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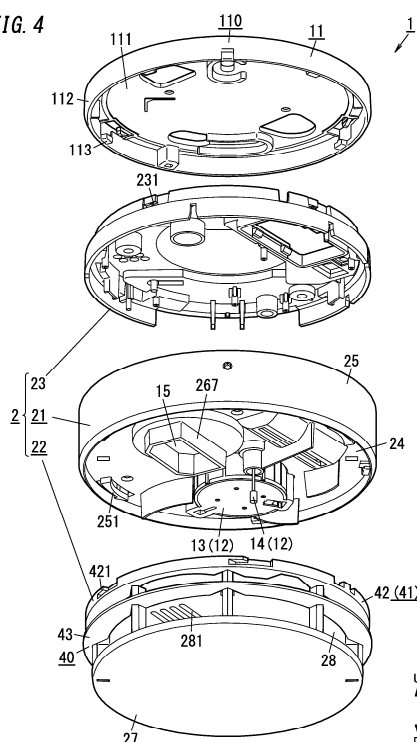
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(54) **SENSOR AND DISASTER PREVENTION SYSTEM**

(57) Provided are a sensor which may call an alert in the form of a sound upon detecting either smoke or heat, and a disaster prevention system. A sensor (1) includes a housing (2), a smoke detection unit (13), a heat detection unit (14), and a sound emission unit (15). The housing (2) is to be mounted on an installation surface of a structure. The smoke detection unit (13) is disposed inside the housing (2). The heat detection unit (14) is disposed inside the housing (2). The sound emission unit (15) is disposed inside the housing (2).

FIG. 4



**Description****Technical Field**

[0001] The present disclosure generally relates to a sensor and a disaster prevention system, and more particularly relates to a sensor including a housing and a detection unit and a disaster prevention system including such a sensor.

**Background Art**

[0002] Patent Literature 1 discloses a fire alarm device including a housing, a smoke detection unit, and a fire alarm. The smoke detection unit includes photosensitive elements, such as photodiodes. The photosensitive elements receive scattered light produced by having the light that has been emitted from an infrared LED to irradiate the internal space of an optical base scattered by smoke particles. That is to say, the photosensitive elements receive the emission of the infrared LED which has been scattered.

**Citation List****Patent Literature**

[0003] Patent Literature 1: JP 2011-164691 A

**Summary of Invention**

[0004] The fire alarm of Patent Literature 1 determines that a fire should be present by detecting smoke, and therefore, cannot determine that a fire should be present without detecting smoke even if heat is present due to the fire.

[0005] An object of the present disclosure is to provide a sensor which may call an alert in the form of a sound upon detecting either smoke or heat, and a disaster prevention system.

[0006] A sensor according to an aspect of the present disclosure includes a housing, a smoke detection unit, a heat detection unit, and a sound emission unit.

[0007] The housing is to be mounted on an installation surface of a structure.

[0008] The smoke detection unit is disposed inside the housing.

[0009] The heat detection unit is disposed inside the housing.

[0010] The sound emission unit is disposed inside the housing.

[0011] A disaster prevention system according to another aspect of the present disclosure includes the sensor described above, a receiver, and a repeater.

[0012] The receiver establishes a communication with the sensor to receive a result of detection obtained by the smoke detection unit and the heat detection unit of the sensor.

[0013] The repeater relays the communication between the sensor and the receiver.

**Brief Description of Drawings****[0014]**

[FIG. 1] FIG. 1 is a side view of a sensor according to an embodiment of the present disclosure;

[FIG. 2] FIG. 2 is a bottom view of the sensor;

[FIG. 3] FIG. 3 is an exploded perspective view of the sensor as viewed from obliquely above the sensor;

[FIG. 4] FIG. 4 is an exploded perspective view of the sensor as viewed from obliquely below the sensor;

[FIG. 5] FIG. 5A is a plan view of a cover portion of the sensor, and FIG. 5B is a partially enlarged view of FIG. 5A;

[FIG. 6] FIG. 6A is a plan view of a bottom plate unit of the cover portion, and FIG. 6B is a side view of the bottom plate unit;

[FIG. 7] FIG. 7A is a plan view of an intermediate plate unit of the cover portion, and FIG. 7B is a side view of the intermediate plate unit;

[FIG. 8] FIG. 8 is a side view illustrating how to assemble the cover portion;

[FIG. 9] FIG. 9 is a vertical sectional view of the cover portion;

[FIG. 10] FIG. 10 is a bottom view of a body portion of the sensor;

[FIG. 11] FIG. 11 is a plan view illustrating the inside of a smoke detection unit of the sensor;

[FIG. 12] FIG. 12 is a schematic representation illustrating a configuration of a disaster prevention system including the sensor;

[FIG. 13] FIG. 13 is a block diagram of the sensor included in the disaster prevention system;

[FIG. 14] FIG. 14 is a block diagram of a receiver included in the disaster prevention system; and

[FIG. 15] FIG. 15 is a block diagram of a repeater included in the disaster prevention system;

**Description of Embodiments**

[0015] A sensor according to the present disclosure and a disaster prevention system including the sensor will be described with reference to the accompanying drawings.

[0016] Note that the drawings to be referred to in the following description of embodiments are all schematic representations.

[0017] Thus, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio.

**(1) Overview**

[0018] An overview of a sensor 1 and disaster preven-

tion system 5 according to the present disclosure will be described.

**[0019]** A sensor 1 according to the present disclosure is a type of disaster prevention equipment for alerting, when sensing any smoke and/or heat involved with a fire, for example, the user to the outbreak of the fire.

**[0020]** That is to say, when smoke and/or heat is present due to the outbreak of a disaster such as a fire, the sensor 1 senses the smoke and/or heat and alerts the user to the outbreak of the disaster by either sounding an alarm or activating other devices via instant communication with those devices.

**[0021]** As used herein, the "disaster prevention equipment" refers to a type of equipment installed in various types of facilities for the purpose of preventing a disaster such as a fire, preventing the spread of damage caused by the disaster, or recovering from the damage caused by the disaster.

**[0022]** The sensor 1 is installed and used in any of various types of facilities.

**[0023]** Examples of those facilities in which the sensor 1 according to the present disclosure may be installed include non-dwelling houses such as historical architectures, hotels, office buildings, schools, welfare facilities, commercial facilities, theme parks, hospitals, and factories.

**[0024]** However, this is only an example of the present disclosure and should not be construed as limiting.

**[0025]** The sensor 1 may naturally be used in dwelling houses including multi-family dwelling houses and single-family dwelling houses.

**[0026]** In any case, the sensor 1 may be installed in any of these various facilities to be mounted on the ceiling, a wall, or any other building component in, for example, a room, a hallway, or stairs of the facility.

**[0027]** As shown in FIGS. 1-4, the sensor 1 includes a housing 2, a smoke detection unit 13, a heat detection unit 14, and a sound emission unit 15.

**[0028]** The housing 2 is to be mounted on an installation surface of a structure.

**[0029]** The smoke detection unit 13 is disposed inside the housing 2.

**[0030]** The sound emission unit 15 is disposed inside the housing 2.

**[0031]** As shown in FIGS. 11-15, the disaster prevention system 5 includes the sensors 1, a receiver 6, and repeaters 7.

**[0032]** The receiver 6 establishes communications with the sensors 1 to receive the results of detection obtained by the smoke detection unit 13 and the heat detection unit 14 thereof.

**[0033]** The repeaters 7 relay the communications between the sensors 1 and the receiver 6.

**[0034]** The sensor 1 and disaster prevention system 5 according to the present disclosure may call an alert in the form of a sound upon detecting either smoke or heat.

## (2) Details

### (2-1) Overall configuration

**[0035]** A detailed configuration for the sensor 1 and disaster prevention system 5 according to an embodiment will be described with reference to FIGS. 1-15.

**[0036]** The sensor 1 is supposed to be a smoke detector for detecting smoke and mounted on the ceiling wall of the facility as a structure, for example.

**[0037]** In a state where the sensor 1 is mounted on the ceiling wall, a direction perpendicular to (i.e., that intersects at right angles with) the surface of the ceiling (which is a lower surface of the ceiling wall and will be hereinafter referred to as an "installation surface") is herein supposed to be an "upward/downward direction." Note that the double-headed arrow indicating the upward/downward direction on the drawings is shown there for illustrative purposes only and is an insubstantial one.

**[0038]** Note that these directions should not be construed as limiting the directions in which the sensor 1 is supposed to be used (or mounted).

### (2-2) Sensor

**[0039]** As shown in FIGS. 1-4, the sensor 1 includes a sensor base 11 mounted on the structure and a sensor body 10 attached to the sensor base 11 (specifically, the housing 2 to be described later).

**[0040]** The sensor body 10 is removably attached to the sensor base 11.

**[0041]** Attaching the sensor body 10 to the sensor base 11 allows the sensor body 10 to be mounted on the installation surface of the structure.

**[0042]** An outer shell of the sensor 1 is formed by combining the housing 2 of the sensor body 10 and a base cover 110 of the sensor base 11.

**[0043]** The base cover 110 is fixed to the installation surface (the ceiling in this case).

**[0044]** Note that, strictly speaking, the base cover 110 is not directly fixed to the installation surface but indirectly fixed to the installation surface by being fixed to an attachment base (not shown) fixed to the installation surface.

### (2-3) Sensor base

**[0045]** The sensor base 11 is mounted on the structure and the housing 2 is attached thereto.

**[0046]** As shown in FIGS. 3 and 4, the sensor base 11 includes the base cover 110 forming part of the outer shell of the sensor 1.

**[0047]** The base cover 110 has an upper wall 111 and a sidewall 112 to form the sensor base 11.

**[0048]** The upper wall 111 is a plate having the shape of a circle when viewed in plan.

**[0049]** That is to say, the upper wall 111 according to this embodiment is a plate having a circular ring shape when viewed in plan.

**[0050]** The sidewall 112 has the shape of a circular

cylinder extending downward from a peripheral edge portion of the upper wall 111.

**[0051]** The upper wall 111 and the sidewall 112 are formed integrally with each other.

**[0052]** The upper wall 111 serves as the upper wall of the outer shell of the sensor 1.

**[0053]** As used herein, the "upper wall" refers to not only the upper wall 111 of the base cover 110 but also the upper wall of the sensor 1.

**[0054]** For the sidewall 112, provided is an attachment portion 113 via which the sensor body 10 is attached to the sensor base 11.

#### (2-4) Sensor body

**[0055]** The sensor body 10 includes the housing 2, the detection unit 12, a sound emission unit 15, and the light source units 16 (refer to FIG. 9).

**[0056]** The housing 2 serves as the outer shell of the sensor 1.

**[0057]** In this embodiment, the sensor 1 further includes a battery 17.

**[0058]** However, the battery 17 is an optional constituent element and does not have to be included in the sensor 1.

#### (2-5) Housing

**[0059]** The housing 2 is to be mounted on the installation surface of the structure.

**[0060]** As described above, the housing 2 is to be mounted on the installation surface of the structure via the sensor base 11.

**[0061]** The housing 2 has the shape of a circle when viewed in plan.

**[0062]** The housing 2 is a molded product made of a resin.

**[0063]** The housing 2 includes the body portion 21, the cover portion 22, and a reverse cover portion 23.

#### (2-6) Body portion and reverse cover portion

**[0064]** The body portion 21 includes the body supporting portion 24 and the body cylindrical portion 25.

**[0065]** The body supporting portion 24 supports the respective weights of the detection unit 12, the sound emission unit 15, the light source unit 16, and a board 18 (i.e., a circuit board).

**[0066]** The body supporting portion 24 is configured as a member substantially having the shape of a disk when viewed in plan.

**[0067]** As used herein, an orientation pointing away from the installation surface refers to a "first orientation." That is to say, the first orientation pointing away from the installation surface is normal to the installation surface.

**[0068]** Since the installation surface is the ceiling surface, the first orientation in this embodiment is a downward orientation (particularly, a vertically downward or-

ientation).

**[0069]** In addition, directions parallel to the first orientation (i.e., a direction corresponding to the first orientation and a direction opposite from the first orientation) will be hereinafter referred to as "first directions." The "first directions" will be hereinafter simply referred to as "upward/downward directions."

**[0070]** The body cylindrical portion 25 is configured as a member having the shape of a cylinder (particularly, the shape of a circular cylinder) which extends in the upward/downward direction to surround the body supporting portion 24.

**[0071]** The body cylindrical portion 25 covers the respective outer side surfaces of the body supporting portion 24 and the devices (namely, the detection unit 12, the sound emission unit 15, and the light source unit 16), of which the respective weights are supported by the body supporting portion 24.

**[0072]** The body supporting portion 24 and the body cylindrical portion 25 are formed integrally with each other.

**[0073]** At the lower end portion of the body cylindrical portion 25, provided is a lower attachment portion 251 via which the cover portion 22 is removably attached to the body portion 21.

**[0074]** At the upper end portion of the reverse cover portion 23, provided is an attachment portion 231 via which the reverse cover portion 23 is removably attached to the sensor base 11.

**[0075]** The reverse cover portion 23 is attached to the body portion 21 with screws 19.

#### (2-7) Cover portion

**[0076]** The cover portion 22 extends in the first orientation (i.e., a downward) from the body portion 21.

**[0077]** The cover portion 22 covers the body portion 21 so as not to leave the lower surface of the body portion 21 exposed downward.

**[0078]** The cover portion 22 includes the plurality of cover supporting portions 26, an intermediate plate 28, the bottom plate 27, and the light guide members 29.

**[0079]** The cover portion 22 has first openings 203 which allow a first space 201 (to be described later) to communicate with an external space.

**[0080]** The cover portion 22 also has second openings 204 which allow a second space 202 (to be described later) to communicate with the external space.

#### (2-7-1) Cover supporting portions, intermediate plate, and bottom plate

**[0081]** The plurality of cover supporting portions 26 extends in the first orientation (i.e., downward) from the body portion 21.

