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(54) **ILLUMINATION DEVICE**

(57) It is an object of the present disclosure to provide an illumination device which enables the degree of design freedom of a housing to be increased. An illumination device includes: a housing (2); a light source (80) provided in the housing (2); and an optical member (9) having an incidence plane (911) via which light output from the light source (80) enters the optical member (9). The housing (2) or the optical member (9) includes an exit plane (94) from which light passing through the optical member (9) goes out of the housing (2). The exit plane (94) has an area (S_2) smaller than an area (S_1) of the incidence surface (911).

FIG. 7A

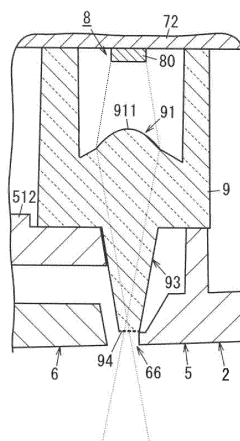


FIG. 7B

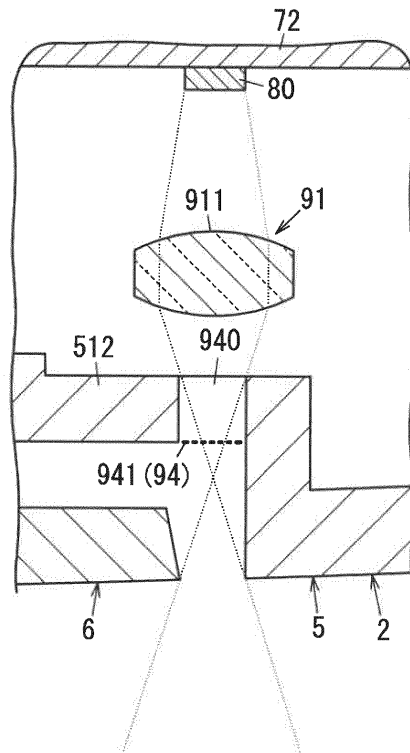
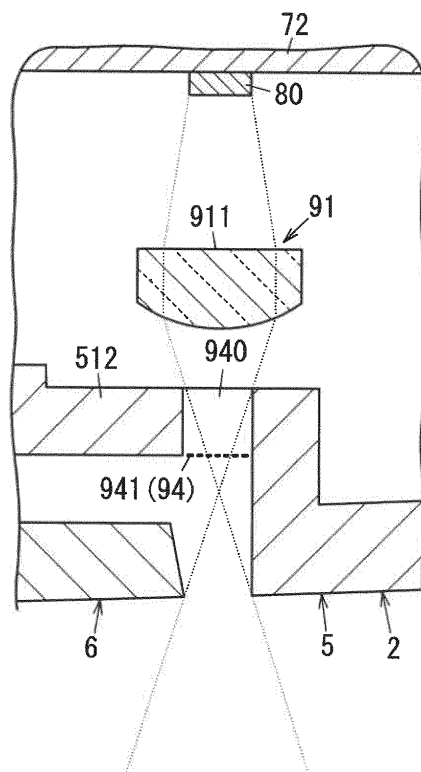


FIG. 7C



Description

Technical Field

[0001] The present disclosure relates generally to illumination devices, and specifically, to an illumination device including a housing in which a light source is provided.

Background Art

[0002] Patent Literature 1 discloses a conventional illumination device. The emergency illumination device described in Patent Literature 1 includes a body attached to a ceiling surface, and a light-emitting diode disposed on a lower surface of the body. The emergency illumination device is configured to illuminate a space under the ceiling surface by the light-emitting diode emitting light.

[0003] Disposing the light-emitting diode on the lower surface of the body, however, restricts design of a lower surface of the body.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2013-025996 A

Summary of Invention

[0005] It is an object of the present disclosure to provide an illumination device which enables the degree of design freedom of a housing to be increased.

[0006] An illumination device of one aspect according to the present disclosure includes: a housing; a light source provided in the housing; and an optical member. The optical member is provided in the housing and has an incidence plane via which light output from the light source enters the optical member. The housing or the optical member has an exit plane. From the exit plane, light passing through the optical member goes out of the housing. The exit plane has an area smaller than an area of the incidence plane.

Brief Description of Drawings

[0007]

FIG. 1 is a perspective view illustrating an illumination device of one embodiment of the present disclosure;

FIG. 2 is an exploded perspective view illustrating the illumination device;

FIG. 3 is a front view illustrating the illumination device, wherein an operation button in the illumination device is indicated by an imaginary line;

FIG. 4A is a sectional view illustrating a vicinity of the operation button, and FIG. 4B is a sectional view

illustrating the operation button of FIG. 4A pushed in a rearward direction;

FIG. 5A is a perspective view illustrating an optical member of the illumination device, FIG. 5B is a back view illustrating the optical member, and FIG. 5C is a front view illustrating the optical member;

FIG. 6A is a side view illustrating the illumination device, FIG. 6B is a front view illustrating the illumination device in which a light source is emitting light, and FIG. 6C is a sectional view taken along line A-A of FIG. 6B;

FIG. 7A is a sectional view illustrating an optical path of an illuminator of the illumination device, FIG. 7B is a sectional view illustrating an optical path of an illuminator of a variation, and FIG. 7C is a sectional view illustrating an optical path of an illuminator of another variation;

FIG. 8 is a front view illustrating the illumination device, wherein an operation button in the illumination device is indicated by an imaginary line;

FIG. 9A is a partially cutaway view illustrating the illumination device with a vicinity of a sound outputter of the illumination device being cut away, and FIG. 9B is an enlarged sectional view of the sound outputter;

FIG. 10A is a front view illustrating a variation of the sound outputter, and FIG. 10B is a front view illustrating another variation of the sound outputter; and FIG. 11A is a front view illustrating a variation, and FIG. 11B is a sectional view taken along line B-B of FIG. 11A.

Description of Embodiments

[0008] An illumination device according to one embodiment of the present disclosure will be described below with reference to the attached drawings. Note that the embodiment and variations described below are mere examples of various embodiments of the present disclosure. Various modifications may be made to the following embodiment depending on design and the like as long as the object of the present disclosure is achieved.

[Schema]

[0009] An illumination device of the present embodiment is an alarm 1 which is configured such that when the alarm 1 senses smoke caused by a fire or the like, the alarm 1 illuminates a path or the like, and in addition, outputs a sound such as a warning sound. The alarm 1 is attached to, for example, a ceiling surface or the like of a living room, a bedroom, a stairs, or a corridor in a dwelling house, or an office, a stairs, a corridor, or the like in a building other than the dwelling house.

[0010] The alarm 1 of the present embodiment has a function as an illumination device configured such that, for example, when the alarm 1 senses smoke, the alarm 1 illuminates a floor surface to light up an evacuation

route and the like. The alarm 1 of the present embodiment further has a function as an acoustic apparatus configured such that, for example, when the alarm 1 senses smoke, the alarm 1 outputs not only the warning sound but also a sound such as a speech and the like.

[0011] As illustrated in FIG. 1, the alarm 1 includes an operation button 6 provided on a surface of a housing 2. When the operation button 6 is pushed toward an inner side of the housing 2 while the alarm 1 is outputting a sound, the alarm 1 stops outputting the sound.

[0012] In the following description, in the alarm 1, the surface provided with the operation button 6 is defined as a front surface, and a surface facing the ceiling surface is defined as a back surface. A direction parallel to a direction from the back surface to the front surface of the alarm 1 is defined as a forward and rearward direction. Viewing an object from the front is defined as a "front view" of the object.

[Configuration]

[0013] As illustrated in FIG. 2, the alarm 1 includes an attachment, the housing 2, a circuit board 72, a sensor 74, an illuminator 8, a sound outputter 70, the operation button 6, and a battery 71.

[0014] The attachment is fixed to a surface (installation surface) such as the ceiling surface to which the alarm 1 is to be installed. In this state, the housing 2 is attached to the attachment. The attachment of the present embodiment includes a base plate 11. The base plate 11 has a fixing plate 111 and a rising part 112. The fixing plate 111 has a disk shape and has a back surface facing the installation surface. The rising part 112 protrudes from an outer periphery of the fixing plate 111 in the forward direction. The rising part 112 includes a plurality of holding claws 113 for holding the housing 2.

[0015] The housing 2 accommodates components such as the circuit board 72, the sensor 74, the illuminator 8, the sound outputter 70, and the battery 71 therein. The housing 2 has a housing space 22. The housing 2 includes a bottom plate 3, a side cover 4, and a top plate 5. The housing 2 is made of a synthetic resin, for example, a flame-retardant ABS resin.

[0016] The bottom plate 3 is detachably attached to the base plate 11. The bottom plate 3 is configured to be fit to an inner side of the rising part 112 of the base plate 11 and is hooked on the plurality of holding claws 113, thereby keeping a state where the bottom plate 3 is fit to the inner side of the rising part 112. The bottom plate 3 is fixed to the side cover 4 with a plurality of fixation tools 31 such as screws.

[0017] The side cover 4 is included in a side surface of the alarm 1. The side surface faces a direction orthogonal to the forward and rearward direction. The side cover 4 has a cylindrical shape whose central axis is parallel to the forward and rearward direction. The side cover 4 includes an outer periphery 41 and a partition 45.

[0018] The outer periphery 41 surrounds the base plate

11 and the bottom plate 3 (is located on an outer side of the base plate 11 and the bottom plate 3 in a direction orthogonal to the forward and rearward direction). The outer periphery 41 has a round shape in a front view thereof. The outer periphery 41 includes a front surface having a front opening 42 and a back surface having a back opening 43.

[0019] The partition 45 has a plate shape orthogonal to the forward and rearward direction and partitions an interior space surrounded by the outer periphery 41 in the forward and rearward direction. The partition 45 is disposed in front of the bottom plate 3 in a state where the bottom plate 3 is fixed to the side cover 4.

[0020] The top plate 5 is fixed to the side cover 4 in a state where the top plate 5 covers the front opening 42 of the outer periphery 41 (side cover 4). The top plate 5 has a disk shape. The top plate 5 is fixed to the bottom plate 3 and the side cover 4 with the plurality of fixation tools 31.

[0021] The housing space 22 is a space in which the components are to be accommodated. The housing space 22 is surrounded by the bottom plate 3, the side cover 4, and the top plate 5. The housing space 22 of the present embodiment has a first space and a second space.

[0022] The first space is a space surrounded by the top plate 5, the outer periphery 41, and the partition 45. In the first space, the circuit board 72, the illuminator 8, the sound outputter 70, and the battery 71 are disposed. The circuit board 72 is provided with a control circuit. The control circuit is electrically connected to the sensor 74, a light source 80 (LED) of the illuminator 8, the sound outputter 70, a push button switch 73 for stopping an output of a sound from the sound outputter 70, and the battery 71 and controls the light source 80 and the sound outputter 70. The circuit board 72 has a front surface provided with the light source 80 and the push button switch 73.

[0023] The second space is a space surrounded by the bottom plate 3, the outer periphery 41, and the partition 45. In the second space, the sensor 74 is disposed.

