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(54) **ALARM DEVICE**

(57) The present invention proposes an alarm device suitable for wall mounting, comprising: a support plate (21); at least three light-emitting units (23), which are disposed on the support plate (21) and are arranged spaced apart from one another along a substantially semicircular arc; at least one reflection cup (25) capable of being fixed to the support plate (21), each reflection cup being adapted to accommodate at least one of the

light-emitting units (23), the reflection cup(s) (25) substantially extending or being arranged in the shape of a semicircular ring, an inner surface of the reflection cup being a reflective surface and being constructed to reflect light emitted by the light-emitting unit (23) towards a cubic optical coverage volume, wherein the alarm device is positioned in a center position on a top edge of the optical coverage volume.

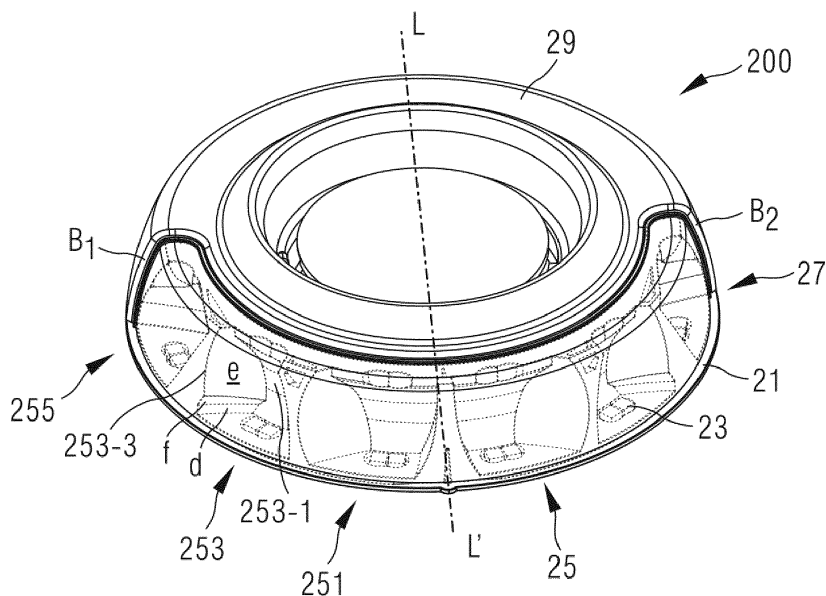


Fig. 2

**EP 3 321 898 A1**

## Description

### Technical field

**[0001]** The present invention generally relates to a notification device for issuing an alert to indicate an emergency, and in particular relates to a visual notification device used in a fire protection system, also called a visual alarm device (VAD) or optical alarm device.

### Background art

**[0002]** Visual alarm devices are widely used in fire alarm systems, being used to send out a visible alarm indication, e.g. high-intensity strobe light, to on-site personnel when an emergency occurs. In general, a visual alarm device (VAD) is connected to a control apparatus (control panel) via a field line or a wireless link. When the occurrence of an emergency (e.g. a fire) is detected, the control apparatus can trigger the VAD via the field line, such that the VAD emits high-intensity alarm light visible to the human eye, to prompt on-site personnel to promptly evacuate a region of danger.

**[0003]** In general, a VAD may be installed on a ceiling (abbreviated as "top-mounted" or on a wall (abbreviated as "wall-mounted"). Fig. 1 demonstratively shows a schematic diagram of a wall-mounted VAD 100. As shown in fig. 1, the VAD 100 is mounted on a wall W, and can illuminate a cubic space V that substantially has the shape of a cube or cuboid, wherein the VAD 100 is located at the mid-point of a top edge of the cubic space V. The light intensity distribution on the surfaces of this cubic space V must meet the requirements of the relevant fire protection standard. The cubic space V is generally described by (X, Y, Y), wherein X represents the mounting height of the VAD 100 from the floor, e.g. 2.4 m, and Y represents the furthest distance that can be reached by light from the VAD in the direction of a perpendicular wall surface, and the range that can be covered by light from the VAD in the direction of a parallel wall surface, e.g. Y = 10 m. Thus, the cubic space V is also called the optical coverage volume, which is also the space specified in the relevant fire protection standard as needing to be illuminated by alarm light. When the VAD 100 is actually mounted, the alarm effectiveness of the VAD can be guaranteed as long as the room in which it is mounted is smaller than the optical coverage volume V.

**[0004]** As light-emitting diode (LED) technology matures, LED chips are gradually being used as light sources in VADs. To meet the requirements of the relevant standard with respect to the VAD light intensity distribution, it is generally necessary to use a high-intensity LED chip, the power consumption of which is also high.

**[0005]** For this reason, there is a need to propose a VAD using an LED chip as a light source, which VAD can lower the performance requirements for single LED chips while meeting the requirements of the relevant standard.

## Content of the invention

**[0006]** An object of the present invention is to provide a visual alarm device (VAD) suitable for wall mounting, which can use LED chips with low power consumption as a light source.

**[0007]** According to one aspect of the present invention, the present invention proposes an alarm device suitable for wall mounting, comprising: a support plate; at least three light-emitting units, which are disposed on the support plate and are arranged spaced apart from one another along a substantially semicircular arc; at least one reflection cup capable of being fixed to the support plate, each reflection cup being adapted to accommodate at least one of the light-emitting units, the reflection cup(s) substantially extending or being arranged in the shape of a semicircular ring, an inner surface of the reflection cup being a reflective surface and being constructed to reflect light emitted by the light-emitting unit towards a substantially cubic optical coverage volume, wherein an equivalent optical center of the alarm device is positioned in a center position on a top edge of the optical coverage volume.

**[0008]** Preferably, if the alarm device comprises two or more reflection cups, two adjacent reflection cups space the light-emitting units in the two reflection cups apart from each other. Optionally, each pair of adjacent light-emitting units is spaced apart by an equal distance. Optionally, each pair of adjacent light-emitting units is spaced apart by a gradually changing distance. Optionally, each light-emitting unit comprises two or more LED chips.

**[0009]** The alarm device described above uses multiple discrete light-emitting units, which are arranged spaced apart from one another substantially along a semicircular arc. When such a distributed arrangement is adopted, multiple light-emitting units can together make a contribution to the light intensity output of the alarm device; this lowers the requirement for light intensity output by each light-emitting unit. If necessary, multiple light-emitting units may also be arranged to provide a higher light flux, to achieve the objective of covering a larger space. Moreover, by disposing light-emitting units close to two end-points of a semicircular arc and having these cooperate with a reflecting structure such as reflection cups, the light intensity distribution close to the top surface of the optical coverage volume V can be improved, so that the requirements of the relevant standard can be met more easily. Thus, the example shown in fig. 2 can use light-emitting units with lower power consumption, with a light intensity distribution capable of meeting standard requirements. In turn, the design of the reflection cups can reflect light emitted by each light-emitting unit towards the optical coverage volume. This design of reflection cup can also effectively meet the requirements set out in the relevant standard with regard to light intensity output of the alarm device in a designated direction, and effectively make up light intensity distribution.