**[0082]** The plurality of cover supporting portions 26 supports the weight of the intermediate plate 28 in the middle in the upward/downward direction.

**[0083]** Also, the plurality of cover supporting portions 26 supports the weight of the bottom plate 27 at the respective tips thereof in the upward/downward direction.

**[0084]** That is to say, the plurality of cover supporting portions 26 supports the intermediate plate 28 and the bottom plate 27 in suspension.

**[0085]** The bottom plate 27 forms the lower surface of the sensor body 10 (i.e., the sensor 1).

**[0086]** The bottom plate 27 has a circular shape when viewed in plan.

**[0087]** The intermediate plate 28 partitions, in the upward/downward direction, the space between the lower surface of the body portion 21 and the upper surface of the bottom plate 27 (i.e., the internal space 20 of the cover portion 22).

**[0088]** The intermediate plate 28 has the same circular shape as that of the bottom plate 27 when viewed in plan.

**[0089]** The space between the bottom plate 27 and the intermediate plate 28 (i.e., the space, located under the intermediate plate 28, of the internal space 20) will be hereinafter referred to as the "first space 201." On the other hand, the space between the intermediate plate 28 and the body portion 21 (i.e., the space, located over the intermediate plate 28, of the internal space 20) will be hereinafter referred to as the "second space 202." The length L1 of the first space 201 as measured in the first direction is greater than the length L2 of the second space 202 as measured in the first direction (refer to FIG. 1).

**[0090]** The intermediate plate 28 and the bottom plate 27 extend in a direction (horizontal direction) intersecting at right angles with the upward/downward direction.

**[0091]** The first space 201 is opened to the external space (to the air) beside itself entirely but the areas in which the plurality of cover supporting portions 26 are arranged.

**[0092]** Those areas that allow the first space 201 to communicate with the external space will be hereinafter referred to as the "first openings 203." In the same way, the second space 202 is also opened to the external space (to the air) beside itself entirely but the areas in which the plurality of cover supporting portions 26 are arranged.

**[0093]** Those areas that allow the second space 202 to communicate with the external space will be hereinafter referred to as the "second openings 204."

**[0094]** The intermediate plate 28 has sound emission holes 281 which allow the first space 201 to communicate with the second space 202.

**[0095]** Each of the sound emission holes 281 is a hole (i.e., an opening) for propagating the sound, which has been emitted by the sound emission unit 15 and then propagated to the second space 202, to the first space 201.

**[0096]** The sound thus propagated to the first space 201 through the sound emission holes 281 is propagated to the external space through the first openings 203.

**[0097]** The second space 202 has surrounding walls 267 surrounding a sound emission path which leads from

the sound emission unit 15 to the sound emission holes 281.

**[0098]** The surrounding walls 267 will be described later.

(2-7-2) Bottom plate unit and intermediate plate unit

**[0099]** As shown in FIGS. 3-5B, in this embodiment, the cover portion 22 includes a bottom plate unit 41 and an intermediate plate unit 40.

**[0100]** As shown in FIGS. 6A and 6B, the bottom plate unit 41 includes an upper frame portion 42, respective first parts 261 of the plurality of cover supporting portions 26, an intermediate frame portion 43, and the bottom plate 27.

**[0101]** The upper frame portion 42 has the same circular ring shape as that of the body cylindrical portion 25 when viewed in plan.

**[0102]** For the upper frame portion 42, provided is a body attachment portion 421 to be removably attached to the lower attachment portion 251 provided at the lower end portion of the body cylindrical portion 25.

**[0103]** The first part 261 of each of the cover supporting portions 26 forms an outer part of the cover supporting portion 26 with respect to the center of the cover portion 22 when viewed in plan.

**[0104]** A plurality of first parts 261 are provided around the center of the cover portion 22 (i.e., arranged along the circumference of the cover portion 22) when viewed in plan.

**[0105]** In this embodiment, eight first parts 261 are arranged every 45 degrees along the circumference.

**[0106]** Each of the first parts 261 is formed integrally with the upper frame portion 42 to protrude downward from the upper frame portion 42.

**[0107]** The intermediate frame portion 43 has the same circular ring shape as that of the upper frame portion 42 when viewed in plan.

**[0108]** When viewed in plan, an inner edge portion of the intermediate frame portion 43 has its weight supported by the plurality of first parts 261 at respective intermediate portions thereof in the upward/downward direction.

**[0109]** The intermediate frame portion 43 is disposed at the same position (i.e., at the same level) as the intermediate plate 28 in the upward/downward direction.

**[0110]** Also, the intermediate frame portion 43 is disposed outside the intermediate plate 28 with respect to the center of the cover portion 22 when viewed in plan.

**[0111]** The bottom plate 27 is supported in suspension by the respective lower end portions of the first parts 261.

**[0112]** More particularly, the upper surface of a peripheral edge portion of the bottom plate 27 is connected to the respective lower end portions of the first parts 261 to be supported in suspension by the plurality of first parts 261.

**[0113]** The upper frame portion 42, the plurality of first parts 261, the intermediate frame portion 43, and the

bottom plate 27 that are the respective constituent members of the bottom plate unit 41 are formed integrally.

**[0114]** The first parts 261 will be described later in detail.

**[0115]** As shown in FIGS. 7A and 7B, the intermediate plate unit 40 includes respective second parts 262 of the cover supporting portions 26 and the intermediate plate 28.

**[0116]** The second part 262 of each of the cover supporting portions 26 forms an inner part of the cover supporting portion 26 with respect to the center of the cover portion 22 when viewed in plan.

**[0117]** A plurality of second parts 262 are provided along the circumference when viewed in plan.

**[0118]** In this embodiment, eight second parts 262 are arranged every 45 degrees along the circumference.

**[0119]** Each of the second parts 262 is formed integrally with the upper frame portion 42 to protrude downward from the upper frame portion 42.

**[0120]** The second parts 262 will be described later in detail.

**[0121]** The outer edge portion of the intermediate plate 28 when viewed in plan has its weight supported by the plurality of second parts 262 at respective intermediate portions thereof in the upward/downward direction.

**[0122]** In this embodiment, the second parts 262 are arranged within the outline of the intermediate plate 28 when viewed in plan.

**[0123]** The intermediate plate 28 is disposed at the same level as the intermediate frame in the upward/downward direction.

**[0124]** Also, the intermediate plate 28 is disposed inside the intermediate frame with respect to the center of the cover portion 22 when viewed in plan.

### (2-7-3) Light guide members

**[0125]** As shown in FIGS. 5A, 5B, and 8, each of the light guide members 29 is configured as a member extending in the first direction.

**[0126]** The light guide member 29 is made of a transparent resin such as an acrylic resin but may also be made of a non-resin material such as glass.

**[0127]** The material for the light guide member 29 is not limited to any particular material.

**[0128]** The light guide member 29 has a rectangular shape on a cross section (horizontal cross section) thereof intersecting at right angles with the upward/downward direction.

**[0129]** In this embodiment, a plurality of light guide members 29 are provided for the housing 2 along the circumference.

**[0130]** More specifically, two light guide members 29 are arranged at regular intervals along the circumference of an outer edge portion inside the housing 2.

**[0131]** That is to say, the two light guide members 29 are arranged to face each other along the circumference of the outer edge portion inside the housing 2.

**[0132]** One end surface, facing the installation surface (on the upper side in this embodiment), of the light guide member 29 serves as the incident surface 291 on which the light emitted from the light source unit 16 is incident.

**[0133]** Also, the other end surface, facing away from the installation surface (on the lower side in this embodiment), of the light guide member 29 serves as the emerging surface 292 from which the light that has entered the light guide member 29 emerges.

**[0134]** The rest of the surfaces of the light guide member 29 other than the incident surface 291 and the emerging surface 292 serves as the side surfaces 293 of the light guide member 29.

**[0135]** The light that has entered the light guide member 29 through the incident surface 291 travels toward the emerging surface 292 while being reflected from the side surfaces 293 of the light guide member 29.

**[0136]** Then, most of the light emerges from the emerging surface 292.

**[0137]** Meanwhile, part of the light that has entered the light guide member 29 through the incident surface 291 emerges from the side surfaces 293.

**[0138]** The incident surface 291 and the emerging surface 292 are not covered by other members at all but exposed.

**[0139]** As shown in FIGS. 2 and 9, the emerging surface 292 is exposed downward through a light guide hole 271 provided through the bottom plate 27.

**[0140]** The respective side surfaces 293 of each of the light guide members 29 are covered by a corresponding one of the cover supporting portions 26.

**[0141]** In this embodiment, each of the cover supporting portions 26 has the first part 261 and the second part 262.

**[0142]** Each of the light guide members 29 is interposed between the first part 261 and the second part 262.

**[0143]** The first part 261 includes a first cover portion 263 covering a surface 294 facing outward which belongs to four side surfaces 293 of the light guide member 29 having the shape of a rectangle when viewed in plan.

**[0144]** The second part 262 includes a second cover portion 264 covering a surface 295 facing inward and two surfaces 296, 296 facing the circumference direction, all of which belong to four side surfaces 293 of the light guide member 29 having the shape of a rectangle when viewed in plan.

**[0145]** The internal space 20 of the second cover portion 264 serves as a housing space for the light guide member 29.

**[0146]** The housing space for the light guide member 29 is opened both upward and downward.

**[0147]** The incident surface 291 and emerging surface 292 of each of the light guide members 29 are not covered by the second part 262.

**[0148]** On the other hand, all the four side surfaces 293 of each of the light guide members 29 are covered by the cover supporting portion 26.

**[0149]** This reduces the chances of part of the light

emerging from the side surfaces 293 of the light guide member 29 irradiating the inside of the housing 2 to eventually leak out of the housing 2.

**[0150]** The light guide member 29 is provided with an attachment portion 297 protruding from a peripheral portion of one of the side surfaces 293 thereof.

**[0151]** Also, the second part 262 of the intermediate plate unit 40 is provided with a groove 266 into which the attachment portion 297 is insertable.

**[0152]** The attachment portion 297 of the light guide member 29 is inserted into the groove 266 of the second part 262.

**[0153]** Specifically, the attachment portion 297 having the shape of a bar protruding in the circumferential direction is provided on one of the two surfaces, facing the circumferential direction, of the light guide member 29.

**[0154]** For the second part 262, provided integrally is a groove member 265, housing the attachment portion 297 and having the groove 266 therein, to protrude in the circumferential direction.

**[0155]** This allows the second part 262 to support the lower surface of the attachment portion 297 of the light guide member 29 using the inner surface of the groove member 265 even though there is no portion for supporting the lower surface of the light guide member 29 (i.e., the emerging surface 292).

#### (2-8) Detection units

**[0156]** As shown in FIGS. 3, 4, 9, and 10, the detection units 12 are arranged inside the housing 2.

**[0157]** In this embodiment, the sensor 1 includes a smoke detection unit 13 and a heat detection unit 14 serving as the detection units 12.

#### (2-9) Smoke detection unit

**[0158]** The smoke detection unit 13 is disposed inside the housing 2.

**[0159]** Specifically, the smoke detection unit 13 is disposed inside the second space 202.

**[0160]** As shown in FIG. 11, the smoke detection unit 13 includes a detection cover 131.

**[0161]** The detection cover 131 has the shape of a bottomed cylinder and has a bottom wall 132.

**[0162]** The bottom wall 132 is a plate member, which is substantially circular when viewed in plan.

**[0163]** That is to say, the detection cover 131 has the shape of a bottomed cylinder.

**[0164]** The lower end portion of the smoke detection unit 13 is inserted into a smoke detection unit hole 283 (refer to FIG. 3) provided through the intermediate plate 28.

**[0165]** The smoke detection space 130 is a space surrounded with the detection cover 131 inside the housing 2.

**[0166]** The smoke detection unit 13 is arranged inside the housing 2 to detect smoke in the smoke detection

space 130.

**[0167]** The smoke detection unit 13 includes a light-emitting unit 134 and a photodetector unit 135 and is a photoelectric type.

**[0168]** As used herein, the adjective "photoelectric" refers to a scheme for sensing, using the light-emitting unit 134 and the photodetector unit 135, smoke based on a variation in the quantity of either light reflected from the smoke in the smoke detection space 130 or light transmitted through the smoke detection space 130.

**[0169]** In this embodiment, the light-emitting unit 134 emits light toward the smoke detection space 130.

**[0170]** The photodetector unit 135 is disposed at a position where the light emitted from the light-emitting unit 134 is not incident directly but the light scattered by the smoke in the smoke detection space 130 is incident.

**[0171]** Thus, when no smoke is present in the smoke detection space 130, the photodetector unit 135 does not receive the light emitted from the light-emitting unit 134.

**[0172]** On the other hand, when any smoke is present in the smoke detection space 130, the photodetector unit 135 receives the light emitted from the light-emitting unit 134 and scattered by the smoke (i.e., receives the scattered light).

**[0173]** This allows the sensor 1 to sense the presence of smoke in the smoke detection space 130 depending on whether or not the photodetector unit 135 receives any light.

**[0174]** In addition, the quantity of light received by the photodetector unit 135 also varies according to the concentration of the smoke in the smoke detection space 130 and the type of the smoke (e.g., whether the smoke is white smoke or black smoke).

**[0175]** The photodetector unit 135 supplies an output signal, representing the quantity of the light received, to a control circuit 181 of the board 18.

**[0176]** The detection cover 131 has a plurality of inlet ports 133, each of which lets the smoke flow into the inside of the detection cover 131 (i.e., into the smoke detection space 130).

**[0177]** This allows the smoke to flow through the plurality of inlet ports 133 into the smoke detection space 130 from the outside of the detection cover 131.

**[0178]** In this embodiment, a labyrinth structure 136 is provided inside the detection cover 131.

**[0179]** The labyrinth structure 136 is a set of small pieces which are arranged inside the detection cover 131 in an annular pattern along the circumference of the detection cover 131 so as to surround the smoke detection space 130.