[0024] The sensor 74 is configured to sense the presence of smoke. The sensor 74 is provided on a back surface of the circuit board 72. The partition 45 has a through hole 46 formed at a location corresponding to the sensor 74. The sensor 74 passes through the through hole 46, thereby being disposed in the second space. That is, the sensor 74 is exposed in the second space.

[0025] The outer periphery 41 has a part (part corresponding to the second space) which is located behind the partition 45 and which has a plurality of slits 44. Each slit 44 extends along a circumferential direction of the outer periphery 41. The plurality of slits 44 are communicated with the second space and a space outside the housing 2. Thus, smoke which is present outside the housing 2 enters the second space through the plurality of slits 44.

[0026] The sensor 74 includes, for example, a photo-

electric sensor. The photoelectric sensor includes a light-emitting element and a light-receiving element. When the light-emitting element outputs light with smoke being present in the second space, the light is irregularly reflected off the smoke. Thus, the light-receiving element senses the light irregularly reflected. When the light-receiving element senses a certain quantity of light, the control circuit senses the presence of the smoke. When the control circuit senses the presence of the smoke based on a signal output from the sensor 74, the control circuit outputs an electric signal to the sound outputter 70 so as to cause the sound outputter 70 to operate.

[0027] The push button switch 73 is a switch configured to stop an output of a sound from the sound outputter 70. The push button switch 73 is configured to be pushed by an operation piece 54 (FIG. 3) of the top plate 5 when a front surface of the operation button 6 is pushed in the rearward direction.

[0028] The operation button 6 receives an operation from outside the alarm 1 to be able to switch functions. When the operation button 6 of the present embodiment is operated in a state where the sound outputter 70 is outputting a sound, the operation button 6 switches the state to a state where the sound outputter 70 is not outputting the sound. The operation button 6 is provided in the opening 51 formed in a front surface of the top plate 5.

[0029] The opening 51 is a section rearwardly recessed from the front surface of the top plate 5. The opening 51 has a round shape in a front view thereof. The opening 51 includes a peripheral wall section 511 and a partition 512 (support plate) having the operation piece 54.

[0030] The peripheral wall section 511 has a cylindrical shape whose center axis is elongated in the forward and rearward direction. The peripheral wall section 511 has surfaces on both sides in a thickness direction thereof, and one of the surfaces which faces the center axis is an inner peripheral surface of the opening 51. An edge line at which a front end of the inner peripheral surface intersects with the front surface of the top plate 5 forms an opening in the top plate 5. The opening is referred to as an operation button opening 513. Note that the peripheral wall section 511 does not have to have a cylindrical shape but may have a rectangular tubular shape.

[0031] The operation button 6 is attached to the partition 512. The partition 512 includes a pair of shaft bodies 631 which will be described later and a pore (second pore 53) which supports a restriction claw 65. The pair of shaft bodies 631 are configured to support a pair of hook pieces 641. The partition 512 supports the operation button 6 in a state where the operation button 6 is attached to the partition 512. The partition 512 is provided at a rear end of the peripheral wall section 511. The partition 512 has a plate shape orthogonal to the forward and rearward direction. The partition 512 has a front surface corresponding to a bottom surface of the opening 51. The partition 512 is located between the operation button 6 and the sound outputter 70 when the top plate 5 is fixed to

the side cover 4.

[0032] As illustrated in FIG. 3, the partition 512 includes a first pore 52 and a second pore 53. Here, as illustrated in FIG. 3, on a plane orthogonal to the forward and rearward direction, a straight line passing through the center of the operation button 6 is defined as a first virtual straight line 100, and a straight line passing through the center of the operation button 6 and orthogonal to the first virtual straight line 100 is defined as a second virtual straight line 200.

[0033] The first pore 52 is part of an acoustic space 520 which will be described later. The first pore 52 is formed on the second virtual straight line 200 and along an outer edge of the partition 512. In the partition 512, the second pore 53 is located on an opposite side of the first virtual straight line 100 from the first pore 52 and is on the second virtual straight line 200. That is, the second pore 53 is provided on an opposite side from the first pore 52 in the radial direction of the opening 51. The first pore 52 and the second pore 53 penetrate through the partition 512. Thus, the operation button opening 513 is communicated with the housing space 22 via the first pore 52 and the second pore 53. The first pore 52 and the second pore 53 will be described later in detail.

[0034] The operation piece 54 is provided to the partition 512. The operation piece 54 is a piece obtained by separating part of the partition 512 from the other portions by a slit having a U-shape in a front view and is configured to elasticity deform when pushed in the rearward direction. As illustrated in FIG. 4A, the operation piece 54 includes an elasticity piece 541 which is elastically deformable and an operation projection 542 facing an operation surface of the push button switch 73.

[0035] The operation button 6 includes a button body 61 included in a main body of the operation button 6 and a pressure projection 62 protruding in the rearward direction from a back surface of the button body 61. The pressure projection 62 has a tip end disposed to face a portion of the elasticity piece 541, the portion being located between the operation projection 542 and a base of the elasticity piece 541. Thus, when the operation button 6 is pushed in the rearward direction, as illustrated in FIG. 4B, the pressure projection 62 pushes the elasticity piece 541 in the rearward direction, and the elasticity piece 541 warps in the rearward direction. Then, the operation projection 542 pushes the push button switch 73.

[0036] The operation button 6 is disposed on an inner side of the operation button opening 513. Saying that the operation button 6 is disposed on an inner side of the operation button opening 513 includes not only that the front surface of the operation button 6 is flush with the front surface of the top plate 5 but also that the operation button 6 is located rearward or forward with respect to the front surface of the top plate 5. That is, the operation button 6 is, in a front view thereof, disposed at least on the inner side of the operation button opening 513. In other words, at least part of the operation button 6 is disposed in the operation button opening 513.

[0037] The housing 2 has a single-sided hinge structure for rotatably attaching the operation button 6 to the top plate 5. The single-sided hinge structure includes the pair of shaft bodies 631 provided to the housing 2 and a bearing 64 provided to the button body 61.

[0038] As illustrated in FIG. 3, the pair of shaft bodies 631 extend in a direction orthogonal to the second virtual straight line 200 in the front view of the operation button 6, and the pair of shaft bodies 631 are apart from each other with the second virtual straight line 200 at the center. Each shaft body 631 has a cylindrical shape. The first pore 52 has a line symmetric shape with respect to the second virtual straight line 200. The pair of shaft bodies 631 protrude from a pair of surfaces in a direction in which the pair of shaft bodies 631 face each other, the pair of surfaces being included in an inner peripheral surface of the first pore 52 and facing each other in a direction along the first virtual straight line 100. A straight line connecting the centers of the pair of shaft bodies 631 is a rotation axis 63 of the operation button 6.

[0039] The rotation axis 63 is a uniform straight line serving as the center of rotation of the operation button 6. In the front view of the operation button 6, the rotation axis 63 is located between the center of the operation button 6 and an outer periphery of the operation button 6. The rotation axis 63 is parallel to the first virtual straight line 100.

[0040] As illustrated in FIG. 4A, the bearing 64 protrudes from the back surface of the button body 61. The bearing 64 includes a pair of hook pieces 641 each having an L-section. The pair of hook pieces 641 are disposed to be apart from each other in the direction along the first virtual straight line 100. The pair of hook pieces 641 are hooked on the pair of shaft bodies 631 on a one-to-one basis. Thus, the operation button 6 rotates about the rotation axis 63 when the front surface of the operation button 6 is pushed toward the housing 2.

[0041] The operation button 6 includes the restriction claw 65. The restriction claw 65 restricts displacement in a direction opposite from a rotation direction (specifically, a push direction of rotation directions about the rotation axis 63) when the front surface of the operation button 6 is pushed toward the housing 2. Thus, in a state where the operation button 6 is attached to the housing 2, the operation button 6 is restricted from rotating in a direction which is one of rotation directions about the rotation axis 63 and which is opposite from the push direction.

[0042] Note that the single-sided hinge structure does not have to include the pair of shaft bodies 631 but has at least a portion serving as the rotation axis 63. The single-sided hinge structure of the present embodiment is made of a synthetic resin but may be made of other materials by two-color molding, insert molding, or the like.

[0043] As illustrated in FIG. 2, the alarm 1 includes the illuminator 8. The illuminator 8 emits light such that as the light propagates in the traveling direction, the light diffuses in the radial direction. The light is emitted from the illuminator 8 in a conical shape viewed as a whole.

The illuminator 8 includes the light source 80 and an optical member 9.

[0044] The light source 80 includes light-emitting diodes (LEDs) attached to the circuit board 72. That is, the light source 80 is provided in the housing 2. The color of light output from the light source 80 is white but may be red, blue, or the like.

[0045] The optical member 9 is on an optical axis of the light source 80 in the housing 2 (in the first space). The optical member 9 is made of a transparent material such as acrylic, glass, or the like. As illustrated in FIG. 5A, the optical member 9 includes: a focusing lens 91 having a first incidence plane 911; an adjacent part 92 having a second incidence plane 921; a light guide 93 having a first exit plane 94 and a second exit plane 95; and a pair of support legs 96.

[0046] The focusing lens 91 collects light emitted from the light source 80. The focusing lens 91 includes an incidence plane (first incidence plane 911) via which light output from the light source 80 enters the focusing lens 91. The first incidence plane 911 has a convex lens shape and is spherically curved to protrude toward the light source 80.

[0047] The light guide 93 guides the light collected by the focusing lens 91 to the first exit plane 94. The light guide 93 is integrally formed with the focusing lens 91. The light guide 93 extends in the forward and rearward direction. The light guide 93 has a pair of inclined surfaces 931. The pair of inclined surfaces 931 face each other in a width direction of the first exit plane 94. The pair of inclined surfaces 931 are tilted such that the distance between the pair of inclined surfaces 931 decreases toward the front. The light guide 93 has an end surface in the forward direction, and the end surface is the first exit plane 94.

[0048] The first exit plane 94 is a surface from which light passing through the first incidence plane 911 is output outside the housing 2. As illustrated in FIG. 6A, the first exit plane 94 is disposed in a hole section 66.

[0049] The hole section 66 is recessed from the surface of the housing 2. As illustrated in FIG. 6C, the hole section 66 includes a pair of inner side surfaces 661 and a bottom surface 662. The pair of inner side surfaces 661 are apart from each other in a radial direction of the opening 51. The bottom surface 662 is located on a rear side of the pair of inner side surfaces 661. In the present embodiment, one of the pair of inner side surfaces 661 is the inner peripheral surface of the opening 51 of the top plate 5, and the other is the outer periphery of the operation button 6. The bottom surface 662 is part of the front surface of the partition 512. The hole section 66 is, in a front view thereof, formed concentrically with the housing 2 and extends along a surface of the housing 2.

[0050] As illustrated in FIG. 6B, the first exit plane 94 has a shape elongated along the longitudinal direction of the hole section 66. As illustrated in FIG. 5C, the first exit plane 94 has, in a front view thereof, a length in a direction in which the hole section 66 extends, and the

first exit plane 94 has a width in a direction orthogonal to the length. The length of the first exit plane 94 is larger than the width of the first exit plane 94. The first exit plane 94 has an arc-like shape in a front view of the first exit plane 94.

