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(54) **LAMP UNIT, AND METHOD FOR VENTILATING BODY HOUSING OF LAMP**

(57) A lamp unit 1a includes a body housing 10, a light source 13, and a pump 15. The body housing 10 includes a light-transmitting member 11, a body wall 12, a first opening portion 12a, and a second opening portion 12b. The body wall 12 is joined to the light-transmitting member 11 to form a housing. The first opening portion 12a and the second opening portion 12b are positioned in the body wall 12 and each form an opening communicating with the external space of the housing. The light source 13 is disposed inside the body housing 10. The pump 15 has a gas discharge port 15a, and the gas discharge port 15a is connected to the first opening portion 12a.

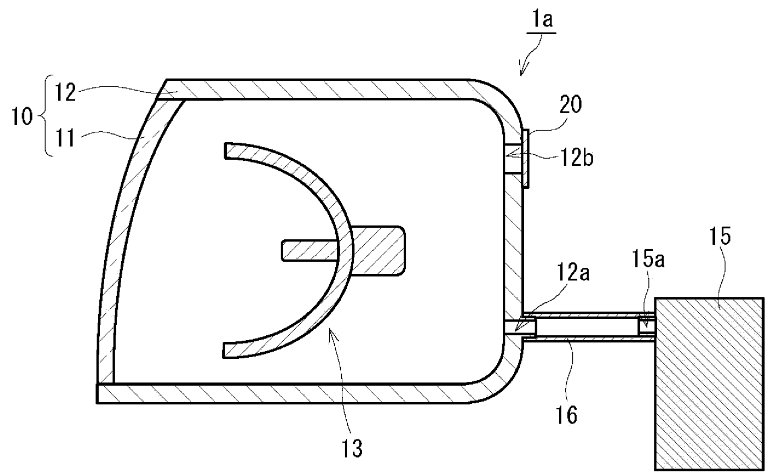

FIG.1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a lamp unit and a ventilation method for a body housing of a lamp.

BACKGROUND ART

[0002] Technologies for ventilation in lamps such as vehicle lamps have been conventionally known.
[0003] For example, Patent Literature 1 describes a vehicle lamp including a lamp chamber composed of a lamp body and a light-transmitting cover. In this vehicle lamp, a ventilation hole is formed in at least one portion of the light-transmitting cover to allow communication between the inside space and external space of the lamp chamber. In addition, a filter with waterproof and moisture-diffusing properties is attached to cover the ventilation hole.

CITATION LIST

Patent Literature

[0004] Patent Literature 1: JP 2018-45879 A

SUMMARY OF INVENTION

Technical Problem

[0005] The technique described in Patent Literature 1 leaves room for reexamination from the viewpoint of preventing fogging inside a lamp or effectively removing fogging that has occurred inside a lamp. In view of this, the present invention provides a lamp unit that is advantageous for preventing fogging inside a lamp or effectively removing fogging that has occurred inside a lamp.

Solution to Problem

[0006] The present invention provides a lamp unit including:

a body housing including: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
a light source disposed inside the body housing; and
a pump having a gas discharge port connected to the first opening portion.

[0007] The present invention also provides a ventilation method for a body housing of a lamp,

the lamp including a lamp unit,
the lamp unit including:

the body housing including: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
a light source disposed inside the body housing;
a pump having a gas discharge port connected to the first opening portion; and
a ventilation member for ventilation between the body housing and the external space, and
the ventilation method including:

allowing the pump to discharge a gas toward the body housing such that requirements represented by the following expressions (IIa) and (IIb) are satisfied,

$$1000p \cdot t \cdot P \cdot A / V \geq 3.0 \qquad \text{(IIa)}$$

$$0 < t \leq 300 \qquad \text{(IIb)}$$

where p is a pressure [kPa] inside the body housing during operation of the pump, t is a discharge time [s] of the pump, P is an air permeability coefficient [$cm^3/(Pa \cdot s \cdot cm^2)$] of the ventilation member, A is a permeable area [cm^2] of the ventilation member, and V is a spatial volume [cm^3] inside the lamp unit.

