**, the electronic cymbal **1** is an electronic percussion instrument that simulates an acoustic cymbal (referred to as "cymbal" in the following). The skeleton of the electronic cymbal **1** is formed by the frame **2**.

[0018] The frame **2** is a frame made of resin and including a bell frame **20** that simulates the shape of a bell of the cymbal and a bow frame **21** that simulates the shape of a bow of the cymbal. The bell frame **20** is formed in a bowl shape tilting downward from the central side thereof toward the outer peripheral side, and the bow frame **21** extends from the outer edge of the bell frame **20** toward the outer peripheral side (the outer side in the left-right direction).

[0019] The bow frame **21** gradually tilts downward with respect to the bell frame **20** toward the outer peripheral side, and the frame **2** as a whole is formed in a substantially disc shape by integrally forming the bell frame **20** and the bow frame **21**.

[0020] A through hole **22** is formed at the center of the bell frame **20**, and an inner wall part **30** of a case **3** is caught to the through hole **22**. The inner wall part **30** is formed in a substantially cylindrical shape, and the inner peripheral side of the inner wall part **30** (the inner side in the left-right direction) is blocked by a disc-shaped support part **32** having a through hole **31** at the center. A rod (not shown) for supporting the electronic cymbal **1** is inserted into the through hole **31** of the support part **32**.

[0021] A bottom wall part **33** extends from the lower end of the inner wall part **30** toward the outer peripheral side. By fixing the outer edge of the bottom wall part **33** to the lower surface of the frame **2** (the bow frame **21**), a space surrounded by the frame **2** and the case **3** is formed on the lower surface side of the frame **2**. Electronic components, such as a striking sensor (not shown), a substrate (not shown) etc., installed to the lower surface of the bell frame **20** is stored in the space. The striking sensor is a piezoelectric element detecting the vibration of the frame **2**.

[0022] The upper surface of each of the bell frame **20** and the bow frame **21** is covered by a cover **4** made of rubber and having a through hole **40** at the center, and the cover **4** is formed in a shape (substantially disc shape) along each of the frames **20** and **21**. A bell part sensor not shown herein is provided between the cover **4** and the bell frame **20**, and the bell part sensor is a pressure sensor (e.g., a membrane switch) that is sheet-like and is ON/OFF when the cover **4** covering the bell frame **20** is struck.

[0023] The striking to the bell frame **20** is detected by the bell part sensor, and the striking to the bow frame **21** is detected by the striking sensor. In addition, as will be explicated in the following, the striking to the edge (outer edge) portion of the bow frame **21** is detected by an edge sensor **5**. The striking detected by each sensor is converted into an electrical signal and output to a sound source device not shown herein. Accordingly, a musical sound in accordance with a striking position to the electronic cymbal **1** is generated.

[0024] Then, referring to FIG. **2** and (a) and (b) of FIG. **3**, the detailed configuration of the edge portion of the electronic cymbal **1** and the function at the time when the edge portion is struck are described.

[0025] FIG. **2** is a partially enlarged cross-sectional view of the electronic cymbal **1** in which a portion II of FIG. **1** is enlarged. In FIG. **3**, (a) is a partially enlarged cross-sectional view of the electronic cymbal **1** illustrating a state in which an edge portion is struck by normal striking, and (b) is a partially enlarged cross-sectional view of the electronic cymbal **1** illustrating a state in which the edge portion is struck by striking from a lateral direction. In FIG. **2** and (a) and (b) of FIG. **3**, in order to simplify the drawings, the hatching of the frame **2** (the bow frame **21**) and the cover **4** is omitted.

[0026] In addition, normal striking refers to striking to the outer edge of an upper cover part **41** from the top in a state in which a stick S is slanted (at an angle close to being horizontal), and striking from the lateral direction refers to striking to the outer edge portion of the upper cover part **41** from the lateral direction in a state in which the stick S is upright (at an angle close to the vertical direction). In addition, each configuration of the electronic cymbal **1** described in the following is formed to be continuous in the peripheral direction. However, a portion of the configuration may also be intermittent in the peripheral direction.

[0027] As shown in FIG. **2**, the cover **4** includes the upper cover part **41** covering the upper surface side of the bow frame **21**, a lateral cover part **42** extending downward from the outer edge (the end part on the left side of FIG. **2**) of the upper cover part **41**, a lower cover part **43** extending from the lower end of the lateral cover part **42** toward the inner peripheral side (the right side of FIG. **2**), and a bonding part **44** bent upward from the inner edge of the lower cover part **43**. The parts **41** to **44** are integrally formed.

[0028] The upper cover part **41** is bonded to the upper surface of the bow frame **21** by a double-side tape **6**, and the upper surface of the bonding part **44** is bonded to the lower surface of the bow frame **21** by an adhesive. Meanwhile, on the outer peripheral side with respect to these bonded portions, neither of the upper cover part **41**, the lateral cover part **42**, and the lower cover part **43** is bonded to the bow frame **21**.