[0051] The area S_2 of the first exit plane 94 is smaller than the area S_1 of the first incidence plane 911. As illustrated in FIG. 7A, when light output from the light source 80 enters the focusing lens 91 through the first incidence plane 911, the light passing through the first incidence plane 911 is collected by the focusing lens 91. The focal point of light collected is located rearward of the first exit plane 94. Then, light passing through the first exit plane 94 is radiated while diverging. Thus, the area S_2 of the first exit plane 94 is smaller than the area S_1 of the first incidence plane 911, and therefore, it is possible to make the first exit plane 94 less noticeable. Moreover, since the area S_1 of the first incidence plane 911 is larger than the area S_2 of the first exit plane 94, a larger quantity of light can be secured than in a case where the area of the incidence plane is equal to the area of the exit plane. In sum, while the area of first incidence plane 911 is maintained to be larger than or equal to a certain area so as to secure the quantity of light, it is possible to make the first exit plane 94 in the housing 2 less noticeable.

[0052] The first exit plane 94 is, for example, not limited to the end surface of the light guide 93 but may be a form as illustrated in FIG. 7B. An exit plane of a variation shown in FIG. 7B includes an opening plane 941 of a pore 940 formed in a partition 512. The pore 940 penetrates through the partition 512. An optical member 9 is a focusing lens 91. The incidence plane (first incidence plane 911) of the focusing lens 91 is a portion which is part of a back surface of the focusing lens 91 and which is irradiated with light. The area of the opening plane 941 is smaller than the area of the incidence plane of the focusing lens 91.

[0053] Alternatively, as illustrated in FIG. 7C, the incidence plane (first incidence plane 911) may be flat. When the optical member 9 is the focusing lens 91, the focusing lens 91 may be a convex lens in which the incidence plane of the focusing lens 91 is flat, and a plane from which light passing through the focusing lens 91 is output spherically protrudes in a travelling direction of the light. Moreover, the optical member 9 does not include the focusing lens 91 and may include only the light guiding member.

[0054] As illustrated in FIG. 5A, the adjacent part 92 includes the second incidence plane 921. The adjacent part 92 is adjacent to an area around the focusing lens 91 and is integrally formed with the focusing lens 91. The second incidence plane 921 is provided to a back surface of the adjacent part 92. The second incidence plane 921 is formed around the first incidence plane 911 and adjoins the first incidence plane 911.

[0055] The second exit plane 95 is a surface from which light passing through the second incidence plane 921

from the light source 80 is output into the hole section 66. In the light guide 93, the second exit plane 95 includes surfaces on both sides in the length direction of the first exit plane 94. From the second exit plane 95, light exits in a direction different from a direction in which light exits from the first exit plane 94. In the present embodiment, an optical axis of light output via the second exit plane 95 and an optical axis of light output via the first exit plane 94 intersect with each other.

[0056] As illustrated in FIG. 6B, the first exit plane 94 and the second exit plane 95 are disposed at a location where the inner peripheral surface of the opening 51 of the housing 2 intersects with the first virtual straight line 100 in plan view. From the first exit plane 94, light exits in the forward direction. That is, the first exit plane 94 allows light to go out toward a space below the ceiling surface. From the second exit plane 95, light exits along the longitudinal direction of the hole section 66. Thus, the light exiting from the second exit plane 95 is radiated downward from the entire perimeter of a gap 21 having an annular shape formed in the hole section 66.

[0057] Here, the hole section 66 has an annular shape and has the pair of inner side surfaces 661 and the bottom surface 662. The gap 21 has the annular shape and includes the pair of inner side surfaces 661. The gap 21 is included in the hole section 66.

[0058] Each inner side surface 661 of the hole section 66 has a smaller surface roughness than the roughness of the surface of the housing 2 (that is, the surface of the housing 2 is rougher than the inner side surface 661 of the hole section 66). In the alarm 1 of the present embodiment, the front surface of the top plate 5 is embossed, but both of the pair of inner side surfaces 661 of the hole section 66 are not embossed. Moreover, in the alarm 1 of the present embodiment, the bottom surface 662 is not embossed. Thus, disposing the second exit plane 95 in the hole section 66 enables light exiting from the second exit plane 95 to be reflected toward the pair of inner side surfaces 661 of the hole section 66. This enables a part between the operation button 6 and the opening 51 of the housing 2 to be illuminated, and thereby, illumination for striking up the operation button 6 is possible.

[0059] Note that only one of the pair of inner side surfaces 661 of the hole section 66 may have a lower surface roughness than the surface of the housing 2. Moreover, the inner side surfaces 661 of the hole section 66 may be mirror-finished.

[0060] The alarm 1 in the present embodiment includes a sound outputter 70. The sound outputter 70 outputs a sound (sound wave). The sound outputter 70 of the present embodiment includes a loudspeaker 700 configured to convert an electric signal into a sound. The loudspeaker 700 includes a diaphragm and mechanically vibrates the diaphragm in accordance with the electric signal to generate a sound. The loudspeaker 700 has a round shape in a front view thereof and has a disk shape. The loudspeaker 700 is smaller than the operation button 6 in the front view of the operation button 6. In other

words, the operation button 6 is larger than the loudspeaker 700.

[0061] As illustrated in FIG. 8, the loudspeaker 700 overlaps the rotation axis 63 in the front view of the operation button 6, and the center 703 of the loudspeaker 700 is located between the first virtual straight line 100 and the rotation axis 63 in a direction along the second virtual straight line 200. Thus, the loudspeaker 700 at least partially overlaps the operation button 6 in the front view of the operation button 6.

[0062] The first pore 52 penetrates the partition 512. The partition 512 has a uniform thickness. The first pore 52 is within the loudspeaker 700 in the front view of the operation button 6 and is smaller than the loudspeaker 700. That is, in the front view of the operation button 6, the area of the first pore 52 is smaller than the area of the loudspeaker 700.

[0063] The loudspeaker 700 is disposed behind the partition 512. Thus, as illustrated in FIG. 9, a space having a dimension greater than or equal to the thickness of the partition 512 is formed in front of the loudspeaker 700. The space forms the acoustic space 520.

[0064] The alarm 1 includes a gap 21 between an edge of the opening 51 of the top plate 5 and the operation button 6. The gap 21 extends over the entire length of the outer perimeter of the operation button 6. As illustrated in FIG. 8, the acoustic space 520 overlaps at least part of the gap 21 in the entire length of the gap 21 in a plan view of the operation button 6. In sum, the acoustic space 520 connects the loudspeaker 700 to the gap 21.

[0065] When a sound is output from a front surface of the loudspeaker 700, the sound propagates in the acoustic space 520 as illustrated in FIG. 9 and is output to the outside through the gap 21. In the present embodiment, of the gap 21 formed between an edge of the opening 51 of the top plate 5 and the operation button 6, a gap corresponding to the first pore 52 and a first recess 55 which will be described later is a tone hole. That is, in the present embodiment, the gap 21 serves as the tone hole, and therefore, the gap 21 is formed at least between the first virtual straight line 100 and the rotation axis 63.

[0066] As illustrated in FIG. 8, the partition 512 has a pair of recesses (first recesses 55) extending along the longitudinal direction (circumferential direction) of the gap 21 from the first pore 52 in the front view of the operation button 6. A space (space in front of the recess) in the first recess 55, connect the first pore 52 to the gap 21.

[0067] Moreover, as illustrated in FIG. 9B, the housing 2 is provided with a sound shielding structure 57. The sound shielding structure 57 limits a sound passing range of the gap 21 in the entire length of the gap 21 to a certain range. The sound shielding structure 57 includes a first vertical surface 571, a horizontal surface 572 orthogonal to the first vertical surface 571, and a second vertical surface 573 orthogonal to the horizontal surface 572. The first vertical surface 571 and the second vertical surface 573 are parallel to the forward and rearward directions

and are orthogonal to the front surface of the partition 512.

[0068] The sound shielding structure 57 suppresses a sound output to the acoustic space 520 from going out through part, other than a range corresponding to the first pore 52 and the first recess 55, of the gap 21. Thus, the sound of the alarm 1 of the present embodiment is mainly output through the gap 21 corresponding to the first pore 52 and the first recess 55. This reduces clipping noise caused due to sounds which have the same frequency but which are output from locations apart from each other.

[0069] Moreover, the loudspeaker 700 of the present embodiment is configured to output two or more types of sounds (sound waves). The loudspeaker 700 is configured to output a first sound which can be output from a first portion 701 of the loudspeaker 700 and a second sound which can be output from a second portion 702 of the loudspeaker 700 as the two or more types of sounds.

[0070] The first sound includes a voice sound and a warning sound. The first sound has a frequency within a voice band (e.g., higher than or equal to 200 Hz and lower than or equal to 4000 Hz) and a frequency within a warning sound band (e.g., higher than or equal to 500 Hz and lower than or equal to 1000 Hz). The first sound is output from the front surface (first portion 701) of a diaphragm of the loudspeaker 700.

[0071] The second sound includes a vibration sound generated when the diaphragm of the loudspeaker 700 vibrates. The second sound is different from the first sound. The phase of the second sound is a reverse phase of the phase of the first sound. The second sound is output from a back surface (second portion 702) of the diaphragm of the loudspeaker 700.

[0072] The partition 512 has a second pore 53 and a second recess 56 via which the second sound is allowed to be output to the outside. The second pore 53 and the second recess 56 are formed on an opposite side from the first pore 52 in a radial direction of the opening 51. The second recess 56 extends in a longitudinal direction (circumferential direction) of the gap 21. The space in the second recess 56 is communicated with the second pore 53 and the gap 21.

[0073] The alarm 1 of the present embodiment outputs, from the front surface (first portion 701) of the diaphragm of the loudspeaker 700, a warning sound as the first sound. Then, the alarm 1 outputs, from the front surface of the diaphragm of the loudspeaker 700, voice as the first sound. These first sounds pass through the acoustic space 520 and are output through the gap 21 to the outside.

[0074] At this time, the vibration sound as the second sound output from the back surface (second portion 702) of the diaphragm of the loudspeaker 700 passes a space (space behind the partition 512) between the partition 512 and the circuit board 72 and goes through an opening of the second pore 53 to the outside of the housing 2.

[0075] Then, the sound gone through the opening of

the second pore 53 to the outside of the housing 2 is output via the space in the second recess 56 through the gap 21.

[0076] Note that since the first sound and the second sound are output from respective different locations of the gap 21, the first sound and the second sound may reinforce or cancel each other, that is, interfere with each other. In the alarm 1 of the present embodiment, the traveling distance of the first sound and the traveling distance of the second sound are determined such that no interference of the first sound and the second sound with each other occurs, but if the interference occurs, it is possible to handle the interference by the following method.