Advantageous Effects of Invention

[0008] The above lamp unit is advantageous for preventing fogging inside a lamp or effectively removing fogging that has occurred inside a lamp.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

FIG. 1 is a cross-sectional view schematically showing a lamp unit of the present disclosure.
FIG. 2A schematically shows an example of the arrangement of opening portions in the lamp unit shown in FIG. 1.
FIG. 2B schematically shows another example of the arrangement of the opening portions in the lamp unit.
FIG. 3 is a cross-sectional view of an example of a ventilation member in the lamp unit.
FIG. 4 is a cross-sectional view of another example of a ventilation member in the lamp unit.
FIG. 5A is a photograph of the front of the headlamp of Chery Tiggo 8.
FIG. 5B is a photograph of the bottom of the headlamp shown in FIG. 5A.
FIG. 5C is a photograph of the rear of a lamp unit according to Example 1A.
FIG. 6A is a photograph of the front of the headlamp of GEELY Emgrand X7.
FIG. 6B is a photograph of the rear of the headlamp shown in FIG. 6A.
FIG. 6C is a photograph of the rear of a lamp unit according to Example 2A.
FIG. 7A is a photograph of the front of the headlamp of Ford Escape.
FIG. 7B is a photograph of the rear of the headlamp shown in FIG. 7A.
FIG. 7C is a photograph of the rear of a lamp unit according to Example 3A.
FIG. 8 is a graph showing, in evaluation of the ventilation performance of the lamp units, the relationship between a time T required for fogging to be removed and the value of $1000 \cdot p \cdot t \cdot P \cdot A/V$.

DESCRIPTION OF EMBODIMENTS

[0010] Embodiments of the present invention will be described with reference to the drawings. The present invention is not limited to the following embodiments.

[0011] As shown in FIG. 1, a lamp unit 1a includes a body housing 10, a light source 13, and a pump 15. The body housing 10 includes a light-transmitting member 11, a body wall 12, a first opening portion 12a, and a second opening portion 12b. The body wall 12 is joined to the light-transmitting member 11 to form a housing. The first opening portion 12a and the second opening portion 12b are positioned in the body wall 12 and each form an opening communicating with the external space of the housing. The light source 13 is disposed inside the body housing 10. The pump 15 has a gas discharge port 15a, and the gas discharge port 15a is connected to the first opening portion 12a. The gas discharge port 15a is connected to the first opening portion 12a, for example, via a flow path member, such as a tube. The gas discharge port 15a may be directly connected to the first opening portion 12a.

[0012] When moisture absorption occurs in a lamp, the air inside the lamp is warmed by solar radiation on the lamp or by lighting of the lamp, causing the moisture to be released into the air outside. When the inside of the lamp is cooled rapidly under this state, condensation occurs inside the lamp, potentially causing the occurrence of fogging on the inner surface of the light-transmitting member that is the member that transmits light generated from the light source in the lamp. For example, events such as vehicle washing and rainfall can rapidly cool the inside of a lamp. When a phenomenon occurs, such as a large area of fogging occurring on the inner surface of the light-transmitting member or prolonged fogging persisting on the inner surface of the light-transmitting member, user dissatisfaction may increase. On the other hand, according to the lamp unit 1a, for example, operation of the pump 15 sends air from the external space into the inside of the housing of the lamp unit 1a through the first opening portion 12a. In addition, moisture present inside the housing of the lamp unit 1a is directed to the outside of the housing through the second opening portion 12b. Therefore, in the lamp unit 1a, fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs on the inner surface of the light-transmitting member 11, the fogging is likely to be effectively removed.

[0013] As shown in FIG. 1, the light-transmitting member 11 is disposed, for example, in front of the light source 13 in the traveling direction of light generated from the light source 13. In the lamp unit 1a, the light-transmitting member 11 transmits light generated from the light source 13.

[0014] As shown in FIG. 1, in the lamp unit 1a, the body wall 12 is disposed, for example, to cover the rear and lateral sides of the light source 13 with respect to the traveling direction of light generated from the light source 13. In the lamp unit 1a, the body wall 12 is joined to the light-transmitting member 11 in a state where the body wall 12 is in contact with the periphery of the light-transmitting member 11. The manner of joining the body wall 12 and the light-transmitting member 11 to each other is not limited to a particular manner. The body wall 12 and the light-transmitting member 11 are joined to each other, for example, by snap-fitting or screwing. The body wall 12 is composed of, for example, a non-light-transmitting member.

[0015] The light source 13 is not limited to a particular light source. The light source 13 may be a halogen lamp, an HID lamp, or an LED lamp.

[0016] As shown in FIG. 1, the lamp unit 1a includes, for example, a ventilation member 20. The ventilation member 20 is a member for ventilation between the body housing 10 and the external space of the body housing 10. The ventilation member 20 is provided at the second opening portion 12b. The ventilation member 20 is, for example, attached to a portion of the body wall 12 that abuts the second opening portion 12b such that the ventilation member 20 covers the second opening portion 12b in a ventilatable manner.