**[0010]** Preferably, each reflection cup is arranged to partially surround at least one of the light-emitting units positioned therein, and a light output opening of the reflection cup is disposed on a periphery of the semicircular ring. Preferably, an inner surface of the reflection cup is a concave surface, the reflection cup has substantially opposite first and second reflective parts and the light-emitting unit is positioned between the first and second reflective parts, wherein at least one of the first and second reflective parts is inclined in a direction away from the light-emitting unit. The design of the first and second reflective parts can increase the light intensity distribution area of light outputted by the light-emitting unit, thereby making up the light intensity distribution in a region outside the range of linear illumination of the light-emitting unit. In other words, the two reflective parts can reflect a greater amount of the energy emitted by the light-emitting unit in a designated direction (the optical coverage volume V) required by a standard.

**[0011]** Optionally, the first and second reflective parts of the reflection cup close to a center point of the semicircular ring are both inclined in a direction away from the light-emitting unit. Optionally, in the case of the reflection cup located in the vicinity of an end point of the semicircular ring, the first reflective part close to the end point of the semicircular ring is inclined towards the light-emitting unit, and the second reflective part is inclined away from the light-emitting unit.

**[0012]** Preferably, the first reflective part or second reflective part of at least one reflection cup comprises two or more secondary reflective parts adjoining each other, each secondary reflective part being a reflective surface in the form of a conical curved surface. By using multiple secondary reflective surfaces, the curvature or orientation of the secondary reflective surfaces can be set more effectively for light that is incident at different angles, thereby increasing reflection efficiency.

**[0013]** Preferably, each reflection cup further comprises a third reflective part, which adjoins the first and second reflective parts and faces the light-emitting unit accommodated in the reflection cup, the third reflective part being a concave surface. Preferably, the third reflective part comprises at least two secondary reflective parts adjoining each other, each secondary reflective part being a reflective surface in the form of a conical curved surface. Light emitted by the light-emitting part away from the optical coverage volume can be reflected towards the optical coverage volume by the third reflective part.

**[0014]** Preferably, each reflection cup further comprises a first auxiliary reflective part disposed on an edge of the reflection cup above the light-emitting unit, the first auxiliary reflective part extending to form a concave surface; preferably, the first auxiliary reflective part has multiple concave surfaces corresponding in quantity and position to the LED chips. The auxiliary reflective part can enhance the light intensity distribution in a region close to the top surface of the optical coverage volume.

**[0015]** Optionally, the alarm device further comprises

a transparent cover, which at least covers the light-emitting units and the reflection cup, with at least one prism part being disposed on the transparent cover, the prism part being capable of guiding light emitted by the light-emitting unit so as to be scattered towards the optical coverage volume. Preferably, the at least one prism part comprises at least one prism part extending in the circumferential direction of the transparent cover, or comprises at least one prism part extending in a direction perpendicular to the circumferential direction of the transparent cover. By setting prisms on the transparent cover, the angle of spread of light emitted by the light-emitting units can be further expanded.

**[0016]** Preferably, the alarm device further comprises a replaceable casing which can at least partially cover the transparent cover, with at least one of the light-emitting unit and the reflection cup being removable. Preferably, the replaceable casing is a first casing having a semicircular ring opening, the semicircular ring opening being adapted to expose the light-emitting units and the reflection cup. The replaceable casing may also be a casing which completely covers the transparent cover. By using a replaceable casing and a removable light-emitting unit or reflection cup, two products, namely an acoustic/optical alarm device and an acoustic alarm device, can be obtained with the same basic structure, with no need for excessive changes to be made. Such a design facilitates production and processing, and so lowers production costs.

**[0017]** Preferred embodiments are explained below in a clear and easily comprehensible way with reference to the accompanying drawings, to further explain the above-mentioned characteristics, technical features and advantages of the present invention and embodiments thereof.

Description of the accompanying drawings

**[0018]** The accompanying drawings below merely illustrate and explain the present invention schematically, without limiting the scope thereof.

Fig. 1 demonstratively shows an optical coverage volume of a wall-mounted VAD.

Fig. 2 shows a schematic diagram of a VAD according to an embodiment of the present invention.

Fig. 3 shows a perspective exploded view of the VAD shown in fig. 2.

Figs. 4A - 4C schematically show layout diagrams of light sources in a VAD according to another embodiment of the present invention.

Figs. 5A and 5B show structural schematic diagrams of a reflection cup in a VAD according to an embodiment of the present invention.

Fig. 6 shows a schematic diagram of a transparent cover in a VAD according to another embodiment of the present invention.

Figs. 7A - 7D show schematic diagrams of a casing of a VAD according to another embodiment of the present invention.

#### Particular embodiments

**[0019]** To enable clearer understanding of the technical features, objectives and effects of the invention, particular embodiments of the present invention are now explained with reference to the accompanying drawings, in which identical labels indicate structurally identical components or components with similar structures but identical functions.

**[0020]** As used herein, "schematic" means "serving as an instance, example or illustration". No drawing or embodiment described herein as "schematic" should be interpreted as a more preferred or more advantageous technical solution.

**[0021]** To make the drawings appear uncluttered, only those parts relevant to the present invention are shown schematically in the drawings; they do not represent the actual structure thereof as a product. Furthermore, to make the drawings appear uncluttered for ease of understanding, in the case of components having the same structure or function in certain drawings, only one of these is drawn schematically, or only one is marked.

**[0022]** In this text, "a" does not only mean "just this one"; it may also mean "more than one". Furthermore, as used herein, "first" and "second" etc. are merely used to differentiate between parts, not to indicate their order or degree of importance, etc.

**[0023]** Fig. 2 shows a wall-mounted VAD 200 according to an embodiment of the present invention. Fig. 3 demonstratively shows an exploded view of the VAD 200 shown in fig. 2. In the example of figs. 2 and 3, the VAD 200 comprises a support plate 21, 6 light-emitting units 23, 6 reflection cups 25, a transparent cover 27, and a casing 29. Here, to facilitate description, 25 refers to a general designation for the reflection cups, or refers to any one reflection cup. 25x (x = 1, 3, 5) refers to a single specific reflection cup. The VAD 200 is mounted on a wall in the manner shown in fig. 1. In other words, an equivalent optical centre of the VAD 200 is positioned in a center position on a top edge of the optical coverage volume V. After mounting on the wall, a plane in which the support plate 21 of the VAD 200 lies is parallel to the wall surface W, and a transparent part A through which light can pass is oriented downward.