[0029] As described in the following, within the bow frame **21**, a portion bonded to the upper cover part **41** (i.e., a portion covered in a state of being contacted by the upper cover part **41**) is described as a covered part **21***a*.

[0030] A bent part **21***b* is bent downward from the outer edge of the covered part **21***a*, an overhang part **21***c* overhangs from the lower end of the bent part **21***b* toward the outer peripheral side. In addition, a sensor installation part **21***d* extends from the upper end on the outer edge side of the overhang part **21***c* to the outer peripheral side. By integrally forming the respective parts of the covered part **21***a*, the bent part **21***b*, the overhang part **21***c*, and the sensor installation part **21***d*, the edge portion of the bow frame **21** is formed.

[0031] The edge sensor **5** is bonded to the upper surface of the sensor installation part **21***d*, and the edge sensor **5** is also a sheet-like pressure sensor (e.g., a membrane switch) like the bell part sensor. The upper cover part **41** covers the bow frame **21** in a state in which a space S**1** is formed between the upper cover part **41** and the edge sensor **5** (the sensor installation part **21***d*).

[0032] A protrusion **45** protruding toward the edge sensor **5** (downward) is integrally formed on the lower surface of the upper cover part **41**. The protrusion **45** is a portion pressing the edge sensor **5** at the time when the outer edge portion of the upper cover part **41** is struck.

[0033] A stopper **46** integrally formed with the upper cover part **41** is provided on the inner peripheral side with respect to the protrusion **45**. The stopper **46** is a protrusion protruding downward from the upper cover part **41** and inserted into a recess part **21***e* formed on the upper surface of the bow frame **21**. The recess part **21***e* is a groove formed by the bent part **21***b*, the overhang part **21***c*, and the sensor installation part **21***d* of the bow frame **21**.

[0034] In a state before the upper cover part **41** is struck (referred to as "pre-striking state" in the following), the stopper **46** and the bottom surface of the recess part **21***e* are in contact with each other or slightly separated (less than a gap between the protrusion **45** and the edge sensor **5**).

[0035] Accordingly, as shown in (a) of FIG. **3**, when the outer edge portion of the upper cover part **41** is struck from the top through normal striking, the stopper **46** contacting the bottom surface of the recess part **21***e* (the upper surface of the overhang part **21***c*) serves as the fulcrum, and the upper cover part **41** is elastically deformed to be bent downward.

[0036] As the upper cover part **41** deforms downward, the lateral cover part **42** and the lower cover part **43** deform downward so as to be separated from the bow frame **21** (the overhang part **21***c* and the sensor installation part **21***d*). This is because, as described above, the lateral cover part **42** and the lower cover part **43** are not bonded to the bow frame **21** on the outer peripheral side with respect to the bonding part **44**.

[0037] Through the downward deformation of the respective cover parts **41**, **42**, and **43**, the protrusion **45** is pressed to the edge sensor **5**, and the striking to the cover **4** (the upper cover part **41**) by the stick S is detected by the edge sensor **5**.

[0038] Meanwhile, as shown in (b) of FIG. **3**, when the upper cover part **41** is struck from the lateral direction, due to the catching between the stopper **46** and the wall surface of the recess part **21***e* (the outer peripheral surface of the bent part **21***b*), the deformation (displacement) of the upper cover part **41** toward the inner peripheral side is limited. By limiting the deformation of the upper cover part **41** toward the inner peripheral side, the contact of the upper cover part **41** and the lateral cover part **42** to the outer edge portion of the sensor installation part **21***d* can be suppressed. Therefore, the protrusion **45** can be easily suppressed to the edge sensor **5**. Accordingly, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0039] In addition, in the pre-striking state (the state of FIG. **2**), the stopper **46** faces the space S**1**, and there is no rubber filling the space S**1** on the outer peripheral side of the stopper **46**. Therefore, the upper cover part **41** is easily deformed to bend with the root portion of the stopper **46** as the start point. Accordingly, for example, even in the case where the outer edge portion of the upper cover part **41** is struck lightly from the lateral direction (see (b) of FIG. **3**), the protrusion **45** is easily pressed to the edge sensor **5**. Accordingly, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0040] Moreover, with the deformation of the upper cover part **41** toward the inner peripheral side being limited by the stopper **46**, the force applied to the bonding portion (the double-side tape **6**) between the covered part **21***a* and the

upper cover part **41** can be reduced. Accordingly, the upper cover part **41** can be prevented from being peeled off from the covered part **21***a*.