**[0180]** The labyrinth structure 136 allows smoke to be taken in the smoke detection space 130 from the outside of the detection cover 131 and through the gaps between the plurality of small pieces.

#### (2-10) Board

**[0181]** As shown in FIG. 9, the sensor 1 includes a

board 18 (circuit board) and a plurality of electronic components including switches.

**[0182]** The plurality of electronic components are assembled together on the board 18.

**[0183]** To an electrical conductor portion of the board 18, electrically connected are the light-emitting unit 134 and photodetector unit 135 of the smoke detection unit 13.

**[0184]** The board 18 includes a control circuit 181 (refer to FIG. 13) made up of a plurality of electronic components.

**[0185]** The control circuit 181 is a circuit provided for the board 18 to control the light-emitting unit 134, the photodetector unit 135, and other units, drives at least the light-emitting unit 134, and performs signal processing on the output signal of the photodetector unit 135.

**[0186]** When performing the signal processing, the control circuit 181 compares the quantity of light received by the photodetector unit 135 (i.e., the magnitude of its output signal) with a threshold value, thereby determining whether or not any smoke is present in the smoke detection space 130.

**[0187]** When finding the quantity of light received by the photodetector unit 135 equal to or greater than a threshold value, the control circuit 181 determines that smoke, of which the concentration is equal to or higher than a certain value, should be present in the smoke detection space 130.

**[0188]** On determining that smoke, of which the concentration is equal to or higher than the certain value, should be present in the smoke detection space 130, the control circuit 181 outputs, to the emission unit

, an electrical signal for driving an emission unit (not shown) which is electrically connected to the electrical conductor portion of the board 18

#### (2-11) Heat detection unit

**[0189]** As shown in FIGS. 3 and 4, the heat detection unit 14 is disposed inside the housing 2.

**[0190]** Specifically, the heat detection unit 14 is disposed inside the first space 201.

**[0191]** To the electrical conductor portion of the board 18, electrically connected is a temperature sensor serving as the heat detection unit 14.

**[0192]** The temperature sensor is implemented as a lead-type thermistor for detecting the heat of a gas which flows in through the first openings 203, for example.

**[0193]** The temperature sensor is connected to the lower surface of the board 18.

**[0194]** Specifically, a lead wire of the temperature sensor extends to the first space 201 through a lead wire insert hole 282 provided through the intermediate plate 28 so that the temperature sensor connected to the tip of the lead wire may be located in the first space 201.

#### (2-12) Sound emission unit

**[0195]** The sound emission unit 15 is disposed inside the housing 2.

**[0196]** Specifically, the sound emission unit 15 is electrically connected to the electrical conductor portion of the board 18.

**[0197]** On receiving the electrical signal from the control circuit 181, the sound emission unit 15 emits a sound.

**[0198]** That is to say, when finding the quantity of the light received by the photodetector unit 135 equal to or greater than a threshold value, the sensor 1 makes the sound emission unit 15 emit a sound.

**[0199]** The sound emission unit 15 may be implemented as, for example, a loudspeaker or buzzer for converting the electrical signal into the sound.

**[0200]** Specifically, the sound emission unit 15 is electrically connected to the electrical conductor portion of the board 18.

**[0201]** The sound emitted from the sound emission unit 15 is propagated to the second space 202. The sound emission path that leads from the sound emission unit 15 to the sound emission holes 281 is surrounded with surrounding walls 267, which makes it less easy for the sound propagated to the second space 202 to go out through the second openings 204.

**[0202]** The sound that has been propagated to the second space 202 to reach the sound emission holes 281 is propagated to the first space 201 through the sound emission holes 281 to go out of the housing 2 through the first openings 203.

**[0203]** The present inventor discovered, via experiments, that when the sound went out of the housing 2 through the first openings 203, the sound pressure under the bottom plate 27 was higher than in a situation where the sound went out of the housing 2 through the second openings 204.

**[0204]** This is partly because in the situation where the sound goes out of the housing 2 through the second openings 204, some components of the sound going out of the housing 2 through the second openings 204 would enter the first space 201 through the first openings 203 and then go out again through the first openings 203.

**[0205]** Those components of the sound going out again through the first openings 203 would be cancelled by some components of the sound going out through the second openings 204, which would cause a decrease in the sound pressure under the bottom plate 27.

**[0206]** In addition, the surrounding walls 267 have a longitudinal axis which extends toward the smoke detection unit 3.

**[0207]** The surrounding walls 267 serve as a guide for guiding the smoke that has flowed into the second space 202 to the smoke detection unit 3.

#### (2-13) Light source units

**[0208]** As shown in FIG. 9, the light source units 16 are

arranged inside the housing 2.

**[0209]** To the electrical conductor portion of the board 18, electrically connected are light emitting elements serving as the light source units 16.

**[0210]** The light emitting elements are implemented as, for example, LEDs (Light Emitting Diodes) and are mounted on the lower surface of the board 18 to be ready to emit light downward.

### (3) Disaster prevention system

**[0211]** As shown in FIG. 12, the disaster prevention system 5 includes the sensors 1, the receiver 6, and the repeaters 7.

**[0212]** The receiver 6 establishes communications with the sensors 1 to receive the results of detection obtained by the detection units 12 thereof.

**[0213]** The repeaters 7 relay the communications between the sensors 1 and the receiver 6.

**[0214]** The receiver 6 and repeaters 7 according to this embodiment are connected to each other via a transmission cable 51 of a two-wire system.

**[0215]** The receiver 6 communicates, via a wired connection, with the repeaters 7 through the transmission cable 51.

**[0216]** Alternatively, the disaster prevention system 5 may also be configured to cause the receiver 6 to communicate with the repeaters 7 by wireless communication via radio waves.

**[0217]** The disaster prevention system 5 according to this embodiment includes a plurality of repeaters 7 (e.g., three in the example illustrated in FIG. 12).

**[0218]** Also, with each of the plurality of repeaters 7, registered are the plurality of sensors 1.

**[0219]** The plurality of repeaters 7 communicate wirelessly with their corresponding sensors 1 via mutually different channels.

**[0220]** Therefore, each of the sensors 1 communicates wirelessly only with a corresponding one of the plurality of repeaters 7.

### (3-1) Configuration for receiver

**[0221]** As shown in FIG. 14, the receiver 6 includes a communications unit 61, a display unit 62, an operating unit 63, a sound input unit 64, a sound emission unit 65, a processing unit 66, and a storage unit 67.

**[0222]** The communications unit 61 includes a communication interface used for establishing a wired communication which is to be connected to the transmission cable 51.

**[0223]** The communications unit 61 is connected to the plurality of repeaters 7 via the transmission cable 51.

**[0224]** The display unit 62 includes, for example, a liquid crystal display, a display lamp, a seven-segment display.

**[0225]** The display unit 62 may display a variety of information.

**[0226]** The operating unit 63 includes various devices which accept an operating command entered by the user (administrator of a facility) of the disaster prevention system 5.

**[0227]** The sound input unit 64 receives the input of a sound in a surrounding environment.

**[0228]** The sound emission unit 65 includes, for example, a loudspeaker to output various types of sounds.

**[0229]** The sound emission unit 65 outputs an artificial voice, a beep sound, or any other type of sound stored in memory on receiving a fire signal from any one of the sensors 1, for example.

**[0230]** The storage unit 67 stores a variety of information.

**[0231]** The storage unit 67 may be a semiconductor memory such as a ROM (Read-Only Memory), a RAM (Random-Access Memory), or an EEPROM (Electrically Erasable Programmable Read-Only Memory).

**[0232]** The processing unit 66 may be implemented as, for example, a computer system including one or more processors (microprocessors) and one or more memories.

**[0233]** The processing unit 66 controls the operation of the receiver 6.

**[0234]** The processing unit 66 receives the fire signal from any one of the sensors 1 via the corresponding one of repeaters 7.

**[0235]** That is to say, the processing unit 66 controls the communications unit 61 to communicate with the sensors 1, thus receiving the result of sensing of any disaster.

**[0236]** The processing unit 66 causes the display unit 62 and the sound emission unit 65 to call an alert when detecting any abnormality in any of the sensors 1.

### (3-2) Configuration for repeaters 7

**[0237]** As shown in FIG. 15, each of the plurality of repeaters 7 includes a first communications unit 71, a second communications unit 72, a storage unit 73, and a processing unit 74.

**[0238]** The first communications unit 71 includes a communication interface used for establishing a wireless communication with an external device (i.e., the sensor 1).

**[0239]** The first communications unit 71 includes, for example, an antenna and a communication circuit.

**[0240]** The second communications unit 72 includes a communication interface used for establishing a wired communication which is to be connected to the transmission cable 51.

**[0241]** The second communications unit 72 is connected to the receiver 6 via the transmission cable 51.

**[0242]** The storage unit 73 stores a variety of information.

**[0243]** The storage unit 73 may be a semiconductor memory such as a ROM, a RAM, or an EEPROM.

**[0244]** The processing unit 74 may be implemented as,

for example, a computer system including one or more processors (microprocessors) and one or more memories.

**[0245]** The processing unit 74 controls the operation of the repeater 7.

**[0246]** That is to say, the processing unit 74 controls the operations of the first communications unit 71, the second communications unit 72, and the storage unit 73.

**[0247]** The processing unit 74 controls the first communications unit 71 and the second communications unit 72 to receive a fire signal from the sensors 1 registered in advance and transmit the fire signal thus received to the receiver 6.

**[0248]** Also, the processing unit 74 according to this embodiment controls the first communications unit 71 and the second communications unit 72 to receive abnormality information from the sensor 1 and transmit the abnormality information thus received to the receiver 6.

**[0249]** In addition, the processing unit 74 according to this embodiment controls the first communications unit 71 and the second communications unit 72 to receive an instruction signal from the receiver 6 and transmit the instruction signal thus received to the sensor 1.

### (3-3) Configuration for sensors

**[0250]** As shown in FIG. 13, each of the sensors 1 includes the detection unit 12, a communications unit 81, a storage unit 82, an operating unit 83, an alert unit 84 (which corresponds to the sound emission unit 15 according to this embodiment), and a processing unit 85.

**[0251]** The communications unit 81 includes a communication interface used for establishing a wireless communication with another device (namely, the repeater 7 or another sensor 1).

**[0252]** The storage unit 82 stores a variety of information.

**[0253]** The storage unit 82 may be a semiconductor memory such as a ROM, a RAM, or an EEPROM.

**[0254]** The operating unit 83 accepts an operating command entered by the user.

**[0255]** The operating unit 83 includes an operating button to be operated by the user, for example.

**[0256]** The operating button according to this embodiment includes an informing button.

**[0257]** When the informing button is pushed by the user, the sensor 1 informs the user of its own identification information.

**[0258]** The alert unit 84 provides the user with a variety of information under the control of an alert controller 88 of the processing unit 85.

**[0259]** The alert unit 84 alerts the user to the outbreak of a disaster when a disaster detector 86 detects the outbreak of the disaster.

**[0260]** In this embodiment, the alert unit 84 includes a loudspeaker.

**[0261]** The alert unit 84 according to this embodiment emits a sound for alerting the user to the outbreak of a

disaster when the disaster detector 86 detects the outbreak of the disaster.

**[0262]** Examples of the sounds for alerting the user to the outbreak of a disaster include a voice for alerting the user to the outbreak of the disaster and an alarm sound.

**[0263]** Also, the alert unit 84 according to this embodiment emits a voice for informing the user of the identification information when an abnormality detector 87 detects any abnormality.

**[0264]** The alert unit 84 informs the user of the identification information in the form of an artificial voice, which makes it easier for the user to learn which sensor 1 has caused the abnormality.

**[0265]** The processing unit 85 may be implemented as, for example, a computer system including one or more processors (microprocessors) and one or more memories.

**[0266]** The processing unit 85 controls the operation of the sensor 1.

**[0267]** The processing unit 85 includes the disaster detector 86, the abnormality detector 87, and the alert controller 88.

**[0268]** The disaster detector 86 determines, based on a physical quantity (or the amount of change thereof) detected by the detection units 12, whether or not any disaster such as a fire has occurred.

**[0269]** The abnormality detector 87 detects any abnormality in the sensor 1.

**[0270]** The abnormality detector 87 according to this embodiment determines whether or not the resistance value of a thermistor of the detection unit 12 falls within a predetermined range.

**[0271]** If the resistance value of the thermistor falls outside of the predetermined range, the abnormality detector 87 detects the abnormality.

**[0272]** The alert controller 88 controls the operation of the alert unit 84.

**[0273]** The alert controller 88 according to this embodiment causes the alert unit 84 to inform the user of the identification information when the abnormality detector 87 has detected any abnormality and the instruction signal has been received from the receiver 6 via the repeater 7.

### (3-4) Operation of disaster prevention system

**[0274]** Next, the operation of the disaster prevention system 5 will be described.

**[0275]** On detecting its own abnormality, the sensor 1 transmits abnormality information to the corresponding one of the repeaters 7.

**[0276]** On receiving the abnormality information, the repeater 7 transmits the abnormality information thus received to the receiver 6.

**[0277]** On receiving the abnormality information from the repeater 7, the receiver 6 detects that the abnormality has occurred in the sensor 1 identified by the identification information included in the abnormality information.

**[0278]** The receiver 6 transmits, to the repeater 7, an instruction signal for causing the sensor 1, which has caused the abnormality, to alert the user to the occurrence of the abnormality.

**[0279]** On receiving the instruction signal from the receiver 6, the repeater 7 transmits the instruction signal thus received to the sensor 1 that has transmitted the abnormality information.

**[0280]** On receiving the instruction signal, the sensor 1 informs the user of its own identification number.

**[0281]** The sensor 1 regularly checks the liveness of a corresponding one of the repeaters 7. The sensor 1 transmits a check signal to the repeater 7.