**[0024]** As shown in figs. 2 and 3, the external form of the VAD 200 is substantially disk-shaped. However, the external form of the VAD is not limited to this, and could also be spherical, hemispherical, rectangular or ellipsoid, etc. Preferably, as fig. 3 shows, the transparent cover 27 is a complete disk-shaped cover, which may be engaged

with the support plate 21, thereby forming a chamber. The light-emitting units 23 and reflection cups 25 are accommodated in the chamber. The casing 29 may be engaged with the transparent cover 27. The casing 29 also has a substantially semi-annular opening 292; the transparent part A may be exposed through the opening 292, and exactly covers the light-emitting units 23 and reflection cups 25.

**[0025]** In the example of figs. 2 and 3, the 6 light-emitting units 23 are disposed on the support plate 21. The support plate 21 is preferably a drive circuit board, which can support the light-emitting units 23 and can transmit a drive signal to each light-emitting unit 23. In this example, the support plate 21 is a main circuit board, which is substantially disk-shaped. Optionally, the support plate 21 may also be semi-annular, and is just used to position the light-emitting units. Preferably, the support plate 21 may also be a drive board of the light-emitting units, not a main circuit board.

**[0026]** The 6 light-emitting units 23 are arranged spaced apart from one another along a semicircular arc C on the support plate 21. Preferably, the semicircular arc C is close to an edge of the support plate 21. Each light-emitting unit 23 may comprise one, two or more LED chips. In the example of figs. 2 and 3, each light-emitting unit 23 has two LED chips arranged side by side, and adjacent light-emitting units 23 are spaced by substantially equal distances. Optionally, according to actual requirements, the number of light-emitting units 23 may also be three, four or five or more.

**[0027]** In fig. 2, the 6 reflection cups 25 may be fixed to the support plate 21 and are arranged together to form a semicircular ring. Openings of the reflection cups are disposed on the periphery of the semicircular ring. Each reflection cup 25 may accommodate one light-emitting unit 23. An inner surface of each reflection cup 25 is designed as a reflective surface; these reflective surfaces can reflect light emitted by the light-emitting units 23 towards an optical coverage volume V as shown in fig. 1, wherein the VAD 200 is disposed in a center position of a top edge of the optical coverage volume V. Optionally, in figs. 2 and 3, the number of reflection cups 25 may also be 1, 2, 3 or more. One, two or more light-emitting units 23 may be accommodated in each reflection cup. In the case of two or more reflection cups, two adjacent reflection cups may space apart light-emitting units in each reflection cup. Preferably, the 6 reflection cups 25 in fig. 3 are constructed as an integrally formed element 26, which substantially extends in a semi-annular shape.

**[0028]** In the embodiment above, the VAD 200 uses multiple discrete light-emitting units, which are arranged spaced apart from one another substantially along a semicircular arc. When such a distributed arrangement is adopted, multiple light-emitting units can together make a contribution to the light intensity output of the VAD; this lowers the requirement for light intensity output by each light-emitting unit. If necessary, multiple light-emitting units may also be arranged to provide a higher light flux,

to achieve the objective of covering a larger space. Moreover, by disposing light-emitting units close to two end-points of a semicircular arc and having these cooperate with a reflecting structure such as reflection cups, the light intensity distribution close to the top surface of the optical coverage volume V can be improved, so that the requirements of the relevant standard can be met more easily. Thus, the example shown in fig. 2 can use light-emitting units with lower power consumption, with a light intensity distribution capable of meeting standard requirements. In turn, the design of the reflection cups can reflect light emitted by each light-emitting unit towards the optical coverage volume V. This design of reflection cup can also effectively meet the requirements set out in the relevant standard with regard to light intensity output of the VAD in a designated direction, and effectively make up light intensity distribution.

**[0029]** Figs. 4A - 4C demonstratively show schematic diagrams of three types of distributed arrangement of light-emitting units. For the sake of simplicity, components such as the reflection cups and casing are omitted from figs. 4A - 4C. In fig. 4A, the VAD 400A comprises 6 light-emitting units which are symmetric with respect to a center line L-L'. These light-emitting units are arranged spaced apart from one another along a semicircular arc C. For example, a light-emitting unit 432 is disposed close to a center point L of the semicircular arc. The light-emitting unit 432 has one LED chip. A light-emitting unit 436 is disposed close to an end-point (B1, B2) of the semicircular arc C. The light-emitting unit 436 has three LED chips. A light-emitting unit 434 located in a middle position has two LED chips. In other words, in the example of fig. 4A, a reflection cup closer to an end-point of the semicircular arc C comprises a greater number of LED chips. Such a design cooperates with the reflection cup design, making it easier to make up light intensity distribution in a region close to the top surface of the optical coverage volume.

**[0030]** In fig. 4B, the VAD 400B comprises 6 light-emitting units which are symmetric with respect to a center line L-L'. These light-emitting units are arranged spaced apart from one another along a semicircular arc C. Each light-emitting unit 435 comprises a single LED chip, and the gap between each pair of adjacent light-emitting units gradually increases from a center point L to an end-point.

**[0031]** In fig. 4C, the VAD 400C comprises 6 light-emitting units which are symmetric with respect to a center line L-L'. These light-emitting units are arranged spaced apart from one another along a semicircular arc C. Each light-emitting unit 439 comprises a single LED chip, and the light-emitting units 439 are arranged in a staggered manner on two sides of the semicircular arc C.

**[0032]** 6 reflection cups 25 as shown in figs. 2 and 3 are arranged in the shape of a semicircular ring, and a direction in which each reflection cup opens is arranged on the periphery of the semicircular ring. The 6 reflection cups 25 are symmetric with respect to the center line L-L'. Characteristics held in common by the reflection cups

in the present invention are described below, taking as an example a reflection cup 251 close to the center point L in figs. 2 and 3. Fig. 5 shows the specific structure of a reflection cup 251. As fig. 5 shows, the reflection cup 251 is arranged to partially surround the light-emitting unit 23, and an inner surface of the reflection cup is a reflective surface. In fig. 5, the light-emitting unit 23 is two LED chips arranged side by side. Preferably, the inner surface of the reflection cup is substantially a concave surface. The inner surface of the reflection cup may be one continuous curved surface, and may also comprise two or more secondary curved surfaces adjoining each other. Optionally, part of a surface in the reflection cup could also be designed as a convex surface, as long as it can reflect light towards the optical coverage volume V.