[0041] In addition, a bonding position P**1** between the bonding part **44** and the lower surface of the bow frame **21** is located on the inner peripheral side with respect to the stopper **46**, and neither of the lateral cover part **42** and the lower cover part **43** is bonded to the bow frame **21** on the outer peripheral side with respect to the bonding position P**1**. Accordingly, in both (referred to as "striking from the respective directions" in the following) of the normal striking (see (a) of FIG. **3**) and the striking from the lateral direction (see (b) of FIG. **3**), the lateral cover part **42** and the lower cover part **43** easily follow the deformation of the upper cover part **41** with the stopper **46** as the fulcrum. That is, the deformation of the upper cover part **41** can be prevented from being obstructed by the lateral cover part **42** and the lower cover part **43**. Therefore, the protrusion **45** is easily pressed to toward the edge sensor **5**. Accordingly, the sensitivity of the edge sensor **5** with respect to the striking from the respective directions can be facilitated.

[0042] In addition, although the lower cover part **43** is also deformed at the time of being struck from the lateral direction, the deformation of the lower cover part **43** is limited by a protrusion part **21***f*. The protrusion part **21***f* protrudes downward from the lower surface of the bow frame **21**, and the bonding part **44** is inserted between a protrusive portion formed by the bent part **21***b*, the overhang part **21***c*, and the sensor installation part **21***d* on the lower surface of the bow frame **21** and the protrusion part **21***f*.

[0043] Accordingly, since the deformation of the lower cover part **43** and the bonding part **44** toward the inner peripheral side at the time of being struck from the lateral direction (see (b) of FIG. **3**) is limited by the protrusion part **21***f*, the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting the outer edge portion of the sensor installation part **21***d*. Thus, since the protrusion **45** is easily pressed to the edge sensor **5**, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated. Moreover, by limiting the deformation the lower cover part **43** and the bonding part **44** toward the inner peripheral side by the protrusion part **21***f*, the force applied to the bonding position P**1** between the bow frame **21** and the bonding part **44** can be reduced, and the bonding part **44** can be suppressed from being peeled off from the bow frame **21**.

[0044] In addition, in order to easily deform the upper cover part **41** by setting the stopper **46** as the fulcrum, a thin part **47** is formed at the upper cover part **41**. More specifically, except for regions in which the protrusion **45** and the thin part **47** are formed, the thickness of the upper cover part **41** is substantially constant in regions on the outer peripheral side with respect to the stopper **46**. Here, "being substantially constant" means that, compared with the averaged thickness of the upper cover part **41** in such regions, the minimum thickness and the maximum thickness of the upper cover part **41** are within ±10% of the averaged thickness. Meanwhile, in the region in which the thin part **47** is formed, the thickness of the upper cover part **41** is thinner than other regions, and the thickness of the upper cover part **41** is gradually reduced toward the stopper **46**.

[0045] By forming such thin part **47** in an adjacent portion to the outer peripheral surface of the stopper **46**, at the time of being struck from the respective directions (see (a) and (b) of FIG. **3**), the upper cover part **41** is easily deformed with the root portion of the stopper **46** as the start point. Accordingly, for example, even in the case where the outer edge portion of the upper cover part **41** is struck lightly, the sensitivity of the edge sensor **5** with respect to the striking from the respective directions can be facilitated.

[0046] In this way, although the deformation of the upper cover part **41** toward the inner peripheral side is limited by the stopper **46** formed at the upper cover part **41** in the embodiment, the deformation of the upper cover part **41** toward the inner peripheral side can also be limited even in a configuration in which a stopper **221***g* protruding upward from a bow frame **221** is fit to a recess part **249** of a cover **204** in a second embodiment (see (a) of FIG. **4**) to be described in the following, for example. However, in such configuration, since the thickness of the region of the cover **204** where the recess part **249** is formed is reduced, the cover **204** is less durable with respect to striking. When the thickness of the cover **204** is increased to ensure the durability, the overall thickness of the electronic cymbal **201** is increased, and it is difficult to keep the shape flat like the cymbal.

[0047] Comparatively, in the embodiment, it is configured that the bent part **21***b* bent downward from the outer edge of the covered part **21***a* is formed at the bow frame **21**, the stopper **46** located on the outer peripheral side of the bent part **21***b* is formed at the upper cover part **41**, and the deformation of the upper cover part **41** toward the inner peripheral side is limited by the bent part **21***b* and the stopper **46**. Accordingly, compared with the configuration in which the stopper **221***g* of the bow frame **221** is inserted into the recess part **249** of the cover **204** as in the second embodiment, the thickness of the cover **4** is ensured, and the overall thickness of the bow frame **21** and the cover **4** can be reduced. Accordingly, the electronic cymbal **1** can be in a shape similar to the cymbal.

[0048] Here, the deformation of the upper cover part **41** toward the inner peripheral side can be generally limited by the stopper **46**. However, at the time of being struck strongly from the lateral direction, for example, the protrusion **45** of the upper cover part **41** is displaced toward the inner peripheral side (the inner side along the left-right direction) instead of being displaced downward. In the case where the protrusion **45** is displaced toward the inner peripheral side, the closer the angle of the upper surface of the sensor installation part **21***d* (the edge sensor **5**) is to being horizontal, the more likely the edge sensor **5** is pressed insufficiently by the protrusion **45**.