[0077] As illustrated in FIGS. 11A and 11B, providing a separator 58 enables the occurrence of interference to be reduced. The separator 58 is provided between the loudspeaker 700 and the second pore 53. The separator 58 protrudes from a back surface of the partition 512 in the rear direction. The separator 58 has a tip end which is in contact with or in the proximity of the circuit board 72. The separator 58 extends along the first virtual straight line 100 and extends in a direction intersecting with a straight line passing through the loudspeaker 700 and the second pore 53. On both sides in a longitudinal direction of the separator 58, spaces are located.

[0078] Since the separator 58 is provided between the loudspeaker 700 and the second pore 53, the second sound output from the back surface of the diaphragm of the loudspeaker 700 passes between the partition 512 and the circuit board 72 but is transmitted to bypass the separator 58 at this time. Thus, the traveling distance of the second sound increases. That is, the separator 58 enables the traveling distance of the second sound to be adjusted, and therefore, it is possible to reduce the occurrence of interference.

[0079] In the present embodiment, the loudspeaker 700 is disposed at a location such that the loudspeaker 700 overlaps the rotation axis 63 in the front view of the operation button 6, but as illustrated in FIG. 10A, the loudspeaker 700 does not have to overlap the rotation axis 63. In this case, the center 703 of the loudspeaker 700 is located between the first virtual straight line 100 and the rotation axis 63 in the front view of the operation button 6.

[0080] Moreover, as illustrated in FIG. 10B, the operation button 6 does not have to be concentric with the housing 2 in the front view of the operation button 6. In this case, the loudspeaker 700 is at least disposed at a location such that at least part of the loudspeaker 700 overlaps the operation button 6 in the front view of the operation button 6, and thereby, part of the gap 21 can be the tone hole.

[Application]

[0081] The illumination device according to the present disclosure is not limited to the above-described embodiment. Various modifications are possible depending on

design and the like as long as the object of the present disclosure can be achieved.

[0082] In one variation, the sensor 74 is not limited to a sensor configured to sense smoke. For example, the sensor 74 may be configured to sense flame or heat.

[0083] In one variation, the operation button 6 does not have to be configured to stop a sound from the sound outputter 70. For example, the operation button 6 may be an operation button for switching modes of the alarm.

[0084] In one variation, the opening 51 does not have to be provided with the peripheral wall section 511 but may be a through hole for the operation button 6 formed in the top plate 5.

[0085] In one variation, the optical member 9 has to be provided with neither the second incidence plane 921 nor the second exit plane 95.

[0086] The illuminator 8 of the above-described embodiment is configured to conically emit light, but the illuminator 8 is not limited to this example. In one variation, the illuminator 8 may emit light such that a specific shape (e.g., arrow shape) is displayed by light shining on a floor surface.

[0087] In the illuminator 8 of the above-described embodiment, a focal point of light passing through the focusing lens is located rearward of the first exit plane 94, but the focal point may be located forward of the first exit plane 94.

[0088] The sound outputter 70 does not have to have a round shape in the front view of the operation button 6 but may have, for example, a quadrangular shape, or an elliptical shape. Moreover, the sound outputter 70 does not have to be the loudspeaker but may be configured to output a warning sound by using a diaphragm.

[0089] In one variation, the second pore 53 does not have to be located on an opposite side of the center of the first virtual straight line 100 from the first pore 52. The second pore 53 is at least located at a location different from the first pore 52.

[Aspect]

[0090] As described above, an illumination device of a first aspect includes: a housing (2); a light source (80) provided in the housing (2); and an optical member (9) provided in the housing (2) and having an incidence plane (911) via which light output from the light source (80) enters the optical member (9). The optical member (9) or the housing (2) has an exit plane (94). From the exit plane (94), light passing through the optical member (9) goes out of the housing (2). The exit plane (94) has an area (S_2) smaller than an area (S_1) of the incidence plane (911).

[0091] This configuration enables the degree of design freedom of the housing (2) to be improved. Moreover, since the area (S_2) of the exit plane (94) is smaller than the area (S_1) of the incidence plane (911), the exit plane (94) is less noticeable. Furthermore, since the area (S_1) of the incidence plane (911) is larger than the exit plane

(94), it is possible to secure a larger quantity of light than in a case where the incidence plane and the exit plane have the same area.

[0092] In an illumination device of a second aspect referring to the first aspect, the housing (2) has a hole section (66) recessed from a surface of the housing (2). The exit plane (94) is located in the hole section (66).

[0093] This configuration enables the exit plane (94) to be much less noticeable in appearance.

[0094] In an illumination device of a third aspect referring to the second aspect, the hole section (66) extends along the surface of the housing (2).

[0095] With this configuration, light from the exit plane (94) enables illumination along the longitudinal direction of the hole section (66) and linear illumination of the housing (2).

[0096] An illumination device of a fourth aspect referring to the third aspect further includes an opening (51) for an operation button (6), the opening (51) formed in the housing (2), and the operation button (6) being located in the opening (51). The hole section (66) includes an inner peripheral surface of the opening (51) and an outer peripheral surface of the operation button (6), the outer peripheral surface facing the inner peripheral surface.

[0097] This configuration enables a part between the opening (51) and the operation button (6) to be illuminated, and thereby, illumination for striking up the operation button (6) is possible.

[0098] In an illumination device of a fifth aspect referring to the third or fourth aspect, the optical member (9) includes: a second incidence plane (921) adjacent to a first incidence plane (911) serving as the incidence plane; and a second exit plane (95). From the second exit plane (95), light entering the optical member (9) via the second incidence plane (921) from the light source (80) exits in a direction different from a direction in which light exits from a first exit plane (94) in the hole section (66).

[0099] This configuration enables the first exit plane (94) to allow light to go out of the housing (2) and enables light going out of the second exit plane (95) to more brightly illuminate the hole (66).

[0100] In an illumination device of a sixth aspect referring to the fifth aspect, the surface of the housing (2) is rougher than an inner side surface of the hole section (66).

[0101] With this configuration, irradiating the inner side surface (661) of the hole section (66) with light from the exit plane (94, 95) enables the light to be effectively reflected off the inner side surface (661). As a result, the hole section (66) can be more brightly illuminated.

[0102] In an illumination device of a seventh aspect referring to any one of the first to sixth aspects, the optical member (9) includes a focusing lens (91) configured to collect light emitted from the light source (80).

[0103] This configuration enables light collected by the focusing lens (91) to be output from the exit plane (94), so that more effective illumination is possible.

[0104] In an illumination device of an eighth aspect re-

ferring to any one of the first to seventh aspects, the optical member (9) includes a light guide (93) configured to guide the light collected by using the focusing lens (91) to the exit plane (94).

[0105] This configuration enables loss of the quantity of light to be reduced, the loss being generated after the light passes through the focusing lens (91) until the light reaches the exit plane (94).

[0106] An illumination device of a ninth aspect referring to any one of the first to eighth aspects further includes an attachment attachable to a ceiling surface. The exit plane (94) is configured to allow light to go out toward a space under the ceiling surface in a state where the attachment is attached to the ceiling surface.

[0107] With this configuration, attaching the illumination device is attached to the ceiling surface enables a floor surface to be illuminated when the illumination device outputs light.

[0108] In an illumination device of a tenth aspect of any one of the first to ninth aspects, the illumination device is an alarm (1), and the illumination device further comprises a sound outputter (70) configured to output a warning sound.

[0109] With this configuration, it is possible to provide an alarm with an illumination function.

[0110] The configurations of the second to tenth aspects are not essential configurations of the illumination device and may be omitted accordingly.

Reference Signs List

[0111]

1	ALARM
11	BASE PLATE (ATTACHMENT)
2	HOUSING
51	OPENING
6	OPERATION BUTTON
66	HOLE SECTION
661	INNER SIDE SURFACE
80	LIGHT SOURCE
9	OPTICAL MEMBER
91	FOCUSING LENS
911	FIRST INCIDENCE PLANE (INCIDENCE PLANE)
921	SECOND INCIDENCE PLANE
93	LIGHT GUIDE
94	FIRST EXIT PLANE (EXIT PLANE)
95	SECOND EXIT PLANE
S ₁	AREA OF FIRST INCIDENCE PLANE (AREA OF INCIDENCE PLANE)
S ₂	AREA OF FIRST EXIT PLANE (AREA OF EXIT PLANE)

Claims

1. An illumination device, comprising:

- a housing;
 a light source provided in the housing; and
 an optical member provided in the housing and
 having an incidence plane via which light output
 from the light source enters the optical member,
 the housing or the optical member including an
 exit plane from which light passing through the
 optical member goes out of the housing,
 the exit plane having an area smaller than an
 area of the incidence plane. 5
2. The illumination device of claim 1, wherein
 the housing includes a hole section recessed from
 a surface of the housing, and
 the exit plane is located in the hole section. 10 15
3. The illumination device of claim 2, wherein
 the hole section extends along the surface of the
 housing. 20
4. The illumination device of claim 3, further compris-
 ing:
 an opening for an operation button, the opening
 being formed in the housing; and
 the operation button located in the opening,
 wherein
 the hole section includes an inner peripheral sur-
 face of the opening and an outer peripheral sur-
 face of the operation button, the outer peripheral
 surface facing the inner peripheral surface. 25 30
5. The illumination device of claim 3 or 4, wherein
 the optical member includes
 a second incidence plane adjacent to a first in-
 cidence plane as the incidence plane, and
 a second exit plane from which light entering the
 optical member via the second incidence plane
 from the light source exits in a direction different
 from a direction in which light exits from a first
 exit plane as the exit plane in the hole section. 35 40
6. The illumination device of claim 5, wherein
 the surface of the housing is rougher than an inner
 side surface of the hole section. 45
7. The illumination device of any one of claims 1 to 6,
 wherein
 the optical member includes a focusing lens config-
 ured to collect light emitted from the light source. 50
8. The illumination device of claim 7, wherein
 the optical member includes a light guide configured
 to guide light collected by the focusing lens to the
 exit plane. 55
9. The illumination device of any one of claims 1 to 8,
 further comprising an attachment attachable to a
 ceiling surface, wherein
 the exit plane is configured to allow light to go out
 toward a space under the ceiling surface in a state
 where the attachment is attached to the ceiling sur-
 face.
10. The illumination device of any one of claims 1 to 9,
 wherein
 the illumination device is an alarm, and
 the illumination device further comprises a sound
 outputter configured to output a warning sound.