**[0033]** As shown in fig. 5A, the reflection cup 251 has three main reflective parts 251\_1, 251\_3 and 251\_5 which adjoin each other. The reflective part 251\_1 faces the light-emitting unit 23, and is substantially a concave surface, extending on an inner periphery of a semicircular ring. Fig. 5B shows a partial section taken along M-M' in fig. 5A. The reflective part 251\_1 can reflect light emitted by the light-emitting unit 23 towards the optical coverage volume V. Preferably, as shown in fig. 5A, the reflective part 251\_1 may also specifically comprise e.g. three secondary reflective parts a, b and c, which adjoin each other. Each secondary reflective part extends in the direction of the inner periphery of the semicircular ring, and the different secondary reflective parts are stacked on top of one another. The three secondary reflective parts (secondary reflective surfaces) show slight differences in curvature and angle of inclination, in order to effectively reflect light which is incident at different angles.

**[0034]** In the reflection cup 251 shown in fig. 5A, the reflective part 251\_3 and the reflective part 251\_5 are substantially opposite each other, with the light-emitting unit 23 being disposed between the reflective parts 251\_3 and 251\_5. As shown in fig. 5A, the reflective parts 251\_3 and 251\_5 are both inclined in a direction away from the light-emitting unit 23, so as to reflect light emitted by the light-emitting unit 23 towards the optical coverage volume V thereof. The design of the reflective parts 251\_3 and 251\_5 can increase the light intensity distribution area of light outputted by the light-emitting unit 23, thereby making up the light intensity distribution in a region outside the range of linear illumination of the light-emitting unit 23; in other words, the two reflective parts can reflect a greater amount of the energy emitted by the light-emitting unit 23 in a designated direction (the optical coverage volume V) required by a standard.

**[0035]** Preferably, to guarantee light intensity distribution in a region close to the top surface of the optical coverage volume V, the reflection cup 251 is also provided with an auxiliary reflective part 251\_7 on an edge located above the light-emitting unit 23. The auxiliary reflective part 251\_7 is a concave surface extending in a circumferential direction. Preferably, one such concave

surface is provided for each LED chip. In the example of fig. 5A, the reflection cup 251 has an auxiliary reflective part 251\_7 comprising two concave surfaces. The auxiliary reflective part 251\_7 can enhance the light intensity distribution in a region close to the top surface of the optical coverage volume V.

**[0036]** In the example of fig. 5A, the reflection cup 251 also has a bottom surface 251\_8. An opening 251\_9 is also provided on the bottom surface 251\_8; the light-emitting unit 23 is adapted to pass through the opening 251\_9 and thereby expose a light-emitting surface thereof. The bottom surface is preferably also a reflective surface. Optionally, the reflection cup could also not have a bottom surface, but be directly fixed to the support plate 21. On the one hand, the bottom surface 251\_8 can subject stray light occurring in the reflection cup 251 to further reflection, in order to make effective use of the energy of the light-emitting unit. On the other hand, the presence of the bottom surface 251\_8 can increase the sturdiness and durability of the overall structure of the 6 reflection cups arranged together.

**[0037]** Figs. 2 and 3 are returned to below. The 6 reflection cups 250 in figs. 2 and 3 are symmetric with respect to the center line L-L', i.e. the symmetrical reflection cups on two sides of the center line have the same structure. The structures of the reflection cup 253 and the reflection cup 255 are substantially similar to the structure of the reflection cup 251. The difference is that the directions of inclination of two substantially opposite reflective parts 253\_3 and 253\_5 of the reflection cup 253 are different. The reflective part 253\_3 close to an end B1 is inclined in a direction away from the light-emitting unit 23, whereas the reflective part 253\_5 close to the center line is inclined towards the light-emitting unit. Such a design can cause more of the light emitted by the light-emitting unit in the reflection cup 253 to be reflected towards the end B. More preferably, the reflective part 253\_3 comprises three secondary reflective parts e, f and d which are stacked. The three secondary reflective parts are each conical curved surfaces; parameters such as curvature and direction of inclination thereof are different from one another. Preferably, an area occupied by the secondary reflective part e is greater than the sum of the other two. The secondary reflective part e is inclined in a direction away from the light-emitting unit. The secondary reflective parts f and d are inclined towards the light-emitting unit. Optionally, the reflective part 253\_3 could also have one continuous reflective surface, or have 2, 4 or more secondary reflective parts. As shown in fig. 3, the reflective part 253\_5 may be one continuous reflective curved surface, and could also be a surface having multiple secondary reflective surfaces. The design of the reflective part 253\_3 of the reflection cup 253 makes it easier for light emitted by the light-emitting unit to be reflected in the direction of the end of the semicircular ring, to enhance light intensity distribution in a region close to the top surface of the optical coverage volume V.

**[0038]** Unlike the reflection cup 251 in fig. 5A, the directions of inclination of two substantially opposite reflective parts 255\_3 and 255\_5 of the reflection cup 255 in fig. 3 are different. The reflective part 255\_3 close to an end B is inclined towards the light-emitting unit, whereas the reflective part 255\_5 close to the center line is inclined in a direction away from the light-emitting unit. Such a design can cause more of the light emitted by the light-emitting unit in the reflection cup 255 to be reflected towards the end B. More preferably, the reflective part 255\_3 comprises three secondary reflective parts which are stacked. The three secondary reflective parts are each conical curved surfaces; parameters such as curvature and direction of inclination thereof are different from one another. Preferably, the three secondary reflective parts have substantially equivalent areas. Preferably, in the reflection cup 255, the reflective part 255\_1 is a conical curved surface tending towards planarity. The reflective part 255\_1 also preferably has two or more secondary reflective parts. As the reflective part 255\_1 is a reflective surface tending towards planarity, it can reflect light in the direction of the vicinity of the end B more effectively, thereby enhancing the light intensity distribution in a region close to the top surface in the optical coverage volume.

**[0039]** Referring to fig. 3, the transparent cover 27 and casing 29 have the function of protecting internal components of the VAD, and can enable light emitted by the VAD to be projected outwards. Optionally, the discrete transparent cover 27 and casing 29 in fig. 3 may be replaced with a casing having a transparent window, or be replaced with a completely transparent casing; the transparent cover 27 may even be omitted, with the light-emitting units being exposed directly to the outside. Preferably, the alarm device shown in fig. 3 is an acoustic/optical alarm device. The transparent cover 27 has a sound channel part 272. When the casing 29 is engaged with the transparent cover 27, a sound chamber is formed at the sound channel part 272. Thus, the use of an integrally formed element 27 can simultaneously realize the functions of a sound channel and an optically transparent cover, increasing the degree of integration of the entire product, and simplifying the processing steps.

**[0040]** Fig. 6 demonstratively shows an alternative solution for the transparent cover 27. As shown in fig. 6, a transparent cover 67 is provided with at least one prism on a transparent part A thereof. In the example of fig. 6, each prism is positioned on an inner surface of the transparent cover 67. Fig. 6 demonstratively shows two prisms 673, each prism 673 extending in the circumferential direction of the transparent cover. The number of prisms 673 may also be increased or reduced as required. Preferably, the inner surface of the transparent cover 67 may also be provided with a prism 675 as shown in fig. 6. The prism 675 extends in a direction perpendicular to the circumferential direction. By providing prisms on the transparent cover, the angle of spread of light emitted by a single light source can be expanded effectively, thereby

improving the light intensity distribution of the VAD.