[0049] Comparatively, in the embodiment, the upper surface of the sensor installation part **21***d* (the edge sensor **5**) and the lower surface of the protrusion **45** are formed to be parallel, and the respective surfaces tilt downward toward the outer peripheral side at a slope greater than that of the upper surface of the covered part **21***a*. Accordingly, a larger angle of the upper surface of the sensor installation part **21***d* (the edge sensor **5**) with respect to the left-right direction (horizontal direction) can be ensured. Thus, even in the case where the protrusion **45** is displaced toward the inner peripheral side due to the striking from the lateral direction, the edge sensor **5** is easily pressed by the protrusion **45**. Therefore, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0050] In addition, the slope of the upper surface of the sensor installation part **21***d* is greater than that of the upper

surface of the covered part **21**, whereas the lower surface of the upper cover part **41** (the portion without the protrusion **45** and the thin part **47**) is parallel to the upper surface of the covered part **21***a*. That is, the lower surface of the upper cover part **41** tilts downward toward the outer peripheral side at a slope less than that of the upper surface of the sensor installation part **21***d*.

[0051] Accordingly, an interval between the upper surface of the sensor installation part **21***d* and the lower surface of the upper cover part **41** is gradually increased from the inner peripheral side to the outer peripheral side. Therefore, a connection position P**2** between the upper cover part **41** and the lateral cover part **42** can be away from the outer edge of the sensor installation part **21***d*. Thus, at the time of being struck from the lateral direction, the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting the outer edge portion of the sensor installation part **21***d*. Accordingly, since the protrusion **45** is easily pressed to the edge sensor **5**, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0052] In this way, in the embodiment, by limiting the deformation of the upper cover part **41** toward the inner peripheral side by the stopper **46**, or by increasing the slope of the upper surface of the sensor installation part **21***d* (the edge sensor **5**), the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0053] Comparatively, referring to a third embodiment (see (b) of FIG. **4**) to be described afterwards, for example, even in a configuration in which the overhang part **21***c* is omitted, and the sensor installation part **21***d* is provided at the lower end of the bent part **21***b*, it is still possible to exert the function of the stopper **46**. However, in the configuration in which the sensor installation part **21***d* with a larger slope is connected to the lower part of the bent part **21***b*, the sensor installation part **21***d* significantly protrudes downward from the bow frame **21**. That is, since the thickness of the edge portion of the bow frame **21** is increased, it is difficult to keep the shape of an electronic cymbal **301** flat like the cymbal.

[0054] Comparatively, in the embodiment, it is configured that the overhang part **21***c* which overhangs from the lower end of the bent part **21***b* toward the outer peripheral side is provided, and the sensor installation part **21***d* is provided at the upper end part on the outer edge side of the overhang part **21***c*. In this way, compared with the configuration in which the overhang part **21***c* is omitted, the arrangement (height) of the sensor installation part **21***d* can be increased. Therefore, the significant downward protrusion of the sensor installation part **21***d* can be suppressed. Accordingly, the thickness of the edge portion of the bow frame **21** can be reduced, and the electronic cymbal **1** can be in a flat shape like the cymbal.

[0055] Here, in addition to the function of detecting the striking to the upper cover part **41**, the edge sensor **5** is also provided with a function of detecting a choke playing technique in which the performer grabs the edge portion of the bow frame **21**. A conventional process may be adopted for the process of distinguishing between the striking to the upper cover part **41** and the choke playing technique. Therefore, details in this regard will be omitted. As a conventional process, a process described in para. 0005 to 0008 of Japanese Laid-open No. H06-035450, etc., may serve as an example.

[0056] In such choke playing technique, as described above, the performer grabs the edge portion of the bow frame **21**. In such case, when the sensor installation part **21***d* is provided at the upper end part on the outer edge side of the overhang part **21***c*, a step difference is formed in the connection portion between the overhang part **21***c* and the sensor installation part **21***d*, and a space S**2** (see FIG. **2**) is created between the step difference portion and the lower cover part **43**. Therefore, the feeling when performing the choke playing technique deteriorates. That is, when the space S**2** is formed to be large, a hard feeling like the cymbal cannot be obtained.

[0057] Comparatively, the lower cover part **43** of the embodiment includes a contact part **48** which fills a portion of the step difference formed by the overhang part **21***c* and the sensor installation part **21***d*. The contact part **48** is a protrusion integrally formed with the upper surface of the lower cover part **43**, and contacts the lower surface of the sensor installation part **21***d* in the pre-striking state (the state shown in (a) and (b) of FIG. **2**). Accordingly, when the performer grabs the vicinity of the contact part **48** to perform the choke playing technique, a relatively hard feeling can be applied, so the electronic cymbal can provide a feeling of performance close to the cymbal.