FIG. 1

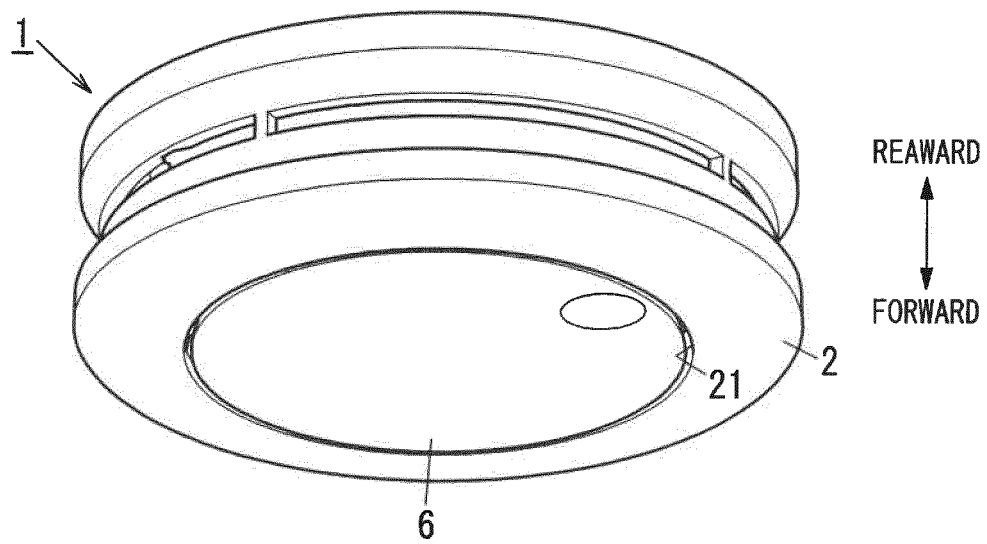


FIG. 2

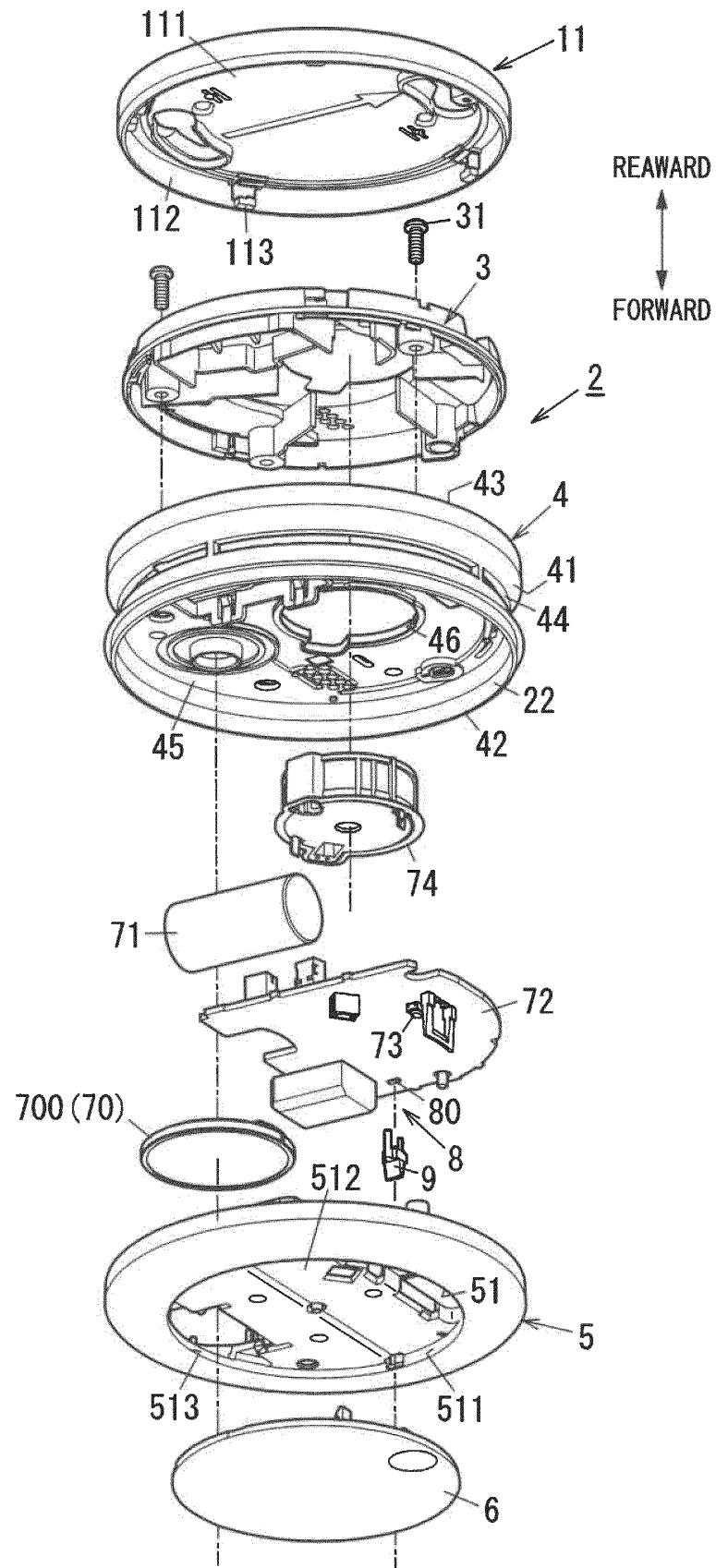


FIG. 3

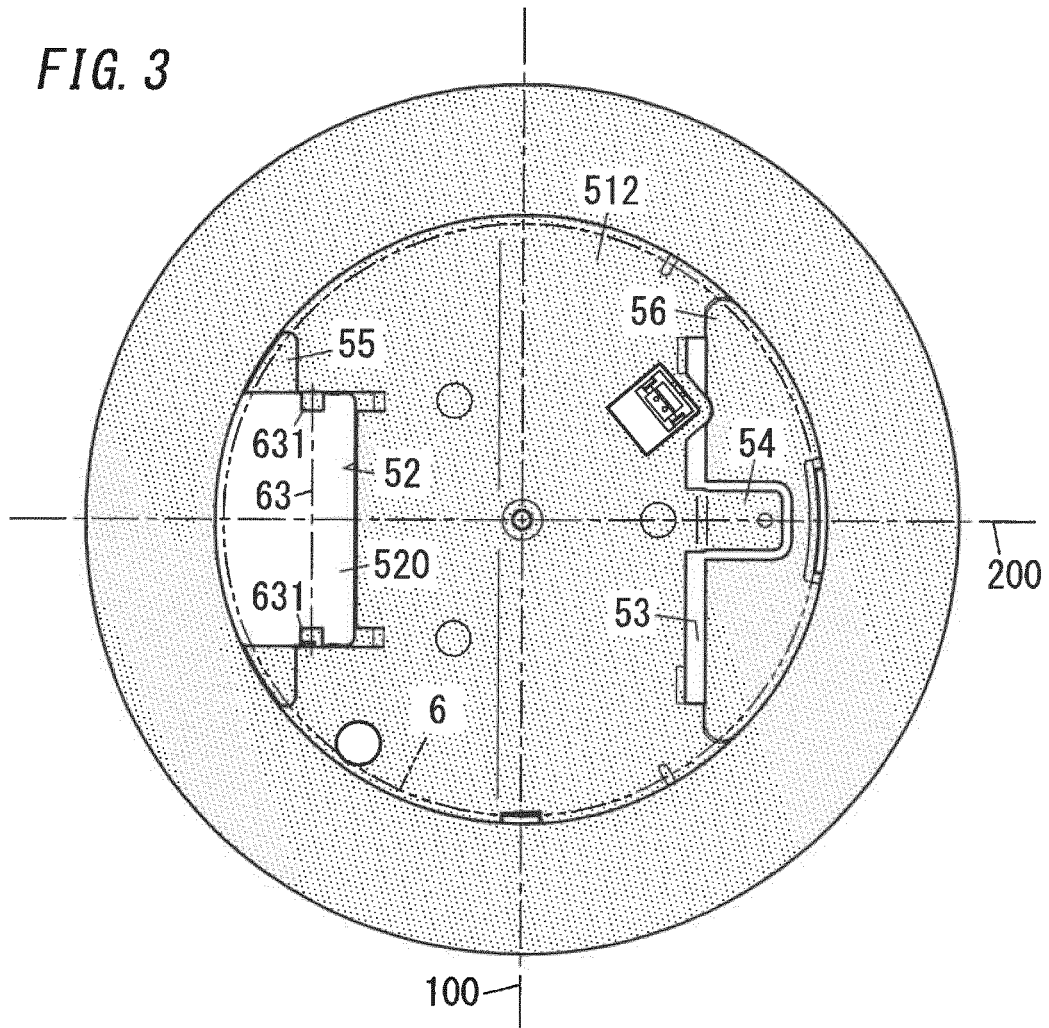


FIG. 4A

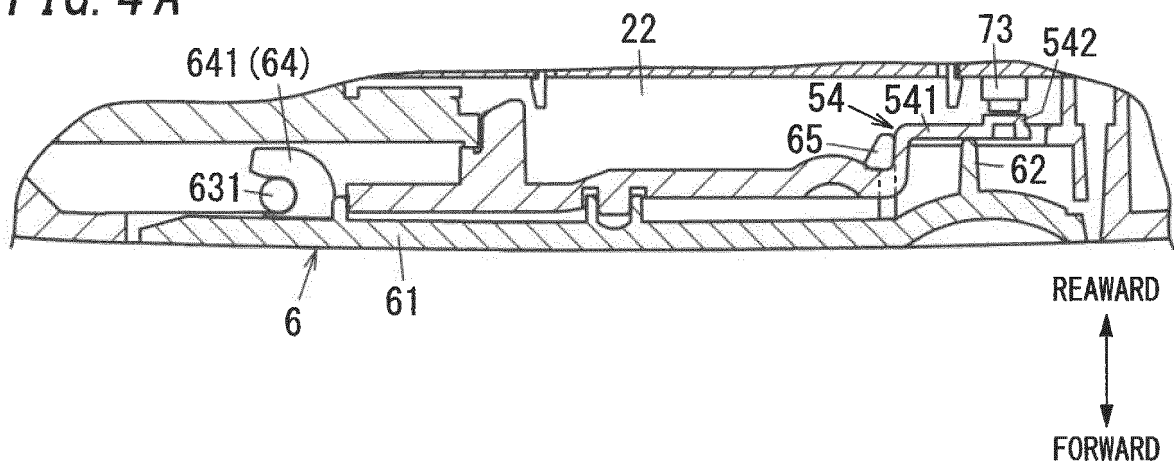


FIG. 4B

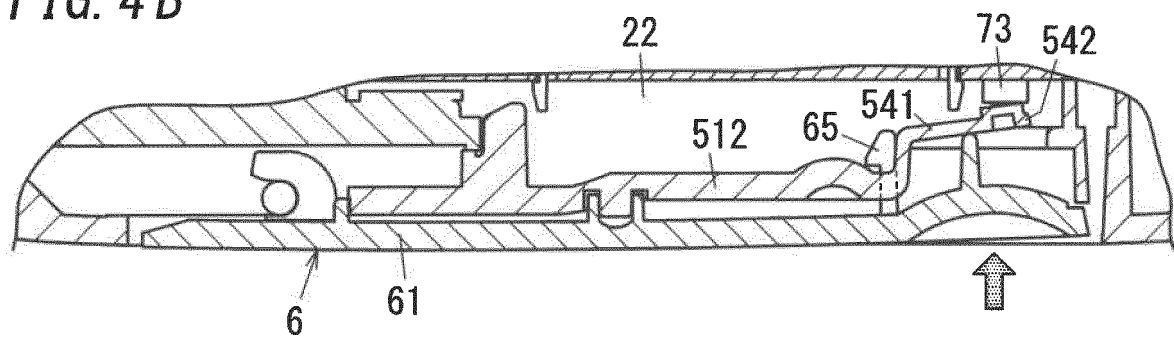


FIG. 5A

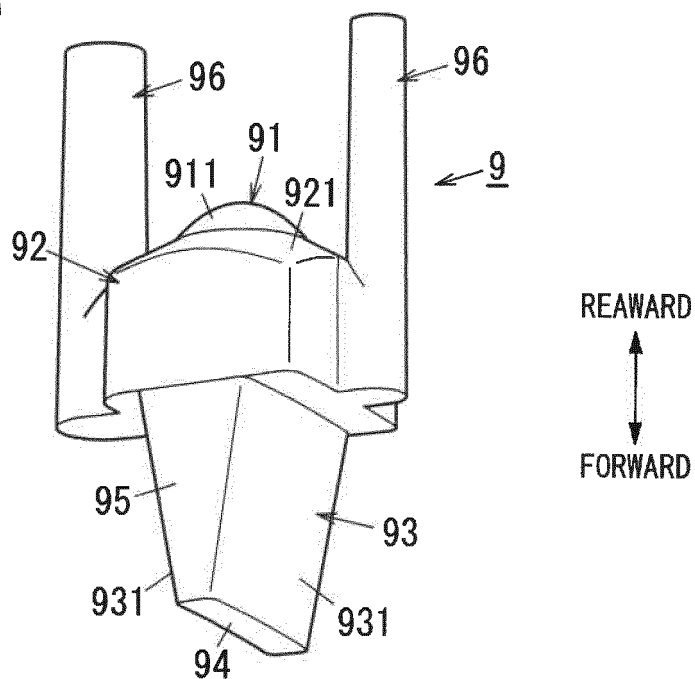


FIG. 5B

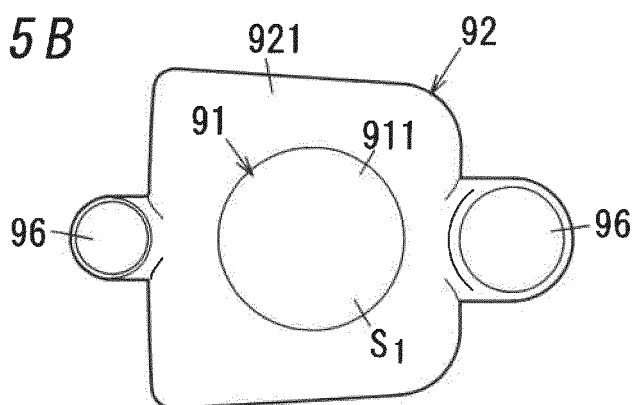


FIG. 5C

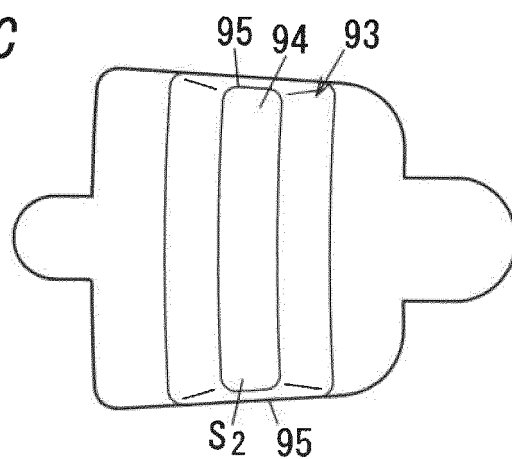


FIG. 6A

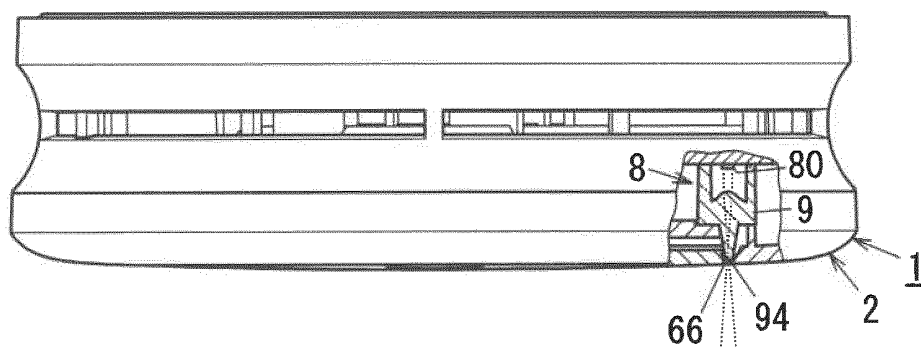


FIG. 6B

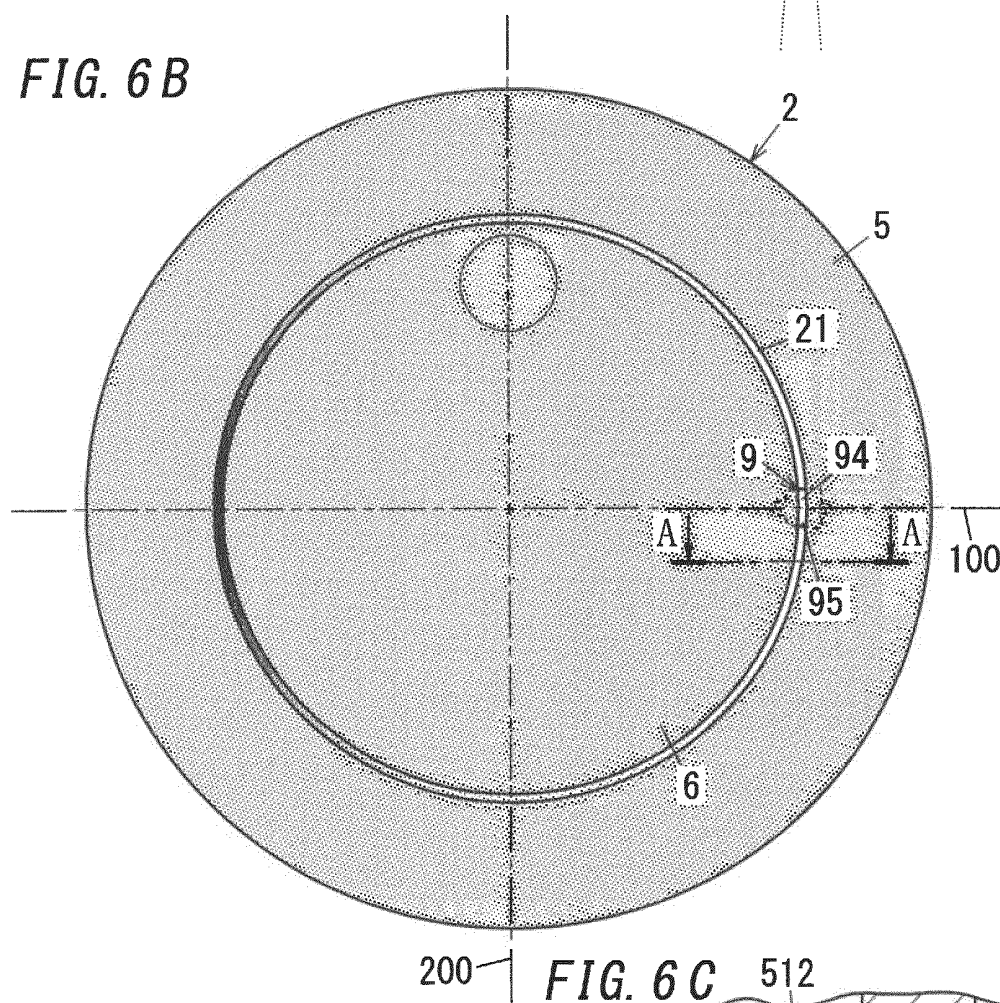


FIG. 6C

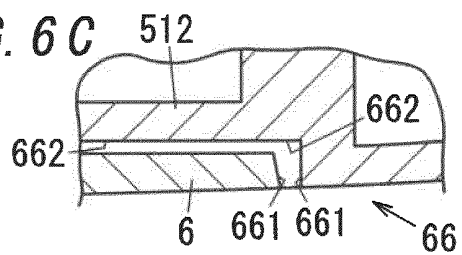


FIG. 7A