**[0041]** Figs. 7A - 7D demonstratively show a VAD according to another embodiment of the present invention. The VAD can achieve switching from an acoustic/optical alarm device (beacon and sounder) to an acoustic alarm device (sounder) by changing the casing. In this embodiment, at least one of the reflection cup and the light-emitting unit is removable. Fig. 7A shows a perspective drawing of the casing 29 and transparent cover 27 in fig. 3 after being engaged with each other. As shown in fig. 7A, the casing 29 has an opening in the form of a semi-circular ring, and the transparent part A of the transparent cover 27 is exposed through the opening. Fig. 7B shows a partial section taken along M-M' in fig. 7A. As fig. 7B shows, the transparent cover 27 covers the light-emitting units 23 and the reflection cups 25. The casing 29 is engaged with the transparent cover 27. A protrusion 278 is provided on the transparent cover 27, and exactly blocks a gap between the casing 29 and the transparent cover 27. By replacing the casing 29 in figs. 7A and 7B with a complete disk casing 79, and removing the reflection cups 25, an acoustic alarm device as shown in fig. 7C can be obtained. Fig. 7D shows a partial sectional drawing of the acoustic alarm device, wherein the casing 79 completely covers the transparent cover 27, and no reflection cups 25 and no light-emitting units 23 are installed in the acoustic alarm device. Thus, two products, namely an acoustic/optical alarm device and an acoustic alarm device, can be obtained with the same basic structure, with no need for excessive changes to be made. Such a design facilitates production and processing, and so lowers production costs.

**[0042]** It should be understood that although the description herein is based on various embodiments, it is by no means the case that each embodiment contains just one independent technical solution. Such a method of presentation is adopted herein purely for the sake of clarity. Those skilled in the art should consider the description in its entirety. The technical solutions in the various embodiments could also be suitably combined to form other embodiments capable of being understood by those skilled in the art.

**[0043]** The series of detailed explanations set out above are merely particular explanations of feasible embodiments of the present invention, which are not intended to limit the scope of protection thereof. All equivalent embodiments or changes made without departing from the artistic spirit of the present invention, such as combinations, divisions or repetitions of features, shall be included in the scope of protection of the present invention.

## Claims

1. An alarm device suitable for wall mounting, comprising:

a support plate (21);

at least three light-emitting units (23), which are disposed on the support plate (21) and are arranged spaced apart from one another along a substantially semicircular arc (C);

at least one reflection cup (25) capable of being fixed to the support plate (21), each reflection cup being adapted to accommodate at least one of the light-emitting units (23), the reflection cup(s) (25) substantially extending or being arranged in the shape of a semicircular ring, an inner surface of the reflection cup being a reflective surface and being constructed to reflect light emitted by the light-emitting unit towards a substantially cubic optical coverage volume (V), wherein an equivalent optical center of the alarm device is positioned in a center position on a top edge of the optical coverage volume (V).

2. The alarm device as claimed in claim 1, wherein two adjacent reflection cups (25) space the light-emitting units (23) in the two reflection cups apart from each other.
3. The alarm device as claimed in claim 1 or 2, wherein each pair of adjacent light-emitting units (23) is spaced apart by an equal distance.
4. The alarm device as claimed in claim 1 or 2, wherein each pair of adjacent light-emitting units (23) is spaced apart by a gradually changing distance.
5. The alarm device as claimed in any one of claims 1 - 4, wherein each light-emitting unit (23) comprises two or more LED chips.
6. The alarm device as claimed in any one of claims 1 - 5, wherein each reflection cup (25) is arranged to partially surround at least one of the light-emitting units (23) positioned therein, and a light output opening of the reflection cup (25) is disposed on a periphery of the semicircular ring.
7. The alarm device as claimed in any one of claims 1 - 6, wherein an inner surface of the reflection cup (25) is a concave surface, the reflection cup has substantially opposite first and second reflective parts (251\_3, 251\_5) and the light-emitting unit (23) is positioned between the first and second reflective parts (251\_3, 251\_5), wherein at least one of the first and second reflective parts is inclined in a direction away from the light-emitting unit (23).
8. The alarm device as claimed in claim 7, wherein the first and second reflective parts (251\_3, 251\_5) of the reflection cup (25) close to a center point (L) of the semicircular ring are both inclined in a direction away from the light-emitting unit (23).

9. The alarm device as claimed in claim 7, wherein in the case of the reflection cup (255) located in the vicinity of an end point (B1, B2) of the semicircular ring, the first reflective part (255\_3) close to the end point (B1, B2) of the semicircular ring is inclined towards the light-emitting unit (23), and the second reflective part (255\_5) is inclined away from the light-emitting unit (23). 5
10. The alarm device as claimed in any one of claims 7 - 9, wherein the first reflective part or second reflective part of at least one reflection cup comprises two or more secondary reflective parts (e, f, d) adjoining each other, each secondary reflective part being a reflective surface in the form of a conical curved surface. 10 15
11. The alarm device as claimed in any one of claims 1 - 10, wherein each reflection cup (25) further comprises a third reflective part (251\_1), which adjoins the first and second reflective parts (251\_3, 251\_5) and faces the light-emitting unit (23) accommodated in the reflection cup (25), the third reflective part being a concave surface. 20 25
12. The alarm device as claimed in claim 11, wherein the third reflective part (251\_1) comprises at least two secondary reflective parts (a, b, c) adjoining each other, each secondary reflective part being a reflective surface in the form of a conical curved surface. 30
13. The alarm device as claimed in any one of claims 1 - 12, wherein each reflection cup (25) further comprises a first auxiliary reflective part (251\_7) disposed on an edge of the reflection cup above the light-emitting unit, the first auxiliary reflective part extending to form a concave surface; preferably, the first auxiliary reflective part has multiple concave surfaces corresponding in quantity and position to the LED chips. 35 40
14. The alarm device as claimed in any one of claims 1 - 13, further comprising a transparent cover (27), which at least covers the light-emitting units (23) and the reflection cup (25), with at least one prism part (673, 675) being disposed on the transparent cover, the prism part being capable of guiding light emitted by the light-emitting unit so as to be scattered towards the optical coverage volume (V); preferably, the at least one prism part comprises at least one prism part (673) extending in the circumferential direction of the transparent cover (67), or at least one prism part (675) extending in a direction perpendicular to the circumferential direction of the transparent cover (67). 45 50 55
15. The alarm device as claimed in any one of claims 1 - 14, further comprising a replaceable casing (29, 79) which at least partially covers the transparent cover (27), with at least one of the light-emitting unit and the reflection cup being removable; preferably, the replaceable casing is a first casing (29) having a semicircular ring opening, the semicircular ring opening being adapted to expose the light-emitting units and the reflection cup, or the replaceable casing is a casing (79) which completely covers the transparent cover.