[0058] To provide the hard feeling close to the cymbal, the space S**2** may be completely filled by the contact part **48**. However, when the space S**2** is completely filled by the contact part **48**, due to a dimension error of the frame **2** or the cover **4**, it is difficult to properly fit the contact part **48** to the step difference portion between the overhang part **21***c* and the sensor installation part **21***d*. In addition, when the space S**2** is completely filled by the contact part **48**, the deformation of the upper cover part **41** is obstructed by the catching between the overhang part **21***c* and the contact part **48**, and it is difficult to press the protrusion **45** to the edge sensor **5**.

[0059] Comparatively, in the embodiment, a gap is formed between the overhang part **21***c* and the contact part **48**, and a portion of the space S**2** is left. Accordingly, even if a dimension error occurs in the frame **2** or the cover **4**, the contact part **48** can still be properly fit to the step difference portion between the overhang part **21***c* and the sensor installation part **21***d*. Therefore, the assemblability of the cover **4** can be facilitated. Moreover, since the space S**2** is left, at the time of being struck from the respective directions (see (a) and (b) of FIG. **3**), the contact part **48** can be suppressed from being caught by the overhang part **21***c*. Therefore, the upper cover part **41** is deformed easily with the stopper **48** as the fulcrum. Thus, since the protrusion **45** is easily pressed to the edge sensor **5**, the sensitivity of the edge sensor **5** with respect to the striking from the respective directions can be facilitated.

[0060] In addition, as described above, although the stopper **46** is inserted into the recess part **21***e*, a gap is also formed between stopper **46** and the wall surface on the outer peripheral side of the recess part **21***e* (the sensor installation part **21***d*) in the pre-striking state. Accordingly, even if a dimension error occurs in the frame **2** or the cover **4**, the stopper **46** can be properly inserted into the recess part **21***e*. Therefore, the assemblability of the cover **4** can be facilitated.

[0061] Then, the electronic cymbal **201** of the second embodiment is described with reference to (a) of FIG. **4**. In the first embodiment, the case where the stopper **46** is formed in the cover **4** is described. However, in the second embodiment, the case where the stopper **221***g* is formed at the bow frame **221** is described. It is noted that components same as those of the first embodiment are labelled with the same reference symbols, and the description thereof is omitted. In FIG. **4**, (a) is a partially enlarged cross-sectional view of the electronic cymbal **201** according to the second embodiment. In (a) of FIG. **4**, in order to simplify the drawing, the hatching of the frame **2** (the bow frame **221**) and the cover **204** is omitted.

[0062] As shown in (a) of FIG. **4**, the bow frame **221** of the electronic cymbal **201** of the second embodiment has the same configuration as the bow frame **21** of the first embodiment, except for the point where, in place of the recess part **21***e* of the first embodiment (see FIG. **2**), the stopper **221***g* is integrally formed. Also, the cover **204** has the same configuration as the cover **4** of the first embodiment except for a point that, in place of the stopper **46** of the first embodiment (see FIG. **2**), the recess part **249** is formed at the upper cover part **41**.

[0063] The stopper **221***g* protrudes upward from the bow frame **221**, and is inserted into the recess part **249** formed on the lower surface of the upper cover part **41**. Accordingly, at the time of being struck from the lateral direction, through the catching between the stopper **221***g* and the recess part **249**, the deformation of the upper cover part **41** toward the inner peripheral side can be limited. Thus, since the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting the sensor installation part **21***d* at the time of being struck from the lateral direction, the protrusion **45** is easily pressed to the edge sensor **5**.

[0064] Also, in the pre-striking state (the state of (a) of FIG. **4**), the stopper **221***g* faces the space S**1** between the sensor installation part **21***d* and the upper cover part **41**, and there is no rubber filling the outer peripheral side of the stopper **221***g*. Accordingly, the upper cover part **41** is easily deformed with the stopper **221***g* as the fulcrum, and thus the protrusion **45** is easily pressed to the edge sensor **5** at the time of being struck from the respective directions.

[0065] Also, like the first embodiment, the upper surface of the sensor installation part **21***d* (the edge sensor **5**) and the lower surface of the protrusion **45** are formed to be parallel, and the angles of the respective surfaces provide slopes greater than the upper surface of the covered part **21***a*. Accordingly, the angle of the upper surface of the sensor installation part **21***d* (the edge sensor **5**) with respect to the horizontal direction can be increased. Thus, even if the protrusion **45** is displaced toward the inner peripheral side due to the striking from the lateral direction, the edge sensor **5** is easily pressed by the protrusion **45**.