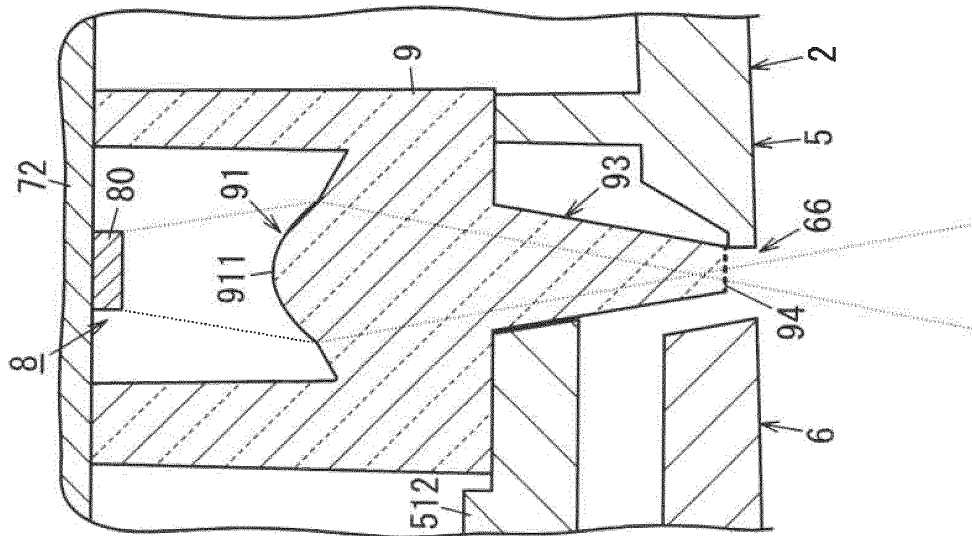


FIG. 7B

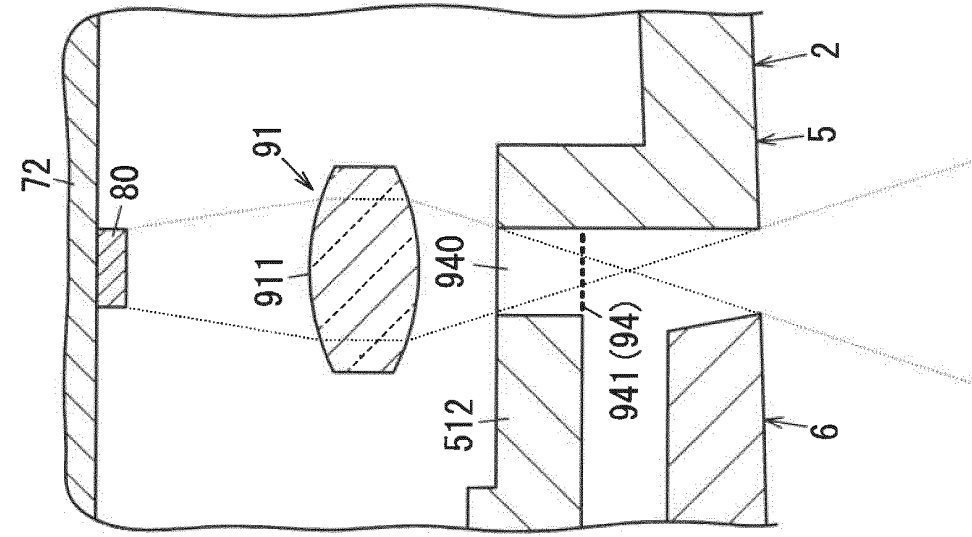


FIG. 7C

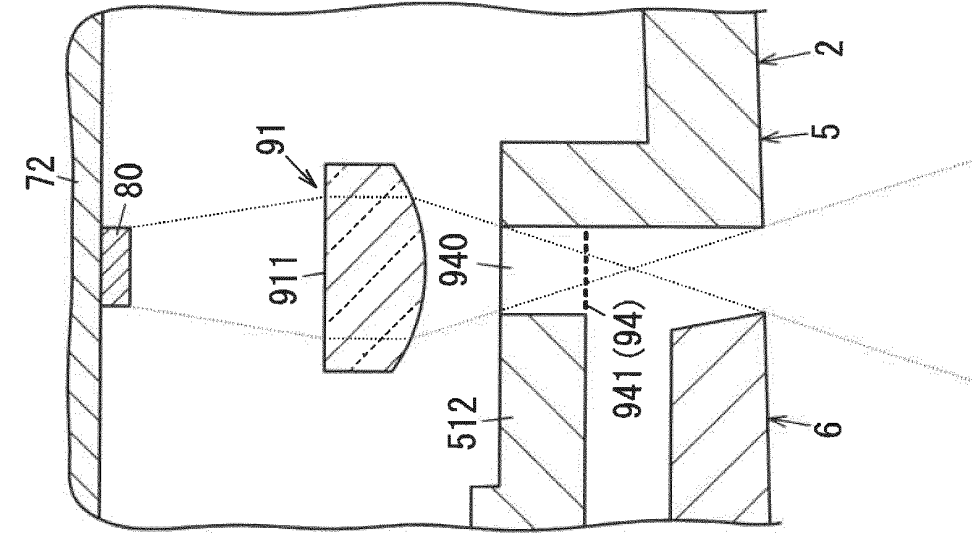


FIG. 8

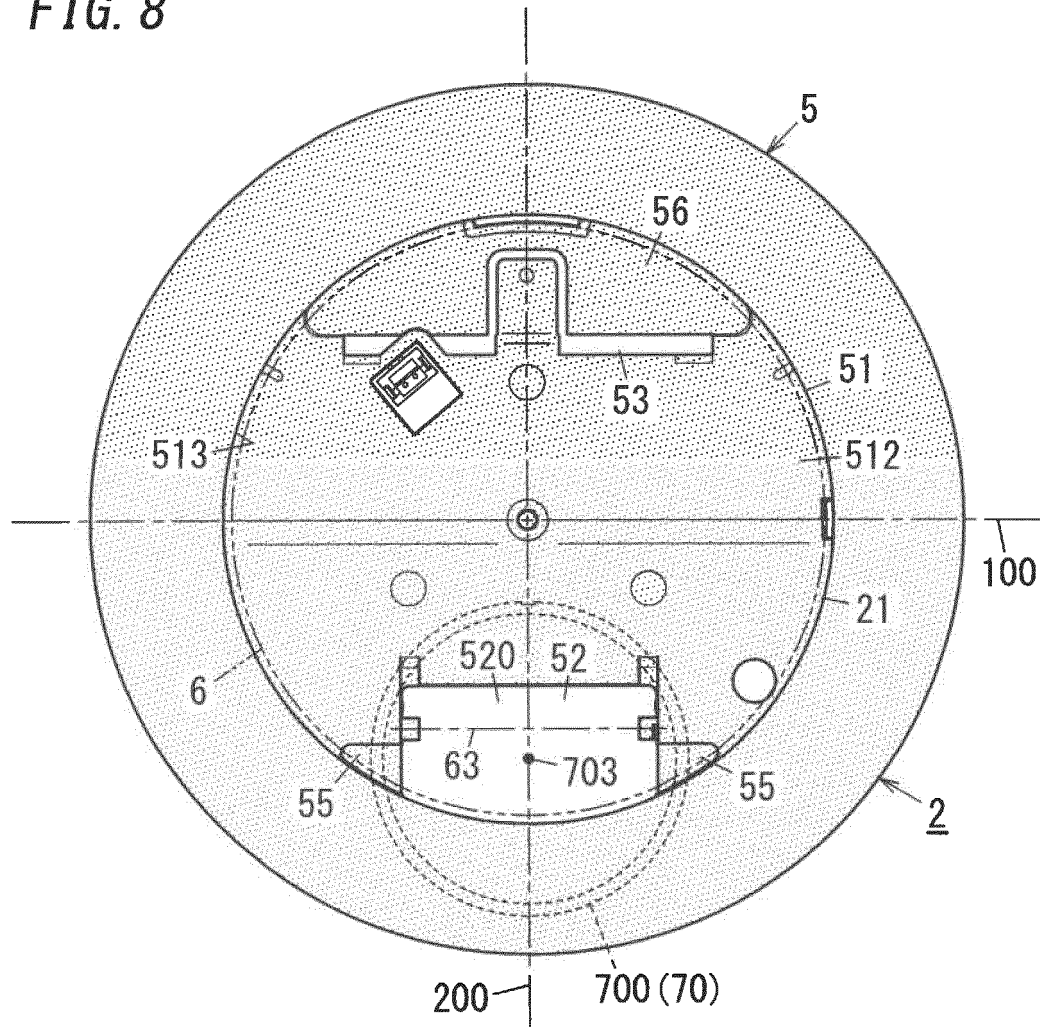


FIG. 9A

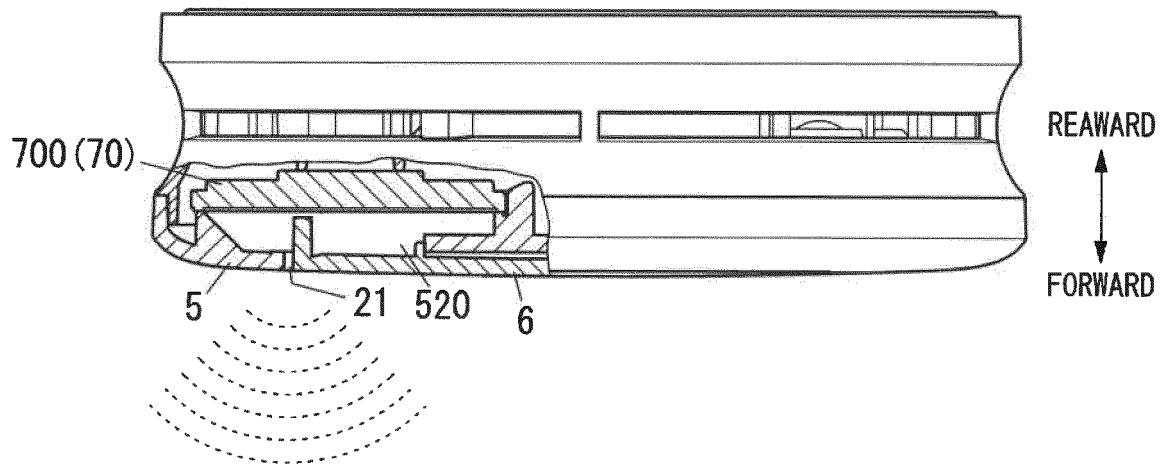


FIG. 9B

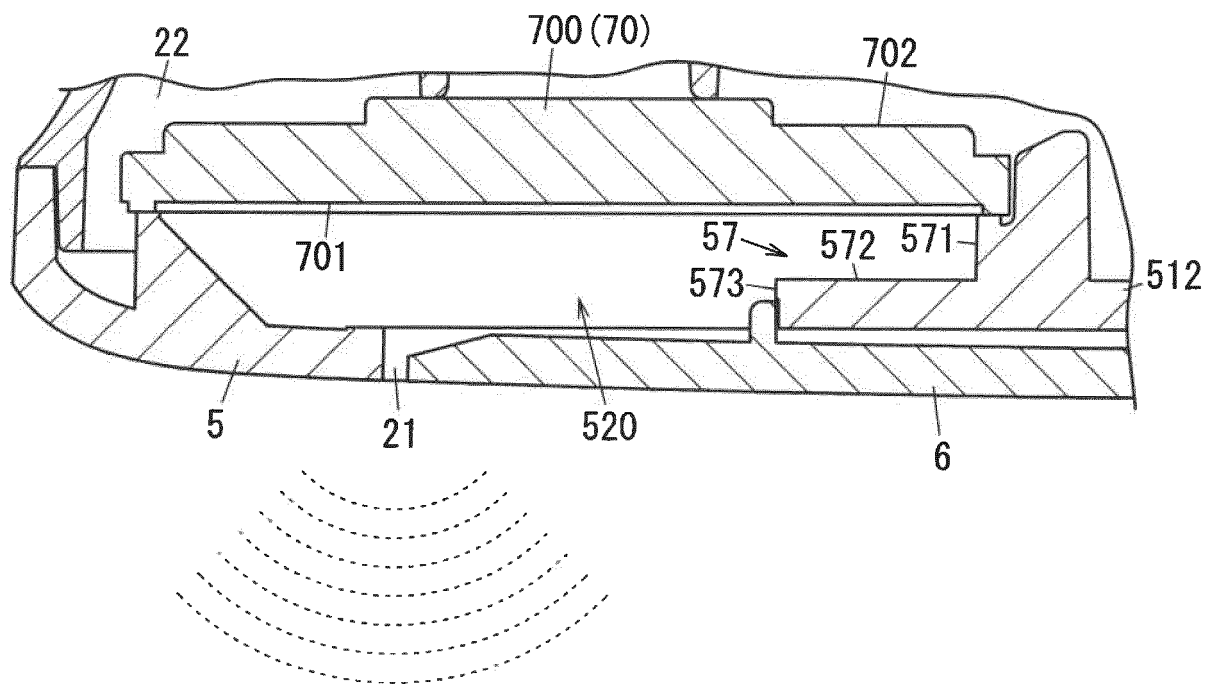


FIG. 10A

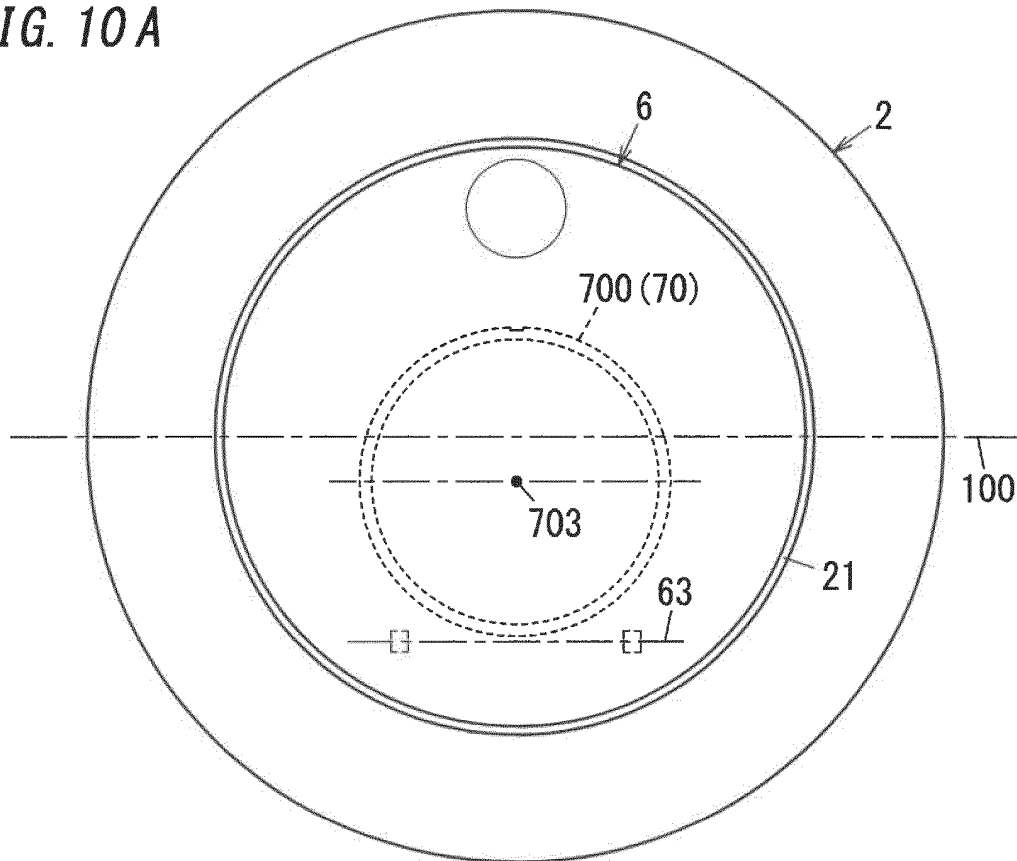


FIG. 10B

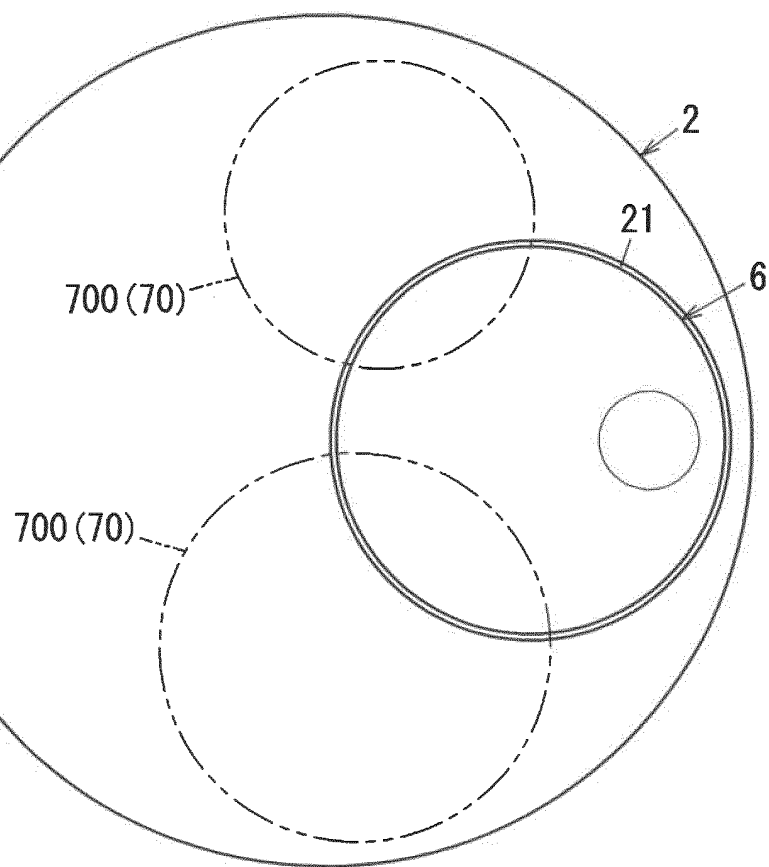


FIG. 11 A

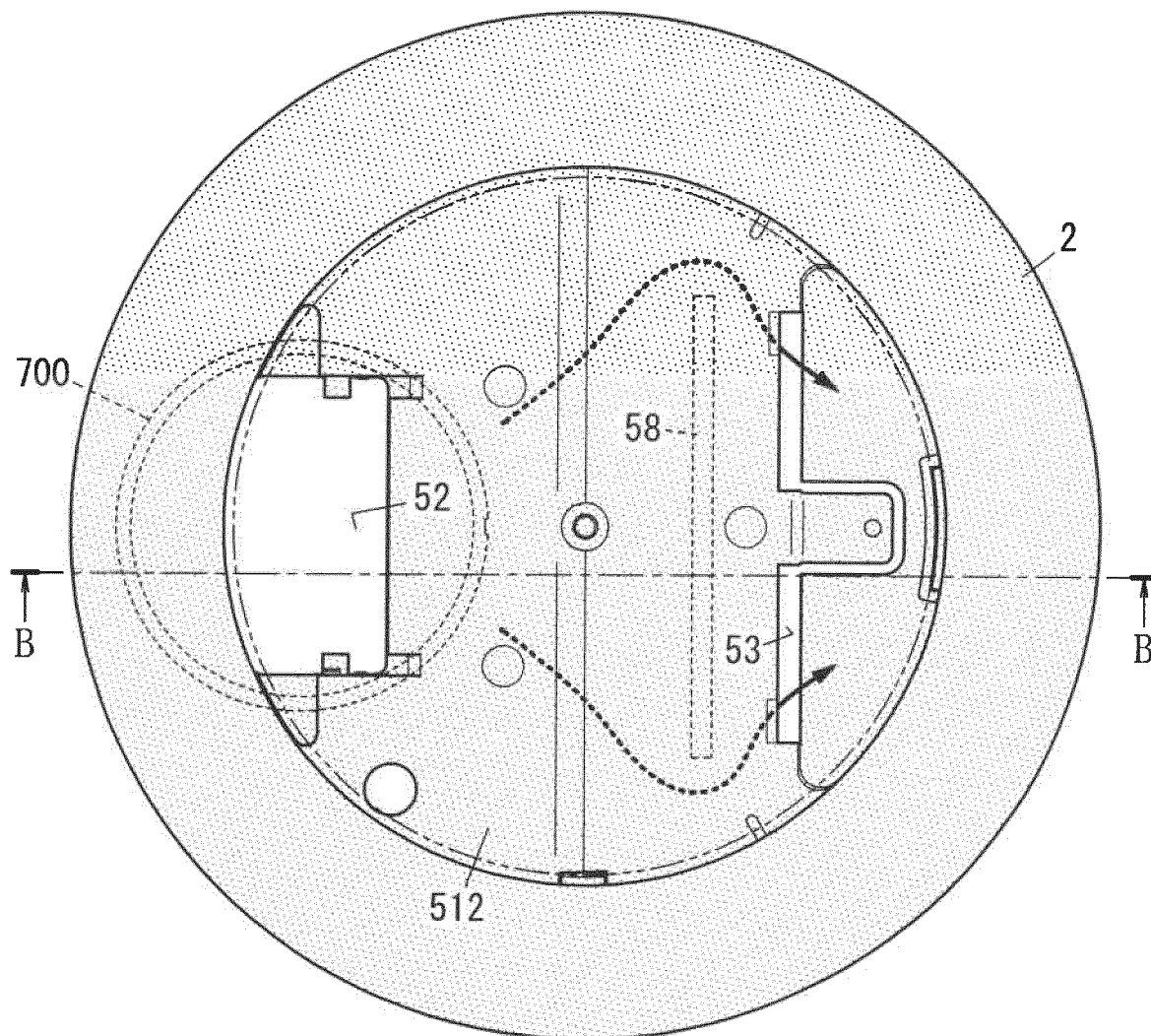
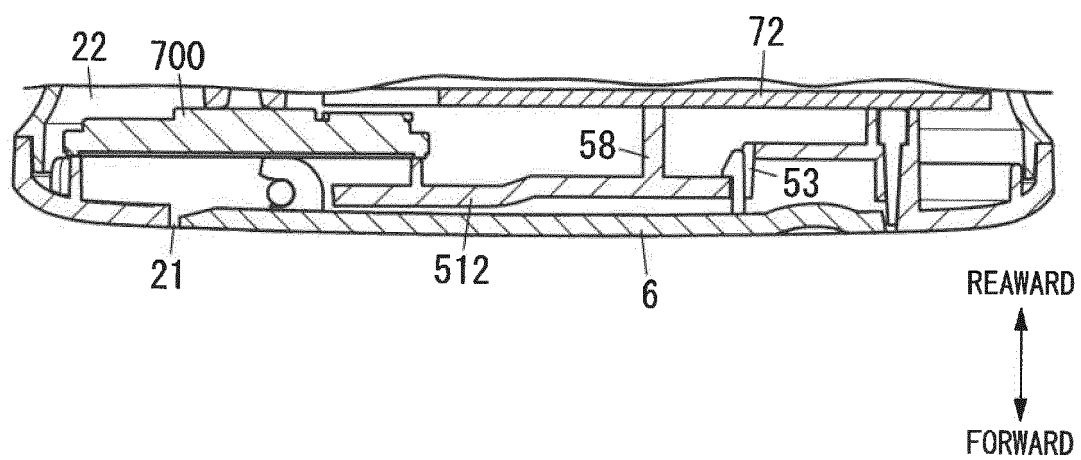


FIG. 11 B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/030929

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F21S9/02 (2006.01) i, F21V5/00 (2018.01) i, F21V5/04 (2006.01) i,
F21V8/00 (2006.01) i, F21V23/00 (2015.01) i, F21V33/00 (2006.01) i,
G08B17/00 (2006.01) i, F21Y115/10 (2016.01) n

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F21S9/02, F21V5/00, F21V5/04, F21V8/00, F21V23/00,
F21V33/00, G08B17/00, F21Y115/10

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 10-111988 A (NITTAN CO., LTD.) 28 April 1998,	1-2
Y	paragraphs [0004], [0043]-[0057] fig. 4-7 (b)	3, 6-10
A	(Family: none)	4-5
Y	JP 2003-36488 A (NOHMI BOSAI LTD.) 07 February	3, 6-10
	2003, paragraphs [0008]-[0015] fig. 1-3 (Family:	
	none)	
Y	JP 2017-84023 A (HOCHIKI CORP.) 18 May 2017,	6-10
	paragraph [0038] fig. 4 (Family: none)	

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

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

Date of the actual completion of the international search
07 November 2018 (07.11.2018)

Date of mailing of the international search report
20 November 2018 (20.11.2018)

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

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Patent documents cited in the description

- JP 2013025996 A [0004]