**[0282]** If the repeater 7 does not receive the check signal from the sensor 1, the repeater 7 does not return a response signal to the sensor 1.

**[0283]** If the sensor 1 does not receive the response signal even when or after a predetermined time has passed since the sensor 1 transmitted the check signal, then the sensor 1 detects a communication error.

**[0284]** Also, as described above, the receiver 6 regularly checks the liveness of the repeaters 7. The receiver 6 transmits a check signal to each of the repeaters 7.

**[0285]** On receiving the check signal from the receiver 6, the repeater 7 transmits a response signal to the receiver 6.

**[0286]** In this case, if the repeater 7 has not confirmed the liveness of the sensor 1, the repeater 7 transmits, to the receiver 6, a response signal including the identification information of the sensor 1 of which the liveness has not been confirmed.

**[0287]** On receiving the response signal, the receiver 6 detects a communication error of the sensor 1 based on the identification information included in the response signal.

**[0288]** Then, the receiver 6 informs the user of the location in the facility at which the sensor 1, whose the liveness has not been confirmed, is installed.

**[0289]** The alert called by the sensor 1 allows the user to learn which sensor 1 has caused the abnormality and the location in the facility at which that sensor 1 is installed.

**[0290]** The user goes to the location at which the sensor 1 is installed to perform a predetermined operation on the operating unit 83.

**[0291]** On accepting the predetermined operation on the operating unit 83, the sensor 1 informs the user of its own identification information.

**[0292]** The user may learn, based on the information provided by the sensor 1, which sensor 1 has caused the abnormality.

(Variations)

**[0293]** In the embodiment described above, the sensor 1 includes the sensor body 10 and the sensor base 11.

**[0294]** However, the sensor 1 does not have to include the sensor base 11.

**[0295]** The housing 2 does not have to be a molded product made of a resin.

**[0296]** That is to say, the material for the housing 2 does not have to be a resin but may also be a metal, for example.

**[0297]** The base cover 110 does not have to have the shape of a circle when viewed in plan and its shape is not limited to any particular one.

**[0298]** The body portion 21 does not have to have the shape of a circle when viewed in plan and its shape is not limited to any particular one.

**[0299]** Also, the body portion 21 does not have to have a plate shape.

**[0300]** Alternatively, the body portion 21 may also have, for example, a frame shape and its shape is not limited to any particular one.

**[0301]** The base cover 110 may also be directly fixed to the installation surface.

**[0302]** In that case, there is no need to fix an attachment base to the installation surface.

**[0303]** The length of the first space 201 as measured in the first direction may also be equal to the length of the second space 202 as measured in the first direction.

**[0304]** Alternatively, the length of the first space 201 as measured in the first direction may also be less than the length of the second space 202 as measured in the first direction.

**[0305]** At least part of the smoke detection unit 13 needs to be disposed in the second space 202.

**[0306]** For example, only some of the inlet ports 133 of the smoke detection unit 13 may be disposed in the second space 202.

**[0307]** The intermediate plate 28 and the bottom plate 27 do not have to extend, in a strict sense of the word, in a direction (horizontal direction) intersecting at right angles with the upward/downward direction.

**[0308]** The cross-sectional shape of light guide members 29 does not have to be a rectangular shape and is not limited to any particular shape.

**[0309]** The number of the light guide members 29 provided does not have to be four and is not limited to any particular number.

**[0310]** A temperature sensor serving as the heat detection unit 14 may also be, for example, a thermocouple and is not limited to the thermistor.

**[0311]** The light emitting elements serving as the light source unit 16 do not have to be LEDs

**[0312]** The light emitted from a single light source unit 16 may also enter the plurality of light guide members 29 through their incident surface 291.

**[0313]** Furthermore, a sound emission hole may be provided through the bottom plate 27.

**[0314]** Surrounding walls, surrounding a sound path which leads from the sound emission holes 281 provided through the intermediate plate 28 to the sound emission hole provided through the bottom plate 27, may also be provided for the first space 201.

## (Recapitulation)

**[0315]** The exemplary embodiment and its variations described above provide specific implementations for the following aspects of the present disclosure.

**[0316]** A sensor (1) according to a first aspect includes a housing (2), a smoke detection unit (13), a heat detection unit (14), and a sound emission unit (15).

**[0317]** The housing (2) is to be mounted on an installation surface of a structure.

**[0318]** The smoke detection unit (13) is disposed inside the housing (2).

**[0319]** The heat detection unit (14) is disposed inside the housing (2).

**[0320]** The sound emission unit (15) is disposed inside the housing (2).

**[0321]** According to the first aspect, the sensor (1) is able to cause the sound emission unit (15) to call an alert upon detecting either smoke or heat.

**[0322]** In a sensor (1) according to a second aspect, which may be implemented in conjunction with the first aspect, the housing (2) includes: a body portion (21) supporting respective weights of the smoke detection unit (13), the heat detection unit (14), and the sound emission unit (15); and a cover portion (22).

**[0323]** The cover portion (22) extends, from the body portion (21), in a first orientation pointing away from the installation surface.

**[0324]** The cover portion (22) includes a plurality of cover supporting portions (26), an intermediate plate (28), and a bottom plate (27).

**[0325]** The plurality of cover supporting portions (26) extends in the first orientation from the body portion (21).

**[0326]** The intermediate plate (28) has its weight supported by the plurality of cover supporting portions (26) at respective intermediate portions of the plurality of cover supporting portions (26).

**[0327]** The bottom plate (27) has its weight supported by the plurality of cover supporting portions (26) at respective tips of the plurality of cover supporting portions (26).

**[0328]** The cover portion (22) has a first opening (203) which allows a first space (201) between the bottom plate (27) and the intermediate plate (28) to communicate with an external space.

**[0329]** The cover portion (22) has a second opening (204) which allows a second space (202) between the intermediate plate (28) and the body portion (21) to communicate with the external space.

**[0330]** The intermediate plate (28) has a sound emission hole (281) which allows the first space (201) to communicate with the second space (202).

**[0331]** The second aspect increases the pressure of a sound emitted from the sound emission unit (15) toward the space under the bottom plate (27).

**[0332]** In a sensor (1) according to a third aspect, which may be implemented in conjunction with the second aspect, the heat detection unit (14) is disposed in the

first space (201).

**[0333]** The smoke detection unit (13) is disposed in the second space (202).

**[0334]** The third aspect allows the smoke detection unit (13) and the heat detection unit (14) to be arranged with less severe constraint with respect to each other

**[0335]** In a sensor (1) according to a fourth aspect, which may be implemented in conjunction with the second or third aspect, the length of the first space (201) as measured in a first direction is greater than the length of the second space (202) as measured in the first direction.

**[0336]** The first direction is parallel to the first orientation.

**[0337]** The fourth aspect further increases the pressure of the sound emitted from the sound emission unit (15) toward the space under the bottom plate (27).

**[0338]** In a sensor (1) according to a fifth aspect, which may be implemented in conjunction with any one of the second to fourth aspects, the second space (202) has a surrounding wall (267) surrounding a sound emission path which leads from the sound emission unit (15) to the sound emission hole (281).

**[0339]** The surrounding wall (267) has a longitudinal axis when viewed in a first direction parallel to the first orientation.

**[0340]** The longitudinal axis extends toward the smoke detection unit (3).

**[0341]** According to the fifth aspect, the surrounding wall (267) serves as a guide for guiding the smoke that has flowed into the second space (202) to the smoke detection unit (3).

**[0342]** In a sensor (1) according to a sixth aspect, which may be implemented in conjunction with any one of the first to fifth aspects, the sensor (1) further includes a sensor base (11) to be mounted on the structure.

**[0343]** The housing (2) is attached to the sensor base (11).

**[0344]** The sixth aspect makes it easier to mount the sensor (1) on the structure.

**[0345]** A disaster prevention system (5) according to a seventh aspect includes the sensor (1) of any one of the first to sixth aspects, a receiver (6), and a repeater (7).

**[0346]** The receiver (6) establishes a communication with the sensor (1) to receive a result of detection obtained by the smoke detection unit (13) and the heat detection unit (14) of the sensor (1).

**[0347]** The repeater (7) relays the communication between the sensor (1) and the receiver (6).

**[0348]** According to the seventh aspect, the sensor (1) is able to cause the sound emission unit (15) to call an alert upon detecting either smoke or heat.

## Reference Signs List

**[0349]**

1      Sensor

|     |                            |    |    |                                                         |
|-----|----------------------------|----|----|---------------------------------------------------------|
| 11  | Sensor Base                |    |    | cover supporting portions; and                          |
| 13  | Smoke Detection Unit       |    |    | a first opening which causes a first space              |
| 14  | Heat Detection Unit        |    |    | between the bottom plate and the inter-                 |
| 15  | Sound Emission Unit        |    |    | mediate plate to communicate with an ex-                |
| 2   | Housing                    | 5  |    | ternal space, and                                       |
| 201 | First Space                |    |    | a second opening which causes a second                  |
| 202 | Second Space               |    |    | space between the intermediate plate and                |
| 203 | First Opening              |    |    | the body portion to communicate with the                |
| 204 | Second Opening             |    |    | external space, and                                     |
| 21  | Body Portion               | 10 |    |                                                         |
| 22  | Cover Portion              |    |    | the intermediate plate has a sound emission             |
| 24  | Body Supporting Portion    |    |    | hole which causes the first space to communi-           |
| 25  | Body Cylindrical Portion   |    |    | cate with the second space.                             |
| 26  | Cover Supporting Portion   |    |    |                                                         |
| 267 | Surrounding Wall           | 15 | 3. | The sensor of claim 2, wherein                          |
| 27  | Bottom Plate               |    |    |                                                         |
| 28  | Intermediate Plate         |    |    | the heat detection unit is disposed in the first        |
| 281 | Sound Emission Hole        |    |    | space, and                                              |
| 5   | Disaster Prevention System |    |    | the smoke detection unit is disposed in the sec-        |
| 6   | Receiver                   | 20 |    | ond space.                                              |
| 7   | Repeater                   |    |    |                                                         |
| L1  | Length                     |    | 4. | The sensor of claim 2 or 3, wherein                     |
| L2  | Length                     |    |    | a length of the first space as measured in a first      |
|     |                            |    |    | direction is greater than a length of the second space  |
|     |                            | 25 |    | as measured in the first direction, the first direction |
|     |                            |    |    | being parallel to the first orientation.                |

## Claims

### 1. A sensor comprising:

a housing to be mounted on an installation surface of a structure;  
a smoke detection unit disposed inside the housing;  
a heat detection unit disposed inside the housing; and  
a sound emission unit disposed inside the housing.

### 2. The sensor of claim 1, wherein the housing includes:

a body portion supporting respective weights of the smoke detection unit, the heat detection unit, and the sound emission unit; and  
a cover portion extending, from the body portion, in a first orientation pointing away from the installation surface,  
the cover portion includes:

a plurality of cover supporting portions extending in the first orientation from the body portion;  
an intermediate plate, a weight of which is supported by the plurality of cover supporting portions at respective intermediate portions of the plurality of cover supporting portions;  
a bottom plate, a weight of which is supported by the plurality of cover supporting portions at respective tips of the plurality of

### 5. The sensor of any one of claims 2 to 4, wherein

the second space has a surrounding wall surrounding a sound emission path which leads from the sound emission unit to the sound emission hole,  
the surrounding wall has a longitudinal axis when viewed in a first direction parallel to the first orientation, and  
the longitudinal axis extends toward the smoke detection unit.

### 6. The sensor of any one of claims 1 to 5, further comprising a sensor base to be mounted on the structure, the housing being attached to the sensor base.

### 7. A disaster prevention system comprising:

the sensor of any one of claims 1 to 6;  
a receiver configured to establish a communication with the sensor to receive a result of detection obtained by the smoke detection unit and the heat detection unit of the sensor; and  
a repeater configured to relay the communication between the sensor and the receiver.