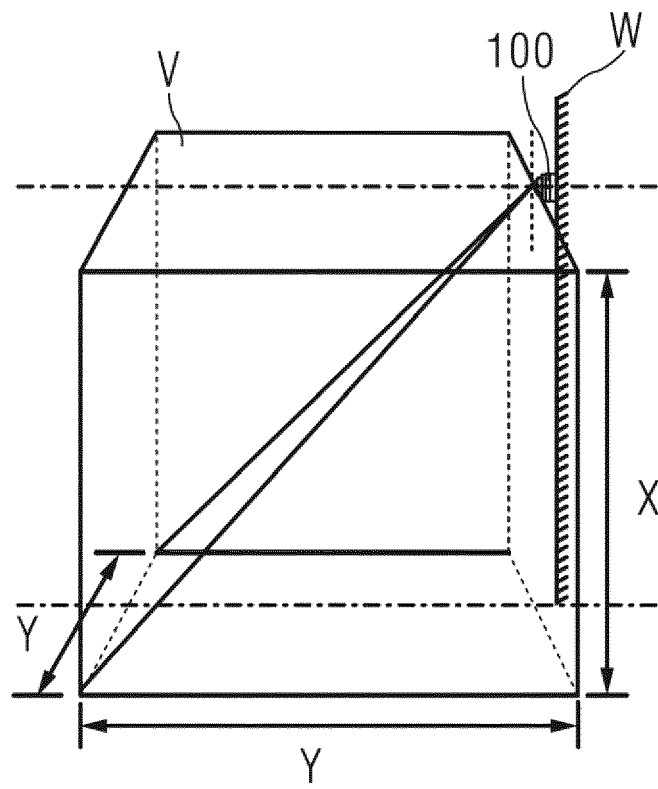


Fig. 1

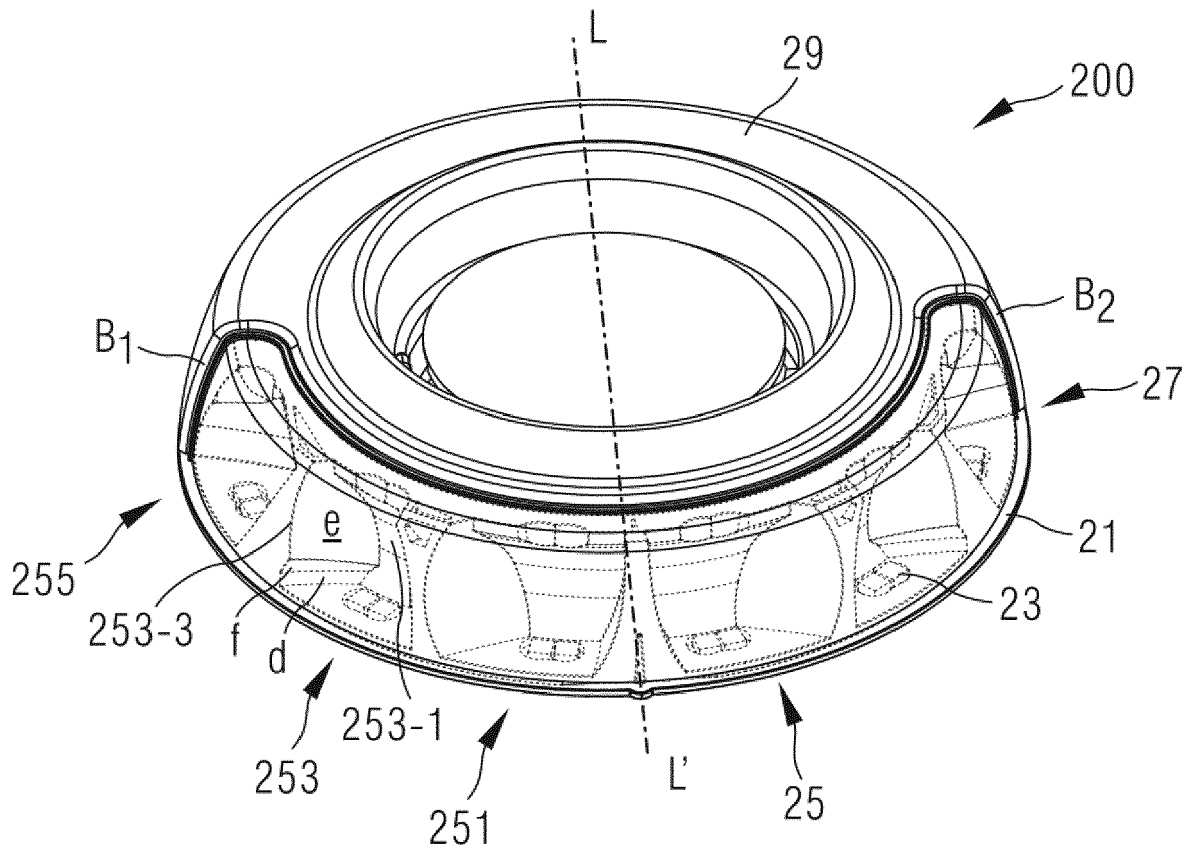


Fig. 2

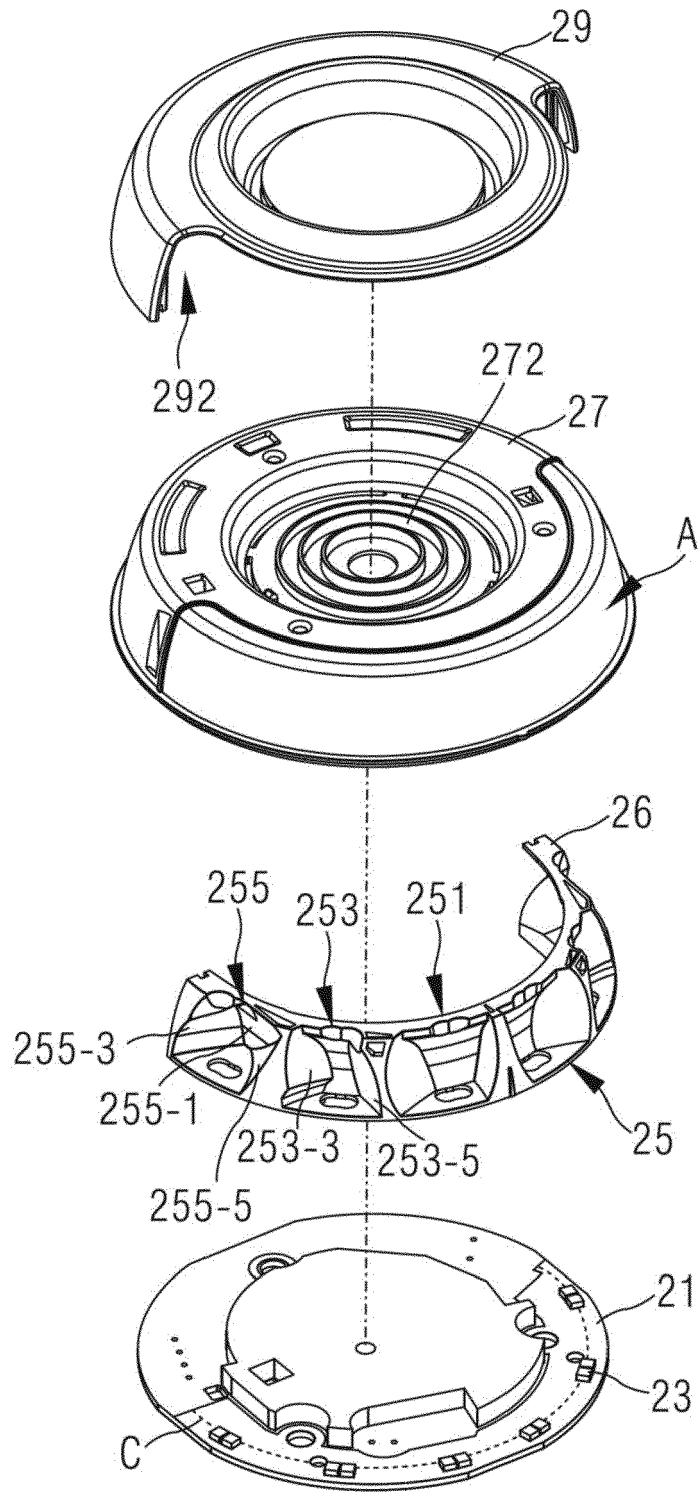