[0017] The ventilation member 20 is not limited to a particular member as long as the ventilation member 20 allows ventilation between the body housing 10 and the external space of the body housing 10. The ventilation member 20 is, for example, a gas-permeable member that prevents the entry of foreign substances such as water and dust. The ventilation member 20 may include a known gas-permeable membrane, or may include a porous body, such as a woven fabric, a nonwoven fabric, or foam, a mesh, or a net.

[0018] The gas-permeable membrane may be a single-layer membrane or a multilayer membrane. In the case where the gas-permeable membrane is a multilayer membrane, each layer thereof can be one selected from the group consisting of a porous membrane, a nonwoven fabric, a cloth, and a mesh. Desirably, the gas-permeable membrane may include: a porous membrane and a nonwoven fabric; a porous membrane and at least one of a cloth and a mesh; or plurality of nonwoven fabrics. The gas-permeable membrane is typically composed of an organic polymer (resin). The material of the porous membrane is, for example, a fluororesin. Examples of the fluororesin that can be used include polytetrafluoroethylene (PTFE), polychlorotrifluoroethylene, tetrafluoroethylene-hexafluoropropylene copolymers, and tetrafluoroethylene-ethylene copolymers. Examples of the materials of the nonwoven fabric, the cloth, and the mesh include polyesters, such as polyethylene terephthalate, polyolefins, such as polyethylene and polypropylene, nylons, aramids, and ethylene-vinyl acetate copolymers.

[0019] The gas-permeable membrane includes, for example, an extended porous PTFE membrane. In this case, the extended porous PTFE membrane may be layered on a gas-permeable supporting member such as a nonwoven fabric.

[0020] The gas-permeable membrane may be subjected to a liquid-repellent treatment as necessary. The liquid-repellent treatment is performed, for example, by forming, on the gas-permeable membrane, a liquid-repellent coating film containing a fluorine surface modifier having a perfluoroalkyl group. The formation of the liquid-repellent coating film is not limited to a particular method, and is performed, for example, by coating a porous resin membrane with a solution or dispersion of a fluorine surface modifier having a perfluoroalkyl group by a method such as air spray coating, electrostatic spray coating, dip coating, spin coating, roll coating, curtain flow coating, or impregnation. Alternatively, electrodeposition coating or plasma polymerization may be employed to form the liquid-repellent coating film.

[0021] The pump 15 is not limited to a particular pump as long as the pump 15 has the gas discharge port 15a. The pump 15 has a maximum discharge pressure P_{dis_max} of, for example, 0.5 to 20 kPa. In this case, in the lamp unit 1a, fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs, the fogging is likely to be effectively removed without breakage of the body housing 10 or the ventilation member 20. The maximum discharge pressure P_{dis_max} is desirably 10 kPa or less, more desirably 5 kPa or less, and even more desirably 4 kPa or less. The maximum discharge pressure P_{dis_max} can be measured, for example, with one end of a flow path member, such as a tube, connected to the gas discharge port 15a and the other end of the flow path member connected to the first opening portion 12a. A pressure gauge is disposed on the flow path member, between the gas discharge port 15a and the first opening portion 12a, allowing the maximum discharge pressure P_{dis_max} to be determined by reading the pressure indicated on the pressure gauge during operation of the pump 15 at maximum output.

[0022] The arrangement of the first opening portion 12a and the second opening portion 12b in the body wall 12 is not limited to a particular arrangement. As shown in FIG. 2A, in plan view of a portion of the outer surface of the body wall 12 that forms the rear of the lamp unit 1a, the first opening portion 12a and the second opening portion 12b are arranged, for example, at opposite end portions in a specific direction. The first opening portion 12a and the second opening portion 12b, in the respective portions of the outer surface of the body wall 12, are arranged at a pair of corners in a diagonal relationship. With this configuration, the air flow sent to the inside of the body housing 10 of the lamp unit 1a through the pump 15 is likely to reach a large area inside the body housing 10. Consequently, in the lamp unit 1a, fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs, the fogging is likely to be more effectively removed. At least one of the first opening portion 12a and the second opening portion 12b may be positioned in the side portion of the body wall 12.