FIG. 1

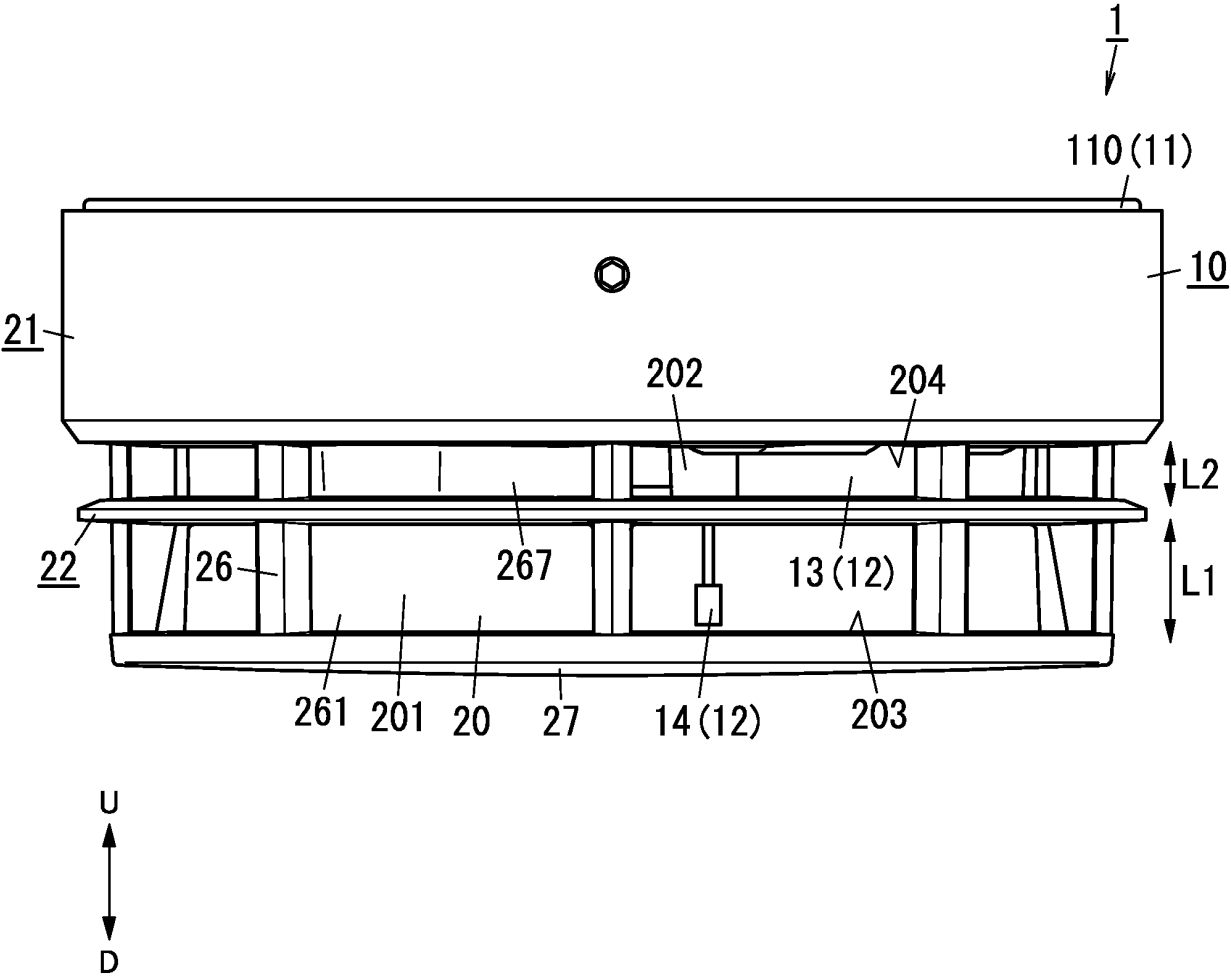


FIG. 2

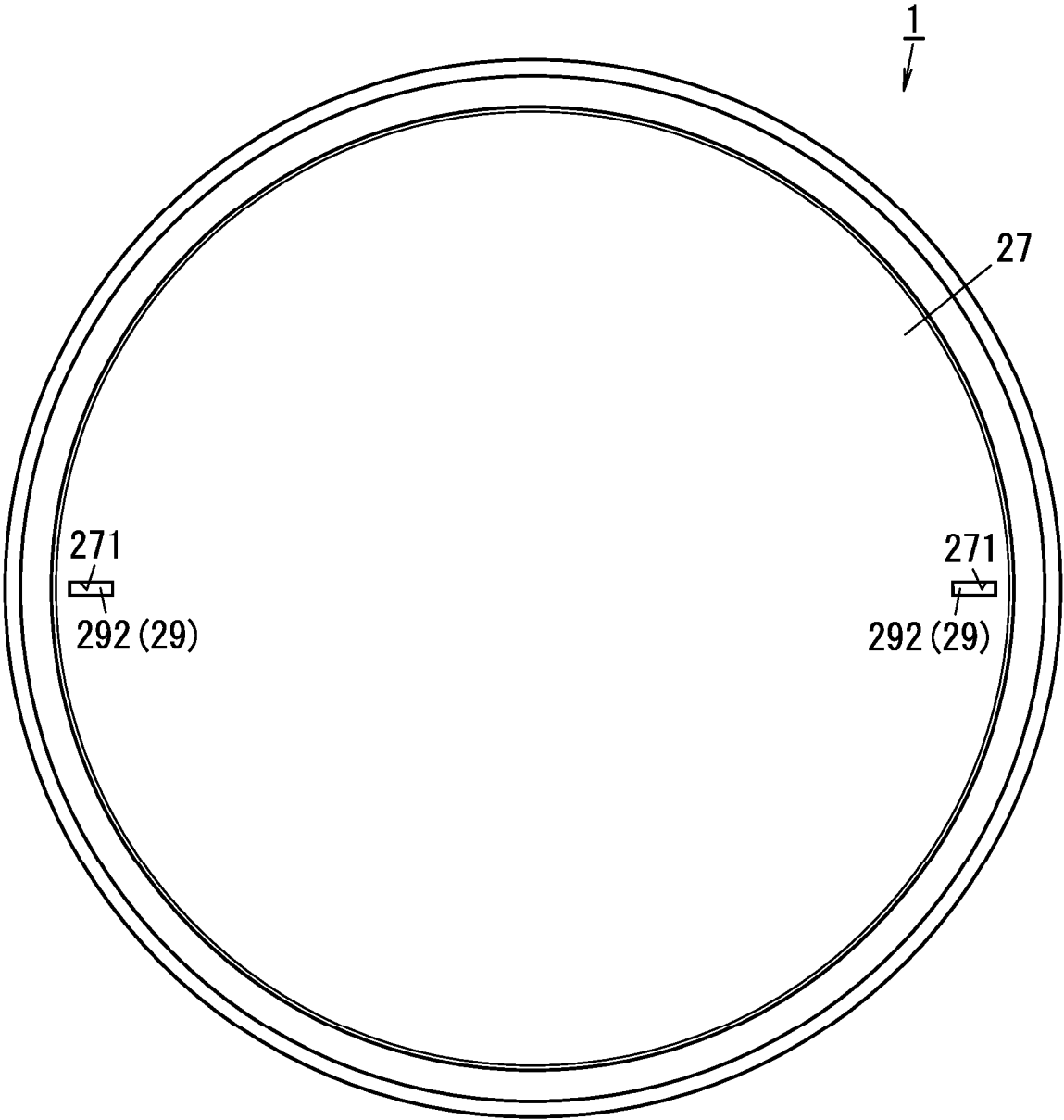


FIG. 3

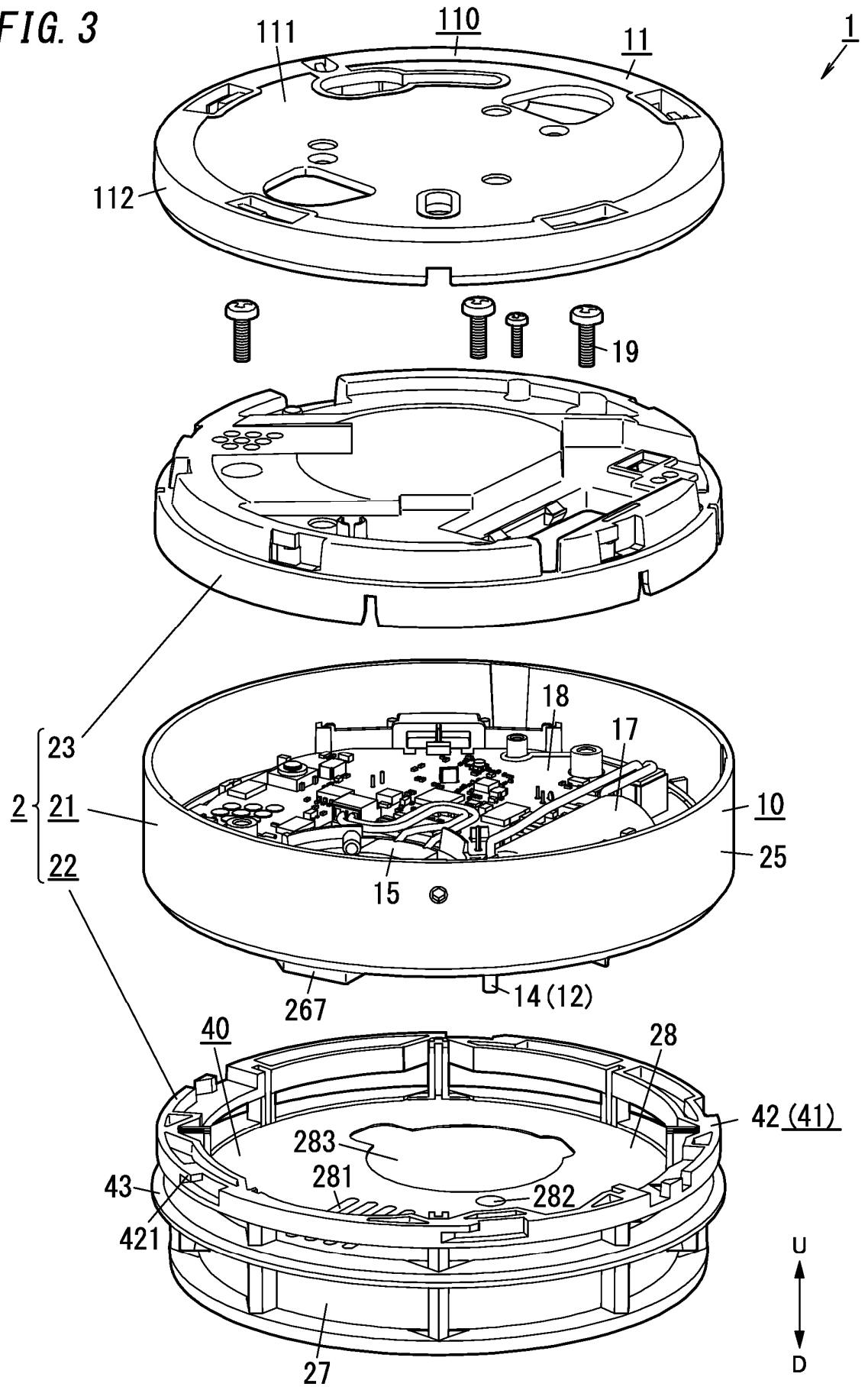


FIG. 4

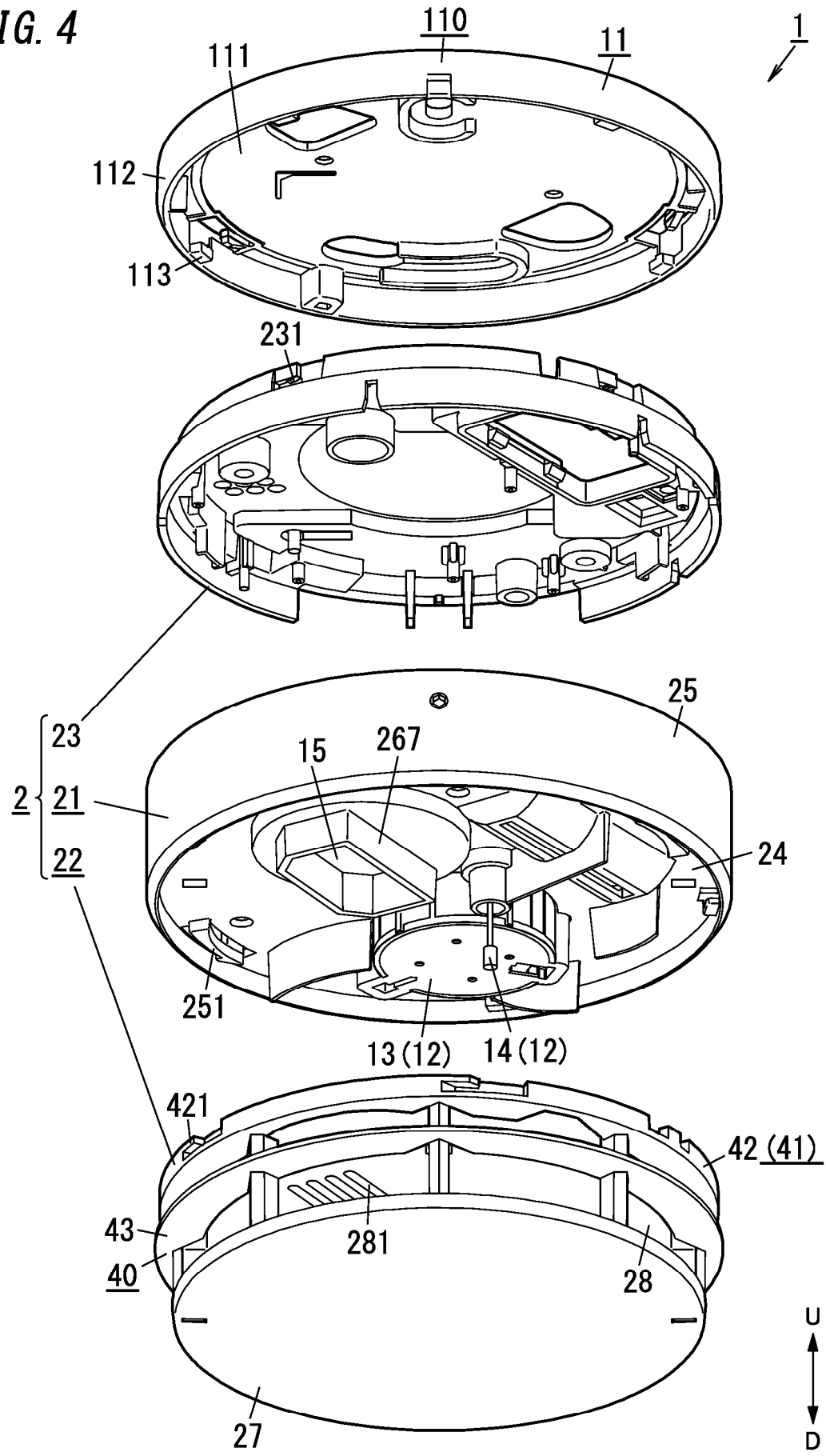


FIG. 5A

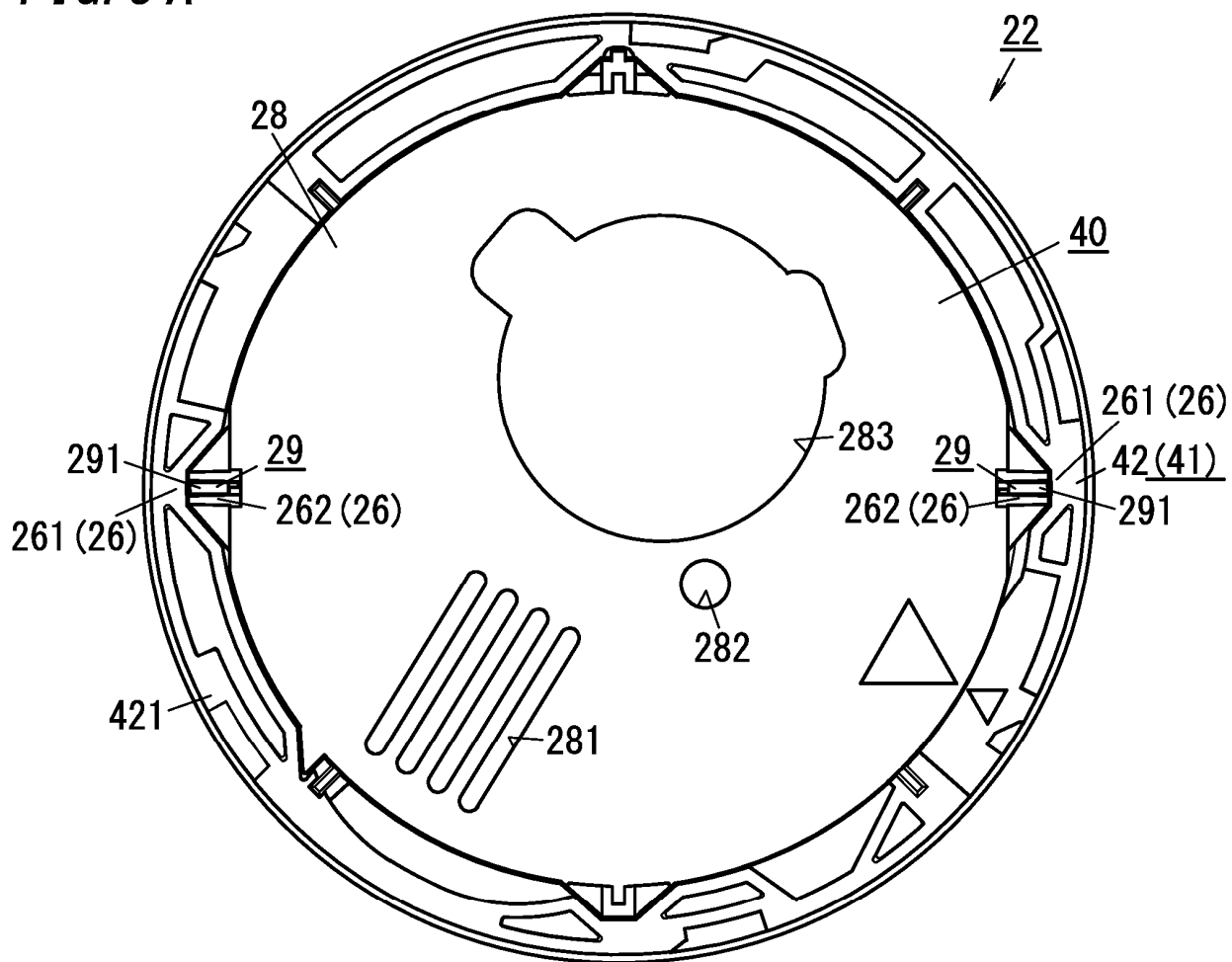


FIG. 5B