Fig. 3

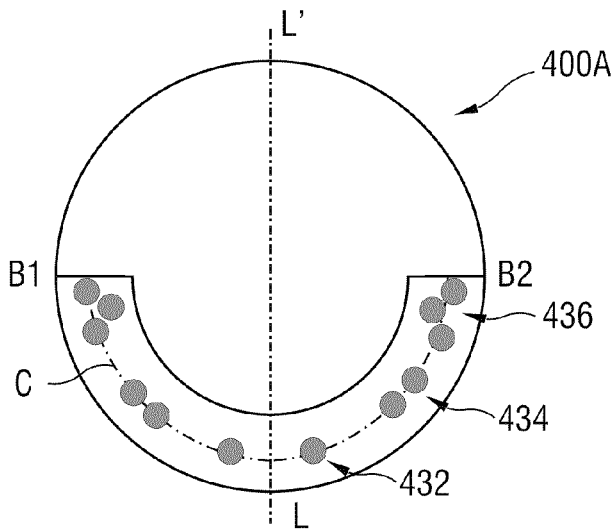


Fig. 4A

Fig. 4B

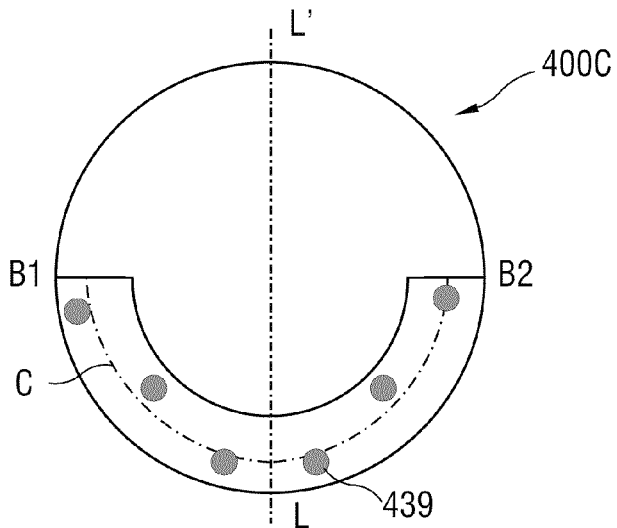
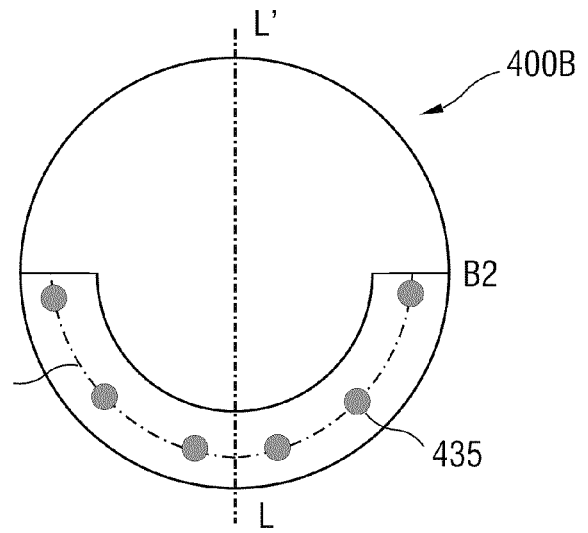