[0066] In addition, since an interval between the sensor installation part **21***d* and the upper cover part **41** is gradually increased toward the outer peripheral side, the connection position P**2** between the upper cover part **41** and the lateral cover part **42** can be away from the outer edge of the sensor installation part **21***d*. Thus, since the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting the sensor installation part **21***d* at the time of being struck from the lateral direction, the protrusion **45** is easily pressed to the edge sensor **5**. Accordingly, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0067] Then, an electronic cymbal **301** of the third embodiment is described with reference to (b) of FIG. **4**. In the first embodiment, the case where the sensor installation part **21***d* is connected to the overhang part **21***c* is described. However, in the third embodiment, the case where the sensor installation part **21***d* is connected to the lower end of the bent part **21***b* is described. In FIG. **4**, (b) is a partially enlarged cross-sectional view of the electronic cymbal **301** according to the third embodiment. In (b) of FIG. **4**, in order to simplify the drawing, the hatching of the frame **2** (a bow frame **321**) and a cover **304** is omitted.

[0068] As shown in (b) of FIG. **4**, the bow frame **321** of the electronic cymbal **301** of the third embodiment has the same configuration as the bow frame **21** of the first embodiment, except for the point that the overhang part **21***c* of the first embodiment (see FIG. **2**) is omitted, and the sensor installation part **21***d* is integrally formed at the lower end of the bent part **21***b*.

[0069] In addition, the cover part **304** has the same configuration as the cover **4** of the first embodiment, except for the point that the upper cover part **41** (a portion on the outer peripheral side with respect to the stopper **46**) or the protrusion **45** is formed to be thicker and the point that the lower cover part **43** omitting the contact part **48** (see FIG. **2**) makes contact along the lower surface of the sensor installation part **21***d*.

[0070] Even in the embodiment, due to the catching between the stopper **46** and the bent part **21***b*, the deformation of the upper cover part **41** toward the inner peripheral side can be limited at the time of being struck from the lateral direction. In this way, since the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting the outer edge portion of the sensor installation part **21***d* at the time of being struck from the lateral direction, the protrusion **45** is easily pressed to the edge sensor **5**.

[0071] In addition, in the pre-striking state (the state of (b) of FIG. **4**), the stopper **46** faces the space S**1** between the sensor installation part **21***d* and the upper cover part **41**, and there is no rubber filling the outer peripheral side of the stopper **46**. Accordingly, since the upper cover part **41** is easily deformed with the stopper **46** as the fulcrum, the protrusion **45** is easily pressed to the edge sensor **5** at the time of being struck from the respective directions.

[0072] Also, like the first embodiment, the upper surface of the sensor installation part **21***d* (the edge sensor **5**) and the lower surface of the protrusion **45** are formed to be parallel, and the angles of the respective surfaces provide slopes greater than the upper surface of the covered part **21***a*. Accordingly, a larger angle of the upper surface of the sensor installation part **21***d* (the edge sensor **5**) with respect to the horizontal direction can be ensured, and thus even if the protrusion **45** is displaced toward the inner peripheral side due to the striking from the lateral direction, the edge sensor **5** is easily pressed by the protrusion **45**.

[0073] In addition, since an interval between the sensor installation part **21***d* and the upper cover part **41** is gradually increased toward the outer peripheral side, the connection position P**2** between the upper cover part **41** and the lateral cover part **42** can be away from the outer edge of the sensor installation part **21***d*. Thus, since the upper cover part **41** and the lateral cover part **42** can be suppressed from contacting

the sensor installation part **21***d* at the time of being struck from the lateral direction, the protrusion **45** is easily pressed to the edge sensor **5**. Accordingly, the sensitivity of the edge sensor **5** with respect to the striking from the lateral direction can be facilitated.

[0074] Although the above description has been made based on the embodiments, the invention is not limited to the embodiments, and it can be easily inferred that various improvements and modifications can be made without departing from the spirit of the invention.

[0075] In the respective embodiments, a configuration in which the frame **2** includes the disc-shaped bell frame **20** and the bow frame **21**, **221**, and **321**, that is, the case in which the electronic cymbal **1**, **201**, **301** is an electronic percussion instrument simulating the cymbal, is described. However, the invention is not limited thereto. For example, the invention may also be applicable to an edge portion of another disc-shaped electronic percussion instrument. In addition, the outer shape of the frame **2** is not limited to being circular (disc-shaped). For example, the outer shape of the frame **2** may also be polygonal.

[0076] In the respective embodiments, the case where the lower surface of the protrusion **45** of the upper cover part **41** is parallel to the upper surface of the sensor installation part **21***d* (the edge sensor **5**) is described. However, the invention is not limited thereto. For example, the slope of the lower surface of the protrusion **45** may also be configured as being greater or less than that of the upper surface of the sensor installation part **21***d* (the edge sensor **5**), and the protrusion **45** may also be omitted.

[0077] In the respective embodiments, the case where the slope of the upper surface of the sensor installation part **21***d* (the edge sensor **5**) is greater than the upper surface of the covered part **21***a* is described. However, the invention is not limited thereto. For example, the slope of the upper surface of the sensor installation part **21***d* may also be configured as being the same as or less than the slope of the upper surface of the covered part **21***a*.