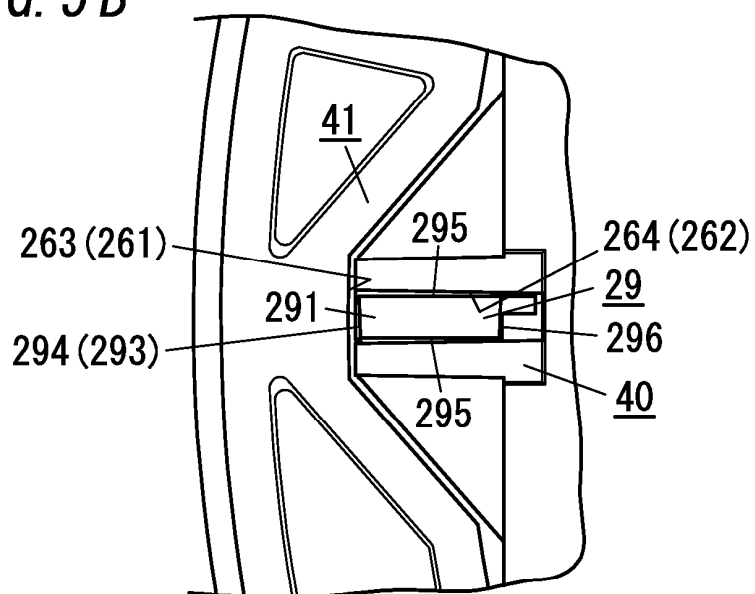


FIG. 6A

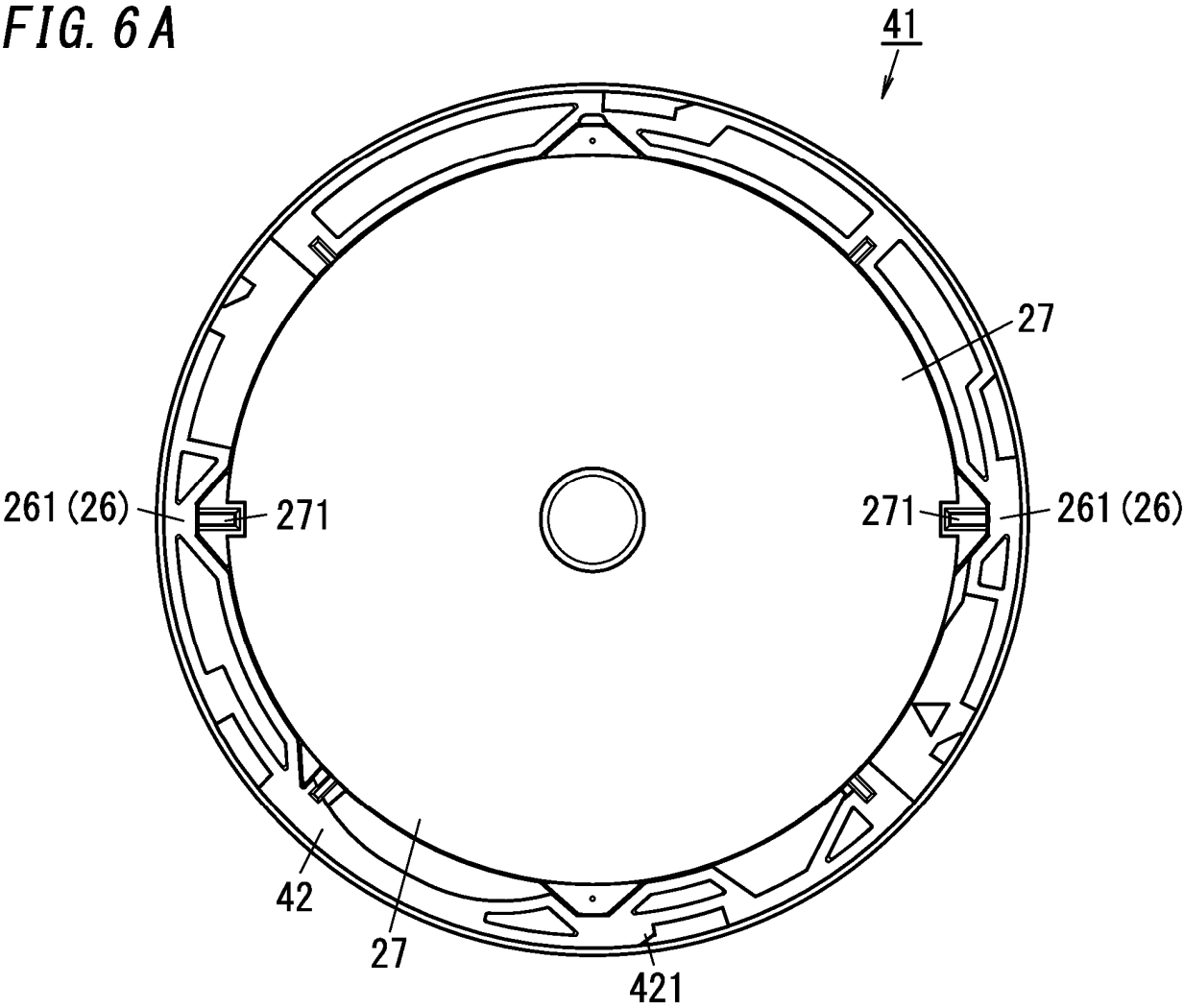


FIG. 6B

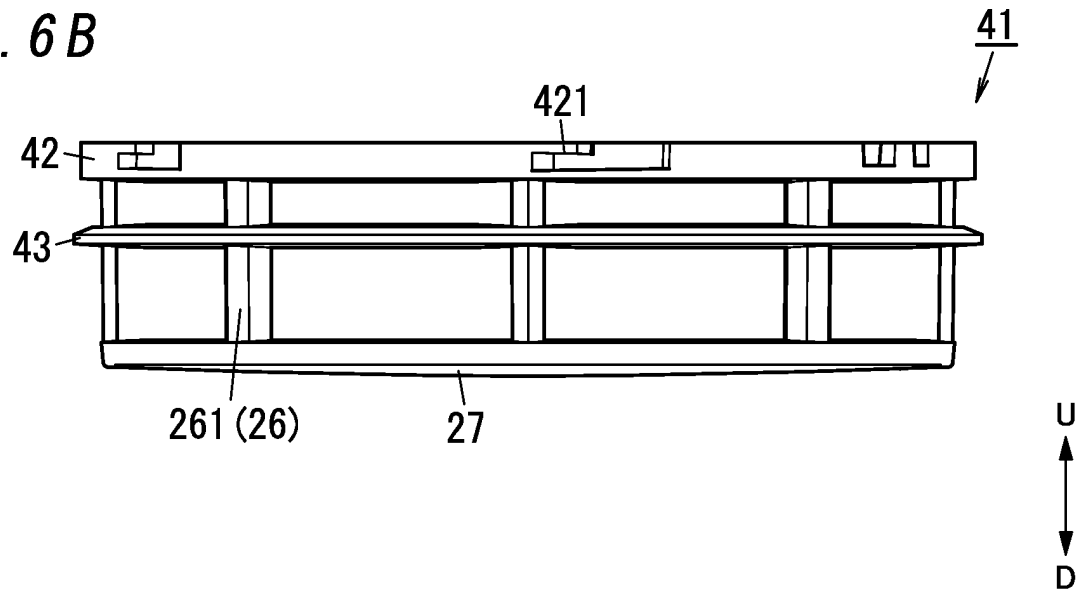


FIG. 7A

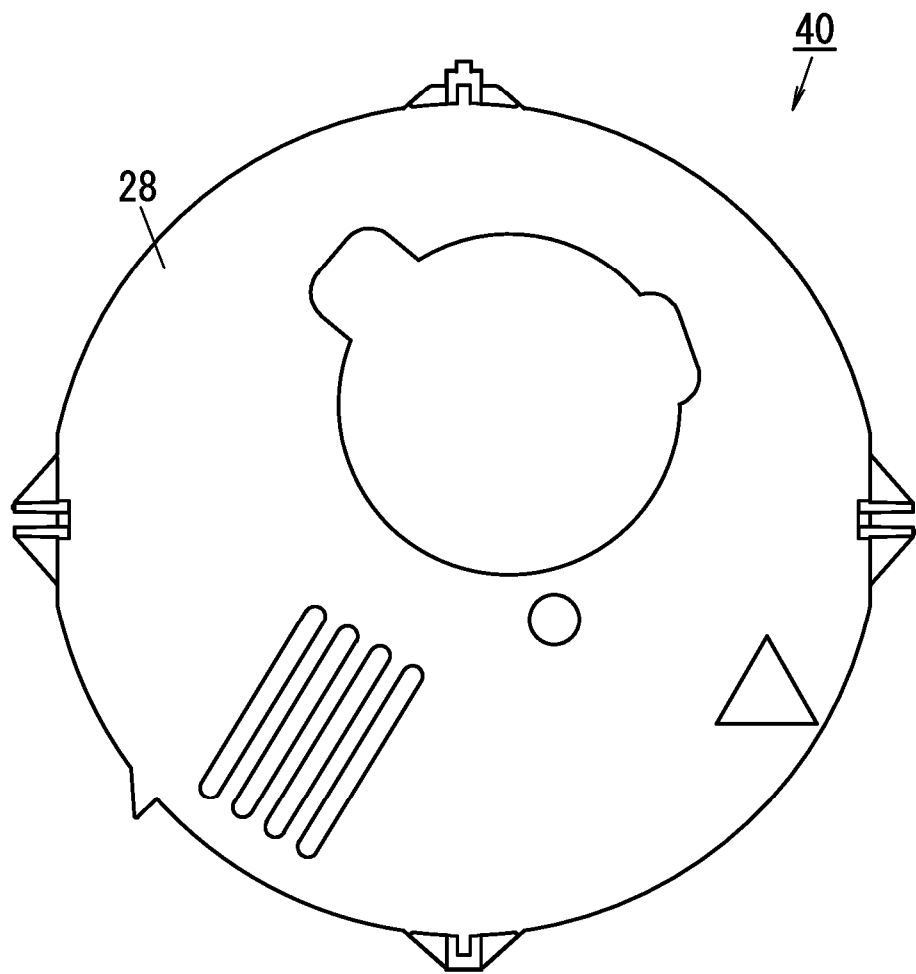
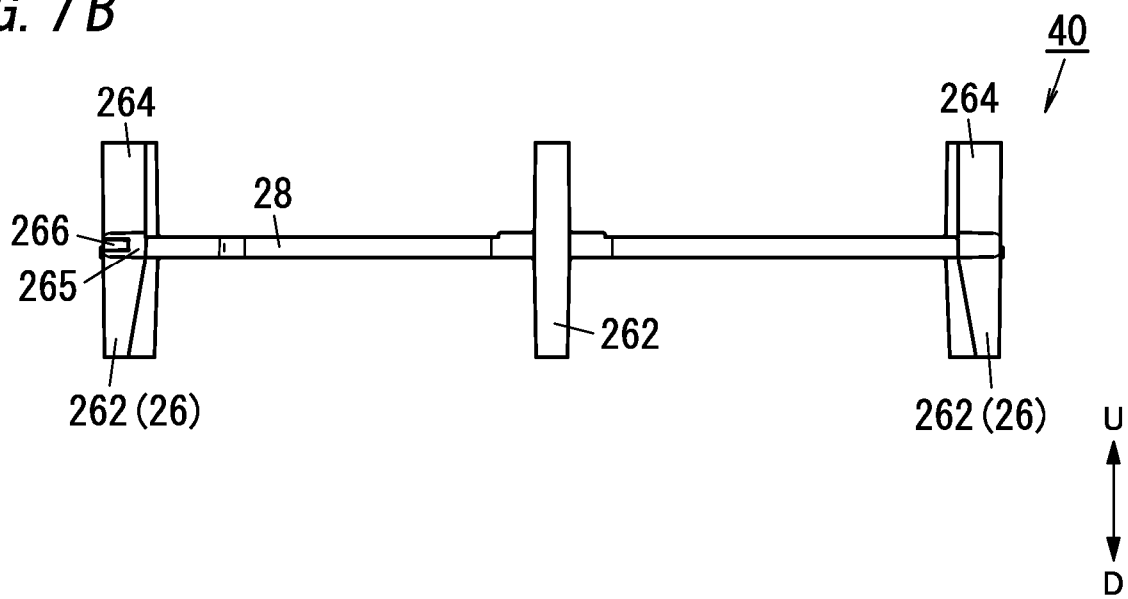
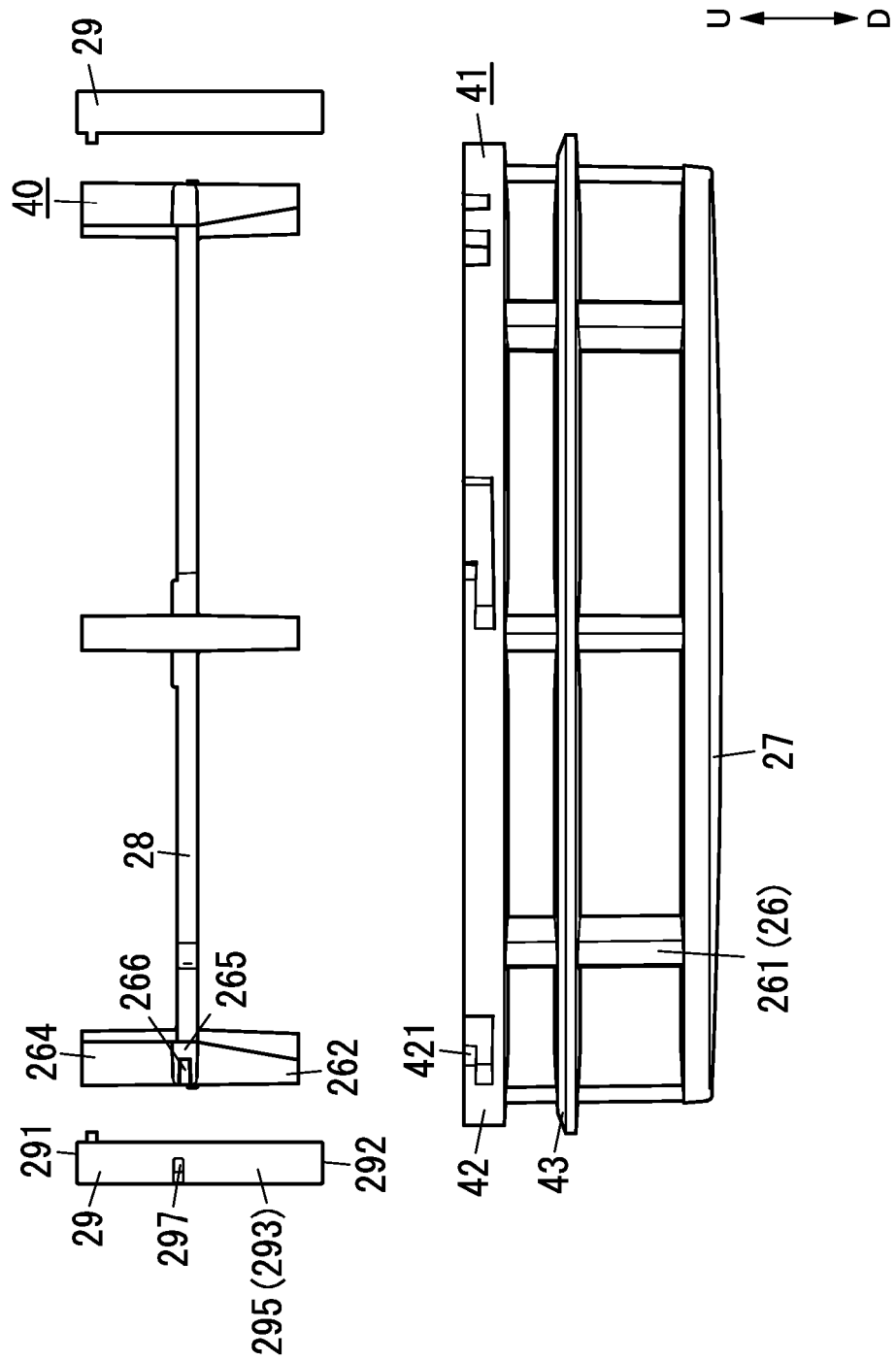