Fig. 4C

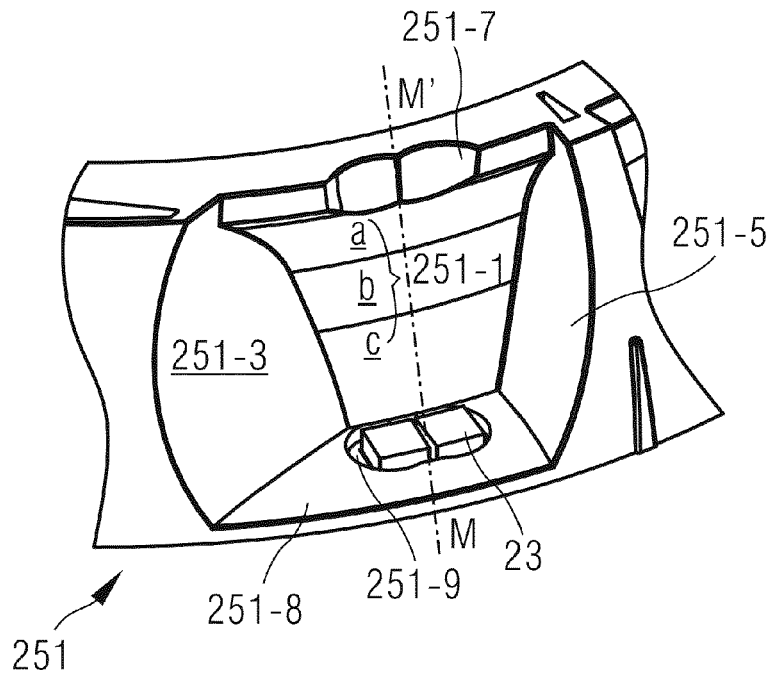


Fig. 5A

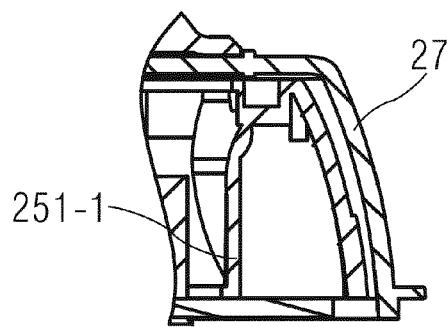


Fig. 5B

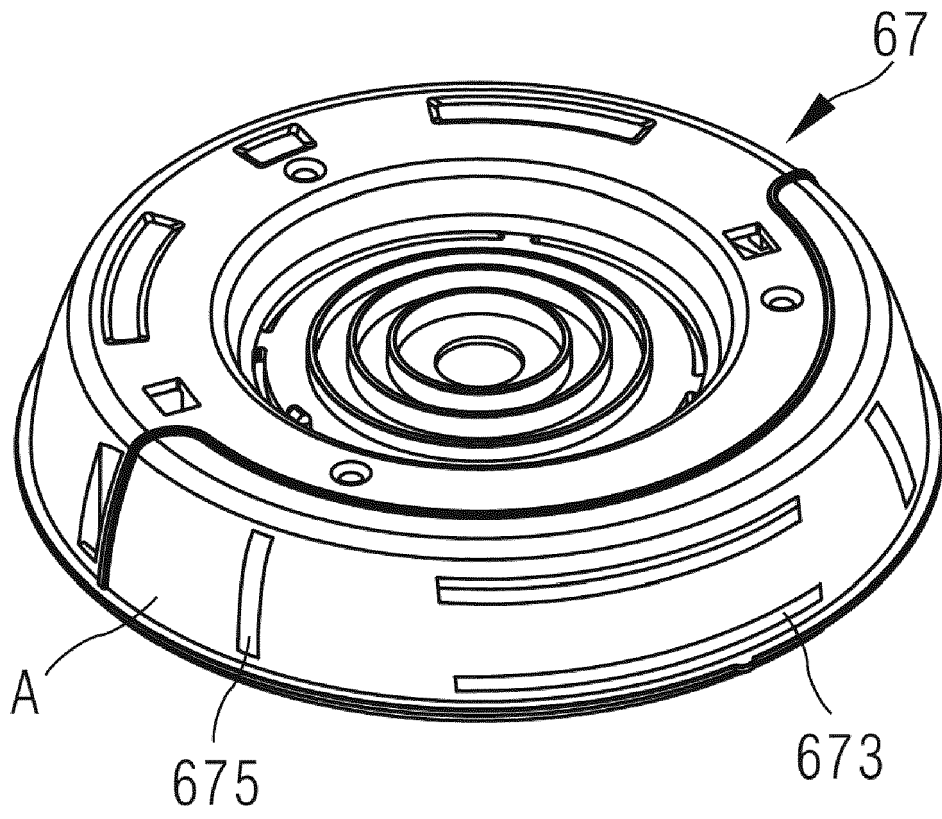


Fig. 6

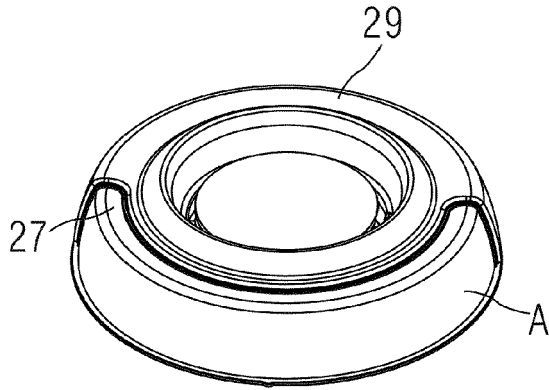


Fig. 7A

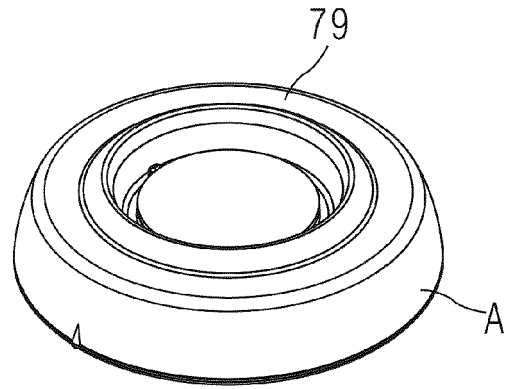


Fig. 7C

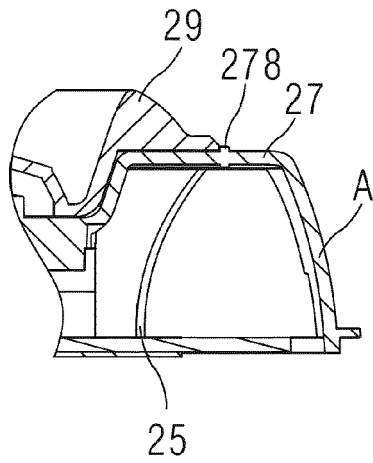


Fig. 7B

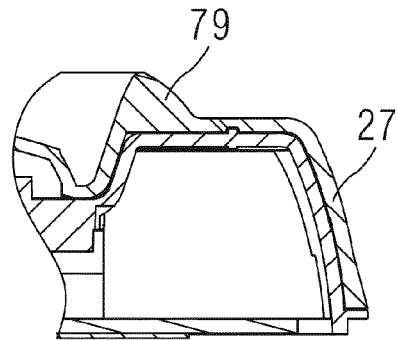


Fig. 7D



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Application Number  
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X	----- US 2014/268753 A1 (BUCHHOLZ MATTHEW J [US] ET AL) 18 September 2014 (2014-09-18) * paragraph [0021] - paragraph [0024]; figures 1,6,8 *	1,5-15	
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X A	----- CN 202 938 198 U (WENZHOU AOLE SAFETY EQUIPMENT CO LTD) 15 May 2013 (2013-05-15) * paragraph [0011] - paragraph [0012]; figure 2 *	1-3,5-8, 10 14,15	
A	----- US 6 739 738 B1 (SMITH TODD J [US]) 25 May 2004 (2004-05-25) * column 3, line 27; figures 1-4 *	1,3,5	TECHNICAL FIELDS SEARCHED (IPC) G08B F21V
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>15 February 2018</b>	Examiner <b>Heß, Rüdiger</b>
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