[0023] The body wall 12 may have a plurality of the first opening portions 12a. In the case where the body wall 12 has the plurality of first opening portions 12a, the lamp unit 1a may include a plurality of the pumps 15, with the gas discharge ports 15a of the plurality of pumps 15 connected to separate first opening portions 12a. The gas discharge port 15a of a single pump 15 may be connected to the plurality of first opening portions 12a.

[0024] The body wall 12 may have a plurality of the second opening portions 12b. As shown in FIG. 2B, the body wall 12 may have two second opening portions 12b, for example. In plan view of the portion of the outer surface of the body wall 12 that forms the rear of the lamp unit 1a, the first opening portion 12a and each of the plurality of second opening portions 12b are arranged, for example, at opposite end portions in different specific directions. The two second opening portions 12b, in the respective portions of the outer surface of the body wall 12, are arranged, for example, at a pair of corners adjacent to each other. For example, as shown in FIG. 2B, in plan view of the portion of the outer surface of the body wall 12 that forms the rear of the lamp unit 1a, one of the plurality of second opening portions 12b is arranged away from a straight line L that intersects both the first opening portion 12a and another second opening portion 12b. At least one of the first opening portion 12a and the plurality of second opening portions 12b may be positioned in the side portion of the body wall 12.

[0025] The body wall 12 may have an opening portion communicating with the external space of the body housing 10, in addition to the first opening portion 12a and the second opening portion 12b. For example, the body wall 12 has three opening portions or less.

[0026] In the body wall 12, the shape of the first opening portion 12a and the second opening portion 12b are not limited to particular shapes. In each of the first opening portion 12a and the second opening portion 12b, the end portion of the opening portion that abuts the external space of the body housing 10 may be positioned flush with the periphery of the opening portion, or may be positioned at the tip of a portion protruding from the periphery of the opening portion.

[0027] The ventilation member 20 may be a patch-type ventilation member, a snap-fit type ventilation member, a cap-type ventilation member, or any other type of ventilation member.

[0028] In the case where the ventilation member 20 is a patch-type ventilation member, the ventilation member 20 is attached to a portion of the body wall 12 that abuts the second opening portion 12b, in a state where an adhesive tape overlapping the gas-permeable membrane along the periphery of the gas-permeable membrane is in contact with the outer surface of the body wall 12 around the second opening portion 12b.

[0029] FIG. 3 shows an example of the ventilation member 20, where the ventilation member 20 is a snap-fit type ventilation member. As shown in FIG. 3, the ventilation member 20 includes a gas-permeable membrane 21, a supporting portion 22, and a protruding portion 23. The supporting portion 22 is an annular and plate-shaped portion in which a through hole forming a portion of a ventilation path 25a is formed at the center, and the gas-permeable membrane 21 is fixed to the supporting portion 22 to cover the through hole. The protruding portion 23 is a tubular portion protruding from the supporting portion 22 at the center of the supporting portion 22. The protruding portion 23 includes a plurality of leg portions 23g arranged away from each other around the axis of the protruding portion 23. The tip portion of each of the plurality of leg portions 23g has a protrusion 23a protruding outward in a direction perpendicular to the axis of the supporting portion 22. The protrusion 23a faces an inner surface 12m of the body wall 12. The ventilation member 20 is configured such that the protrusion 23a allows the ventilation member 20 to snap-fit onto the body wall 12. The ventilation member 20 further includes a sealing member 24, for example. The sealing member 24 is disposed around the protruding portion 23 at a corner formed by the outer surface of the protruding portion 23 and the supporting portion 22. The sealing member 24 is an annular member and is disposed in contact with the supporting portion 22 and the outer surface of the body wall 12. This seals the ventilation path 25a against the space outside the body wall 12 between the supporting portion 22 and the outer surface of the body wall 12.

[0030] As shown in FIG. 3, the ventilation member 20 further includes a cover 26, for example. The cover 26 covers the gas-permeable membrane 21, forming a ventilation path 25b between the gas-permeable membrane 21 and the cover 26. An opening is formed on the lateral side of the cover 26, allowing ventilation between the space inside the body wall 12 and the space outside the body wall 12 through the ventilation path 25a and the ventilation path 25b.