[0078] In the respective embodiments, the configuration in which the interval between the sensor installation part **21***d* (the edge sensor **5**) and the upper cover part **41** is gradually increased is described. However, the invention is not limited thereto. For example, the interval between the sensor installation part **21***d* (the edge sensor **5**) and the upper cover part **41** may also remain the same or be gradually decreased from the inner peripheral side to the outer peripheral side.

[0079] In the respective embodiments, the case where the bonding position P**1** between the bow frame **21**, **221**, **321** and the bonding part **44** is located on the inner peripheral side with respect to the stopper **46**, **221***g* is described. However, the invention is not limited thereto. For example, the bonding position P**1** may also be located on the outer peripheral side with respect to the stopper **46**, **221***g*, the bonding part **44** may be omitted, and the inner edge of the lower cover part **43** is directly bonded to the lower surface of the bow frame **21**, **221**, **321**.

[0080] In the respective embodiments, the case where the upper cover part **41** or the bow frame **221** (the frame **2**) includes the stopper **46**, **221***g* limiting the deformation of the upper cover part **41** toward the inner peripheral side is described. However, the invention is not limited thereto. For example, the stopper **46**, **221***g* may be omitted.

[0081] In the first and second embodiments, a portion of the step difference portion (the space S**2**) between the overhang part **21***c* and the sensor installation part **21***d* is filled by the contact part **48**. However, the invention is not limited thereto. For example, the contact part **48** may also completely fill the step difference portion (the space S**2**), or the contact part **48** may also be omitted.

[0082] Although omitted in the description of the first and third embodiments, the stopper **46** may contact the wall surface (the outer peripheral surface of the bent part **21***b*) of the recess part **21***e* in the pre-striking state. However, the wall surface (the outer peripheral surface of the bent part **21***b*) on the inner peripheral side of the recess part **21***e* and the stopper **46** may be separated from the stopper **46** as long as the pressing to the edge sensor **5** by the protrusion **45** does not become insufficient.

[0083] Although the first embodiment describes the case where a gap is formed between the sensor installation part **21***d* and the stopper **46**, the invention is not limited thereto. For example, the sensor installation part **21***d* and the stopper **46** may also be connected with each other in the pre-striking state.

[0084] The first embodiment describes the case where the thickness of the upper cover part **41** in the thin part **47** is gradually reduced toward the stopper **46**, but the invention is not limited thereto. For example, the thickness of the upper cover part **41** in the thin part **47** may also be constant. In addition, it may also be that the thin part **47** is omitted, and the thickness of the upper cover part **41** (the region where the protrusion **45** or the stopper **46** is not formed) may also remain constant. That is, if it is configured that the upper cover part **41** (the protrusion **45**) can be deformed to the side of the edge sensor **5** by the stopper **46** as the fulcrum, the thickness of the upper cover part **41** can be set as appropriate.

[0085] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure covers modifications and variations provided that they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An electronic cymbal, comprising:

a plate-like frame;

a sensor installed to an upper surface on an outer edge side of the frame; and

a cover covering upper surfaces of the sensor and the frame,

wherein the cover comprises:

an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor;

a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and

a lower cover part extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame, and

the upper cover part or the frame comprises a stopper facing the space between the upper cover part and the sensor and limits deformation of the upper cover part toward the inner peripheral side.

2. The electronic cymbal as claimed in claim **1**, wherein the upper cover part is bonded to the upper surface of the frame on an inner peripheral side of the stopper.

3. The electronic cymbal as claimed in claim **1**, wherein the lower cover part is bonded to a lower surface of the frame on the inner peripheral side with respect to the stopper, and is not bonded to the lower surface of the frame on an outer peripheral side with respect to a position of the bonding.

4. The electronic cymbal as claimed in claim **1**, wherein the upper cover part comprises a thin part formed in an adjacent portion to an outer peripheral surface of the stopper.

5. The electronic cymbal as claimed in claim **1**, wherein the frame comprises:

a covered part covered in a state of being contacted by the upper cover part; and

a bent part bent downward from an outer edge of the covered part,

the upper cover part comprises the stopper protruding toward the frame on an outer peripheral side of the bent part, and

the deformation of the upper cover part toward the inner peripheral side is limited through catching between the bent part and the stopper.

6. The electronic cymbal as claimed in claim **5**, wherein the frame comprises:

an overhang part extending from a lower end of the bent part to an outer peripheral side; and

a sensor installation part which extends from an upper end part on an outer edge side of the overhang part to the outer peripheral side and to which the sensor is installed,

the upper cover part comprises a protrusion which protrudes toward the sensor and in which a lower surface is parallel to an upper surface of the sensor installation part, and

the upper surface of the sensor installation part tilts downward toward the outer peripheral side at a slope greater than that of an upper surface of the covered part.