FIG. 7B



**FIG. 8**



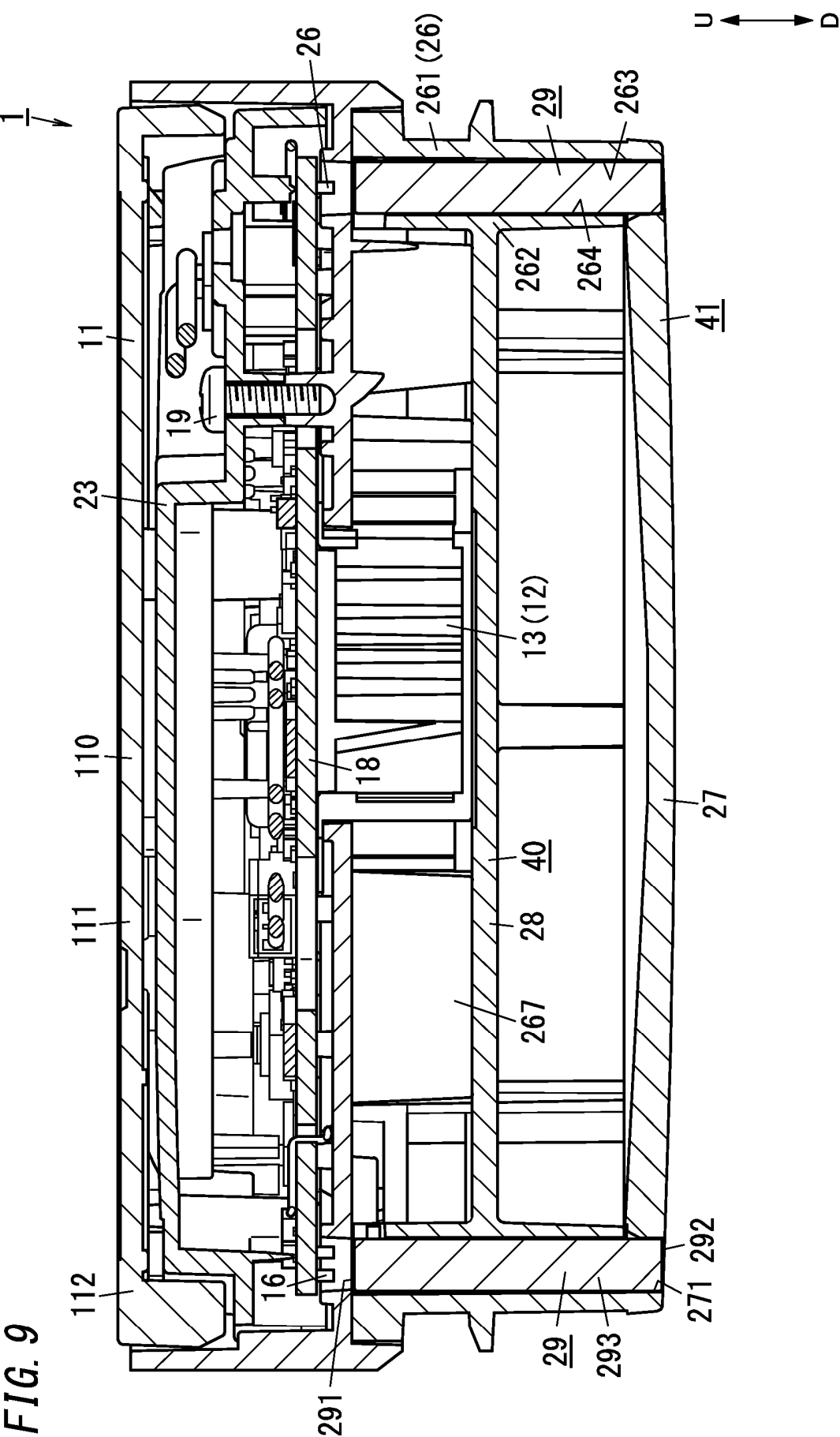


FIG. 10

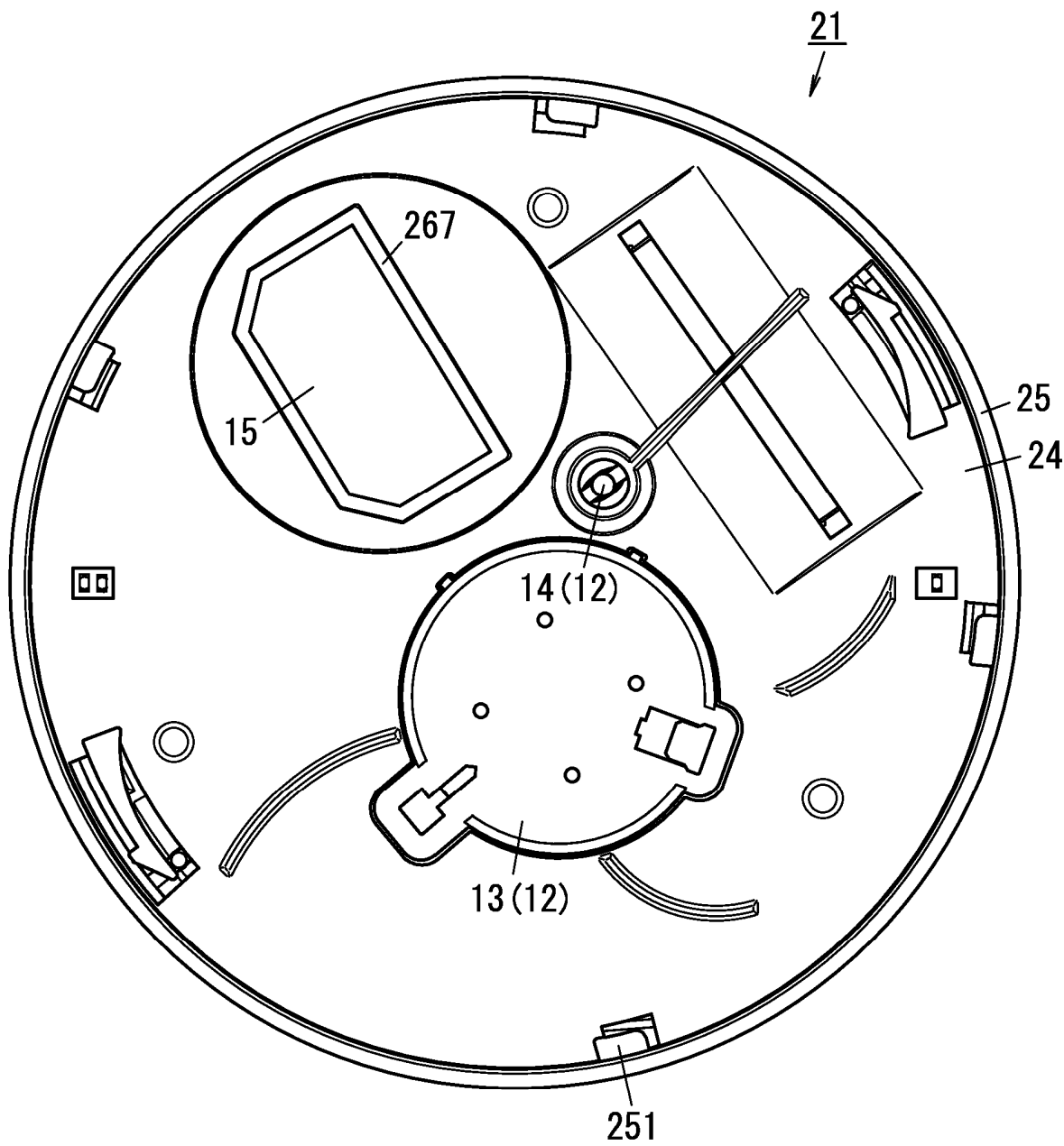


FIG. 11

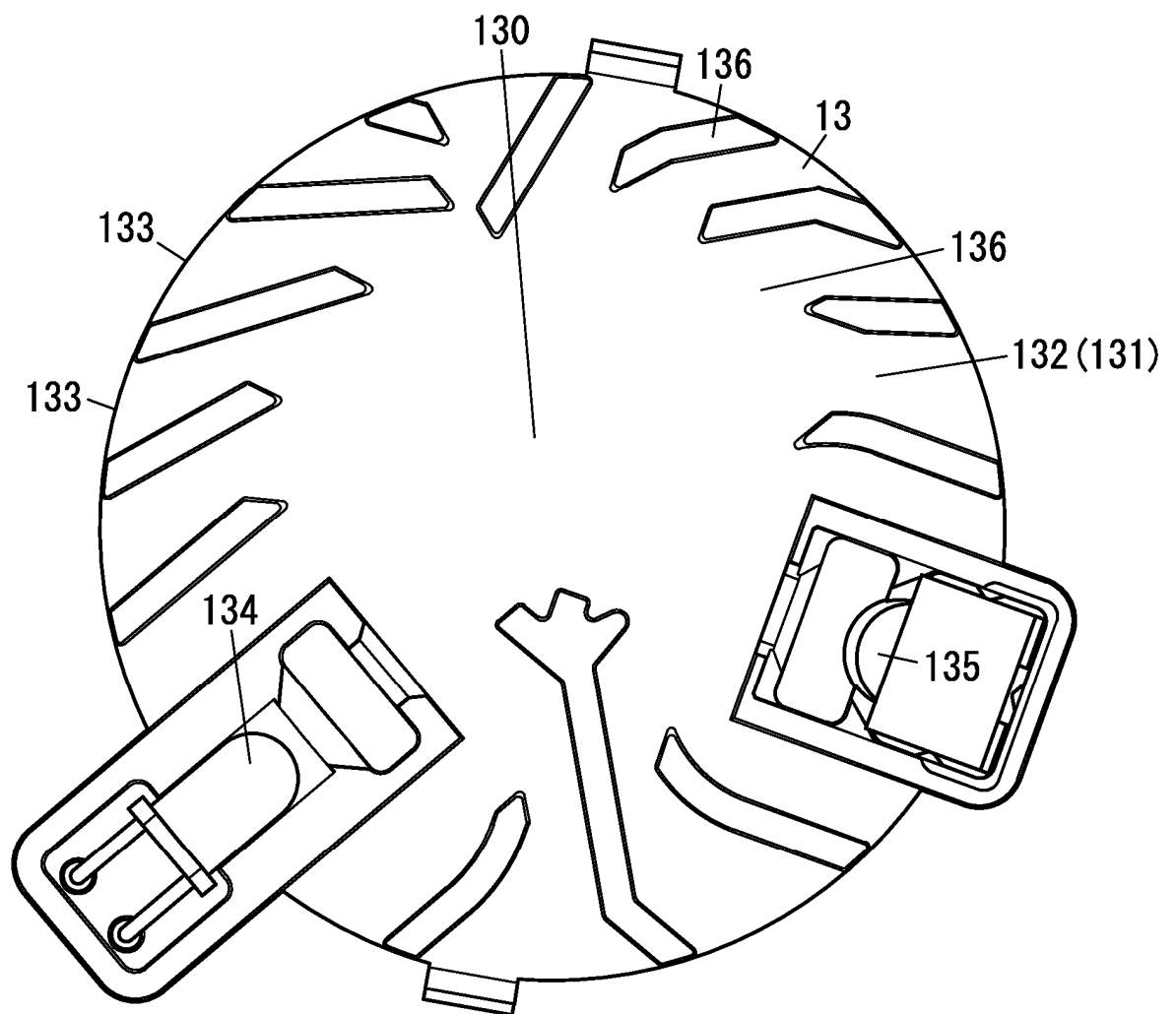


FIG. 12

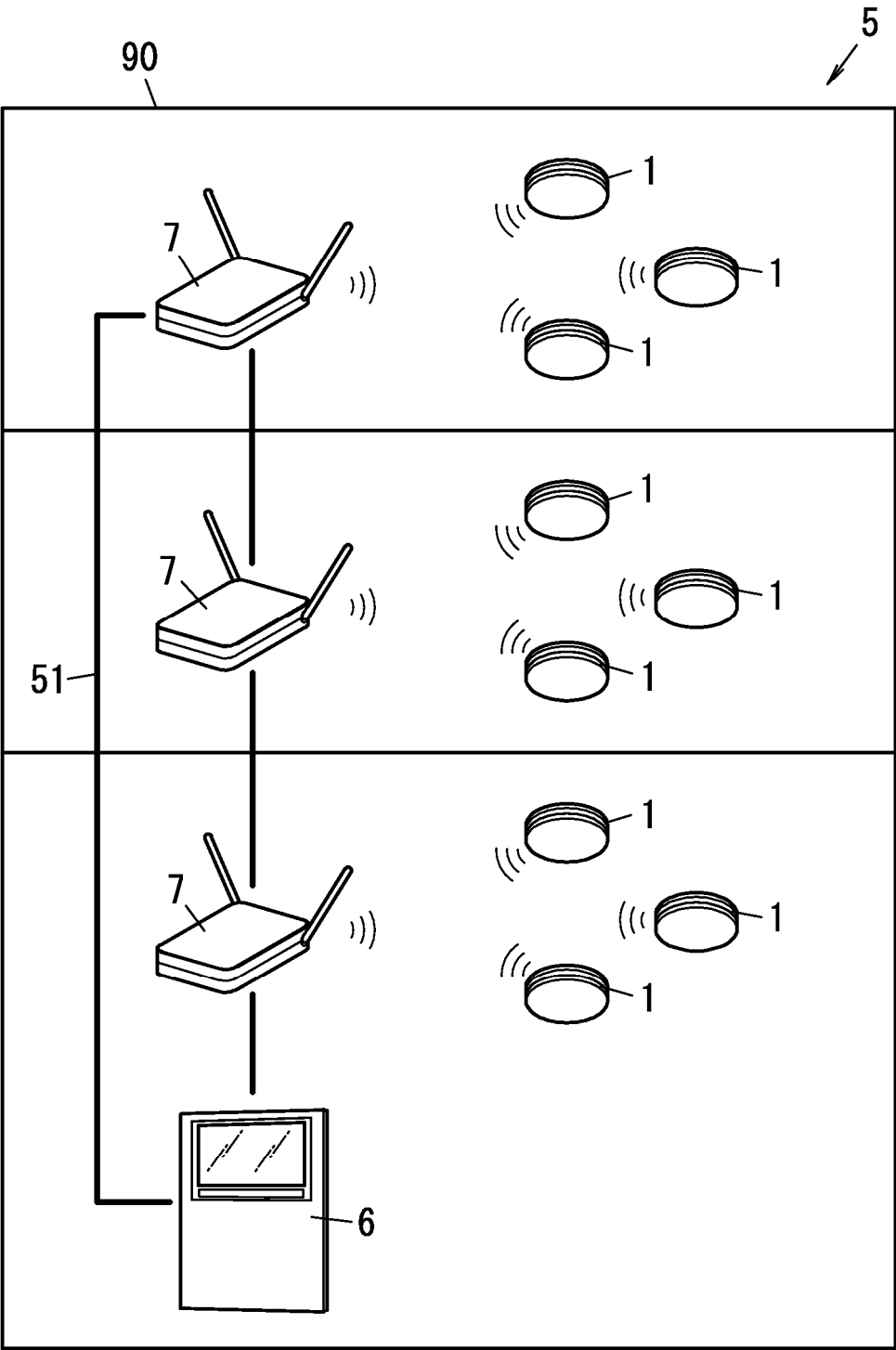


FIG. 13

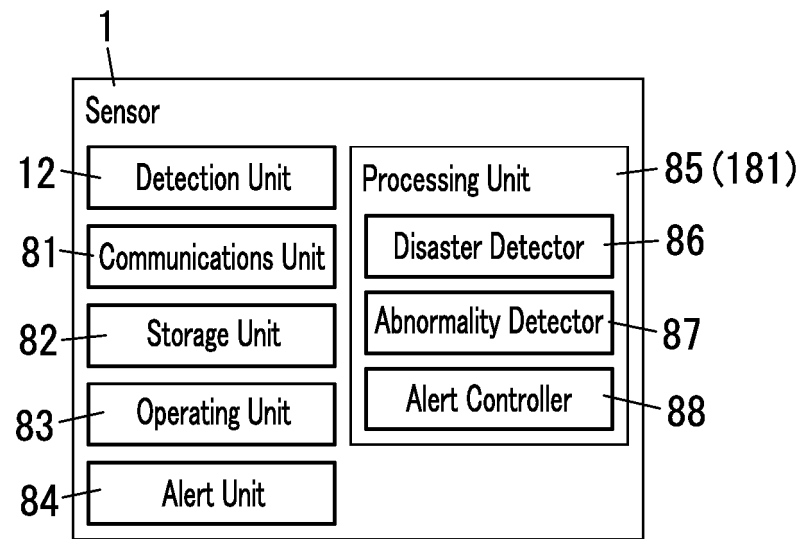
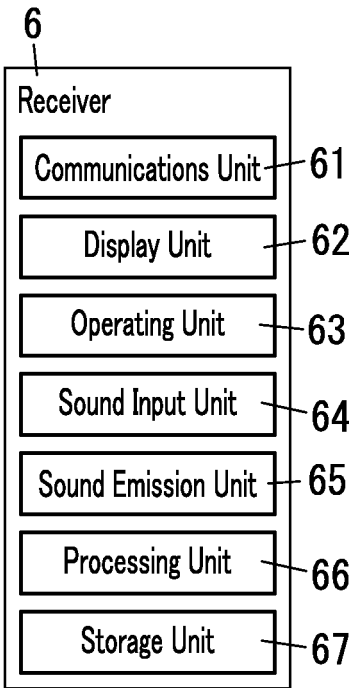
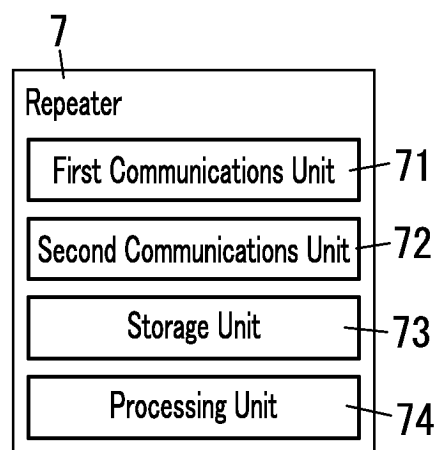


FIG. 14



**FIG. 15**



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/026281

**A. CLASSIFICATION OF SUBJECT MATTER**

**G08B 17/00**(2006.01)i; **G08B 17/06**(2006.01)i; **G08B 17/107**(2006.01)i  
FI: G08B17/00 C; G08B17/107 A; G08B17/06 F

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)  
G08B17/00; G08B17/06; G08B17/107

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

Published examined utility model applications of Japan 1922-1996  
Published unexamined utility model applications of Japan 1971-2024  
Registered utility model specifications of Japan 1996-2024  
Published registered utility model applications of Japan 1994-2024

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         | JP 2011-175416 A (NOHMI BOSAI LTD.) 08 September 2011 (2011-09-08)<br>paragraphs [0014], [0021]-[0023]                                     | 1                     |
| Y         | paragraphs [0014], [0021]-[0023]                                                                                                           | 6                     |
| X         | JP 2004-086566 A (MATSUSHITA ELECTRIC WORKS, LTD.) 18 March 2004<br>(2004-03-18)<br>paragraphs [0015], [0022]                              | 1                     |
| Y         | paragraphs [0015], [0022]                                                                                                                  | 6                     |
| X         | JP 2021-144445 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 24 September 2021 (2021-09-24)<br>paragraphs [0020]-[0021], fig. 2 | 1                     |
| Y         | paragraphs [0020]-[0021], fig. 2                                                                                                           | 6-7                   |
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| Y         | paragraphs [0010]-[0024], fig. 1                                                                                                           | 6-7                   |

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

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Date of the actual completion of the international search

03 October 2024

Date of mailing of the international search report

15 October 2024

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)  
3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915  
Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

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| International application No. |
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| C. DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                               |                       |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category*                              | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                            | Relevant to claim No. |