[0031] FIG. 4 shows an example of the ventilation member 20, where the ventilation member 20 is a cap-type ventilation member. As shown in FIG. 4, the cap-type ventilation member 20 includes, for example, the gas-permeable membrane 21, a cap 27, and an inner member 28. The ventilation member 20 is attached to the body wall 12 with the inner surface of the inner member 28 in contact with the outer surface of a protruding portion 12p. Consequently, an airtight state is maintained between the inner surface of the inner member 28 and the outer surface of the protruding portion 12p. The protruding portion 12p is a tubular portion protruding outward in the body wall 12, inside which the second opening portion 12b is formed. The inner member 28 is a tubular member. To one end of the inner member 28, the gas-permeable membrane 21 is fixed to cover the inner space of the inner member 28. The cap 27 is attached to the inner member 28 to cover the gas-permeable membrane 21. There exists, between a portion of the side wall of the cap 27 and the inner member 28, a gap included in a portion of the ventilation path.

[0032] In the lamp unit 1a, the combination of the body housing 10, the pump 15, and the ventilation member 20 is not limited to a particular combination. For example, the body housing 10, the pump 15, and the ventilation member 20 form a combination satisfying the requirements represented by the following expressions (Ia) and (Ib). In this case, in the lamp unit 1a, fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs, the fogging is likely to be more effectively removed. In these requirements, p is the pressure [kPa] inside the body housing 10 during operation of the pump 15, t is the discharge time [s] of the pump 15, P is the air permeability coefficient [$cm^3/(Pa•s•cm^2)$] of the ventilation member 20, A is the permeable area [cm^2] of the ventilation member 20, and V is the spatial volume [cm^3] inside the lamp unit 1a. The pressure p is a gauge pressure.

$$1000p•t•P•A/V \geq 3.0 \qquad (Ia)$$

$$0 < t \leq 300 \qquad (Ib)$$

[0033] The combination of the body housing 10, the pump 15, and the ventilation member 20 may satisfy the requirement $1000p•t•P•A/V \geq 4$, $1000p•t•P•A/V \geq 5$, or $1000p•t•P•A/V \geq 10$. The combination of the body housing 10, the pump 15, and the ventilation member 20 satisfies the requirement $1000p•t•P•A/V \leq 20$, for example.

[0034] The pressure p inside the body housing 10 can be regulated, for example, by a valve disposed between the gas discharge port 15a and the first opening portion 12a. In the case where the pump 15 has the function of adjusting its output in multiple stages, the function may be used to regulate the pressure p.

[0035] The time t is desirably 240 seconds or less, and more desirably 180 seconds. Owing to the satisfaction of the requirement (Ia), fogging is less likely to occur on the inner surface of the light-transmitting member 11, even with a discharge time t of the pump 15 being as short as described above. Even if fogging occurs, the fogging is likely to be effectively removed. The time t may be 10 seconds or more.

[0036] The permeability coefficient P of the ventilation member 20 can be determined, for example, by dividing the air volume [$cm^3/(cm^2•s)$] obtained according to Frajour type method (Method A) specified in Japanese Industrial Standards (JIS) L 1096:2010 by the pressure of 125 Pa indicated by the inclined barometer of a Frajour type testing machine. The permeability coefficient P may also be determined by converting the measured value indicating air permeability, as measured using an air permeability testing machine other than a Frajour type testing machine, such as a Gurley densometer, into dimensions of [$cm^3/(Pa•s•cm^2)$].

[0037] The permeability coefficient P is not limited to a particular value. The permeability coefficient P is, for example, adjusted such that the requirement in (Ia) is satisfied. The permeability coefficient P is, for example, 0.00008 to 0.80293 [$cm^3/(Pa•s•cm^2)$]. In this case, the requirement (Ia) is likely to be satisfied and fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs, the fogging is likely to be more effectively removed. The permeability coefficient P is desirably 0.00008 to 0.8 [$cm^3/(Pa•s•cm^2)$], more desirably 0.0008 to 0.16 [$cm^3/(Pa•s•cm^2)$], and even more desirably 0.004 to 0.03 [$cm^3/(Pa•s•cm^2)$].

[0038] The permeable area A of the ventilation member 20 is the area of the air-permeable portion of the ventilation member 20. For example, in the case where the ventilation member 20 includes a gas-permeable membrane, the effective area of the air-permeable portion of the gas-permeable membrane corresponds to the permeable area A. In the ventilation member 20, for example, in the case where the periphery of the gas-permeable membrane is fixed to a given supporting member and the inner side of the periphery of the gas-permeable membrane abuts the ventilation path, the area of the portion of the gas-permeable membrane that abuts the ventilation path on the inner side of the periphery of the gas-permeable membrane can correspond to the permeable area A. For example, in the case where the gas-permeable membrane is fixed to the supporting member with an annular adhesive tape, the area of the inner portion of the annular adhesive tape can correspond to the permeable area A. In addition, in the case where the gas-permeable membrane is fixed to the supporting member by welding, the area of the inner portion of the welded portion can correspond to the permeable area A. In the case where the lamp unit 1a includes a plurality of the ventilation members 20, the sum total of the permeable areas of the ventilation members 20 can correspond to the permeable area A.