7. The electronic cymbal as claimed in claim **6**, wherein the lower cover part comprises a contact part contacting a lower surface of the sensor installation part in a manner of filling at least a portion of a step difference formed by the overhang part and the sensor installation part.

8. The electronic cymbal as claimed in claim **7**, wherein a gap is formed between the overhang part and the contact part.

9. The electronic cymbal as claimed in claim **6**, wherein a gap is formed between the stopper and the sensor installation part.

10. The electronic cymbal as claimed in claim **7**, wherein a gap is formed between the stopper and the sensor installation part.

11. The electronic cymbal as claimed in claim **8**, wherein a gap is formed between the stopper and the sensor installation part.

12. An electronic cymbal, comprising:

a plate-like frame;

a sensor installed to an upper surface on an outer edge side of the frame; and

a cover covering upper surfaces of the sensor and the frame,

wherein the cover comprises:

an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor;

a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and

a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame,

the frame comprises:

a covered part covered in a state of being contacted by the upper cover part; and

a sensor installation part which is located on an outer peripheral side with respect to the covered part and to which the sensor is installed,

the upper cover part comprises a protrusion which protrudes toward the sensor and in which a lower surface is parallel to an upper surface of the sensor installation part, and

the upper surface of the sensor installation part tilts downward toward an outer peripheral side at a slope greater than that of an upper surface of the covered part, and an interval between the upper surface of the sensor installation part and the lower surface of the upper cover part is formed to gradually increase toward the outer peripheral side.

13. The electronic cymbal as claimed in claim **12**, wherein the frame comprises:

a bent part bent downward from an outer edge of the covered part,

the upper cover part comprises a stopper protruding toward the frame on an outer peripheral side of the bent part and faces the space between the upper cover part and the sensor, and

the deformation of the upper cover part toward the inner peripheral side is limited through catching between the bent part and the stopper.

14. The electronic cymbal as claimed in claim **13**, wherein the frame comprises:

an overhang part extending from a lower end of the bent part to an outer peripheral side, and

the sensor installation part which extends from an upper end part on an outer edge side of the overhang part to the outer peripheral side.

15. The electronic cymbal as claimed in claim **14**, wherein the lower cover part comprises a contact part contacting a lower surface of the sensor installation part in a manner of filling at least a portion of a step difference formed by the overhang part and the sensor installation part.

16. The electronic cymbal as claimed in claim **15**, wherein a gap is formed between the overhang part and the contact part.

17. The electronic cymbal as claimed in claim **14**, wherein a gap is formed between the stopper and the sensor installation part.

18. The electronic cymbal as claimed in claim **15**, wherein a gap is formed between the stopper and the sensor installation part.

19. A striking detection method for an electronic cymbal, the electronic cymbal comprising:

a plate-like frame;

a sensor installed to an upper surface on an outer edge side of the frame; and

a cover covering upper surfaces of the sensor and the frame,

wherein the cover comprises:

an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor;

a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and

a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame,

the upper cover part or the frame comprises a stopper facing the space between the upper cover part and the sensor,

the striking detection method comprising:

at the time of striking an outer edge of the cover, limiting deformation of the upper cover part toward the inner peripheral side by the stopper, and detecting striking to the cover by pressing the sensor by the upper cover part deformed with the stopper as a fulcrum.

20. A striking detection method for an electronic cymbal, the electronic cymbal comprising:

a plate-like frame;

a sensor installed to an upper surface on an outer edge side of the frame; and

a cover covering upper surfaces of the sensor and the frame,

wherein the cover comprises:

an upper cover part covering the upper surface of the frame in a state in which a space is formed between the upper cover part and the sensor;

a lateral cover part extending from an outer edge of the upper cover part and covering an outer peripheral surface of the frame in a state in which a space is formed between the lateral cover part and an outer peripheral surface of the frame; and

a lower cover part, extending from a lower end of the lateral cover part to an inner peripheral side and covering a lower surface of the frame,

the frame comprises:

a covered part covered in a state of being contacted by the upper cover part; and

a sensor installation part which is located on an outer peripheral side with respect to the covered part and to which the sensor is installed,

the upper cover part comprises a protrusion which protrudes toward the sensor and in which a lower surface is parallel to an upper surface of the sensor installation part, and

the upper surface of the sensor installation part tilts downward toward an outer peripheral side at a slope greater than that of an upper surface of the covered part, and an interval between the upper surface of the sensor installation part and the lower surface of the upper cover part is formed to gradually increase toward the outer peripheral side,

the striking detection method comprising:

at the time of striking an outer edge of the cover, suppressing the upper cover part and the lateral cover part from contacting an outer edge of the sensor installation part, and detecting striking to the cover by pressing the sensor by the protrusion displaced together with deformation of the upper cover part.

* * * * *