| Y                                      | JP 2018-190096 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 29 November 2018 (2018-11-29) paragraphs [0013], [0097], fig. 1                                                       | 7                     |
| A                                      | WO 2020/075487 A1 (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 16 April 2020 (2020-04-16)                                                                                           | 1-7                   |
| A                                      | JP 2009-211613 A (NOHMI BOSAI LTD.) 17 September 2009 (2009-09-17)                                                                                                                            | 1-7                   |
| A                                      | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 114697/1988 (Laid-open No. 035295/1990) (HOCHIKI CO.) 07 March 1990 (1990-03-07) | 1-7                   |

## INTERNATIONAL SEARCH REPORT

### Information on patent family members

International application No.

**PCT/JP2024/026281**

| Patent document<br>cited in search report |             |    | Publication date<br>(day/month/year) | Patent family member(s) | Publication date<br>(day/month/year) |
|-------------------------------------------|-------------|----|--------------------------------------|-------------------------|--------------------------------------|
| JP                                        | 2011-175416 | A  | 08 September 2011                    | (Family: none)          |                                      |
| JP                                        | 2004-086566 | A  | 18 March 2004                        | (Family: none)          |                                      |
| JP                                        | 2021-144445 | A  | 24 September 2021                    | (Family: none)          |                                      |
| JP                                        | 2008-165677 | A  | 17 July 2008                         | (Family: none)          |                                      |
| JP                                        | 2018-190096 | A  | 29 November 2018                     | (Family: none)          |                                      |
| WO                                        | 2020/075487 | A1 | 16 April 2020                        | JP                      | 2020-61122 A                         |
|                                           |             |    |                                      | EP                      | 3866130 A1                           |
| JP                                        | 2009-211613 | A  | 17 September 2009                    | (Family: none)          |                                      |
| JP                                        | 02-035295   | U1 | 07 March 1990                        | (Family: none)          |                                      |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2011164691 A [0003]