[0039] The permeable area A of the ventilation member 20 is not limited to a particular value. The permeable area A is, for example, adjusted such that the requirement in (Ia) is satisfied. The permeable area A is, for example, 0.03142 to 50.26548 cm^2. In this case, the requirement in (Ia) is likely to be satisfied. Even if fogging occurs on the inner surface of the light-transmitting member 11, the fogging is likely to be more effectively removed. The permeable area A may be 0.785 to 38.48 cm^2 or 1.767 to 28.27 cm^2.

[0040] The maximum diameter of the portion of the ventilation member 20 having the permeable area A is, for example, 2 to 80 mm, and may be 10 to 70 mm or 15 to 60 mm.

[0041] The spatial volume V inside the lamp unit 1a can be determined, for example, by injecting water into the lamp unit 1a until the entire space inside the lamp unit 1a is filled and applying the relationship $V = (W2 - W1)/\rho_w$. In this relationship, W2 is the weight [kg] of the lamp unit 1a after water injection, W1 is the weight [kg] of the lamp unit 1a before water injection, and ρ_w is the density of water, 1.0×10^{-3} kg/cm^3.

[0042] The spatial volume V is not limited to a particular value. The spatial volume V is, for example, adjusted such that the requirement in (Ia) is satisfied. The spatial volume V is, for example, 1000 to 20000 cm^3. Owing to the spatial volume V being 1000 cm^3 or more, light generated from the light source 13 is likely to be emitted in a desired state. Owing to the spatial volume V being 20000 cm^3 or less, fogging is less likely to occur on the inner surface of the light-transmitting member 11. Even if fogging occurs, the fogging is likely to be effectively removed.
[0043] The spatial volume V is desirably 2000 to 18000 cm^3, and more desirably 3000 to 15000 cm^3.
[0044] In the lamp unit 1a, ventilation of the body housing 10 is performed by operation of the pump 15. In this case, the pump 15, for example, discharges a gas toward the body housing 10 such that the requirements represented by the above expressions (Ia) and (Ib) are satisfied.
[0045] The application of the lamp unit 1a is not limited to a particular application. For example, the lamp unit 1a is for a vehicle. In a vehicle, events such as vehicle washing and rainfall rapidly cool the inside of the lamp and fogging is likely to occur on the inner surface of the light-transmitting member. According to the lamp unit 1a, fogging is less likely to occur on the inner surface of the light-transmitting member, and even if fogging occurs, the fogging is likely to be effectively removed. Therefore, the lamp unit 1a can enhance the value of a vehicle including the lamp unit 1a.
[0046] The lamp unit 1a may be a lamp unit for a headlight, a lamp unit for a small light, a lamp unit for a fog light, or a lamp unit for a brake light.

Examples

[0047] The present invention will be described in more detail below with reference to examples. The present invention is not limited to the following examples.

<Example 1A>

[0048] Water was injected into the inside of the headlamp of Chery Tiggo 8 (headlamp C) until the entire space inside the headlamp C was filled, and the above relationship $V = (W2 - W1)/\rho_w$ was applied to determine the spatial volume V inside the headlamp C. The result indicated that the spatial volume V inside the headlamp C was 9400 cm^2. All the valves attached to the housing of the headlamp C were detached and the headlamp was dried in an 80°C environment for 24 hours. Other conditions may be employed for drying the headlamp as long as the inside of the headlamp can be sufficiently dried. For example, the headlamp can also be dried in a 50°C environment over 1 week.
[0049] The dried headlamp C was transferred into a thermo-hygrostat maintained in an environment with a temperature of 40°C and a relative humidity of 90% and allowed to stand for 24 hours. Thus, the humidity control process for the headlamp C was performed. The headlamp C was taken out of the thermo-hygrostat and left in an environment with a temperature of 20°C and a relative humidity of 65% for 1 hour. Thus, the air inside the headlamp C was displaced. The suction port of FLEXTAILGEAR portable compact pump TINY PUMP X was covered with a gas-permeable membrane to obtain a pump according to the example. This pump had a maximum discharge pressure of 3.5 kPa. The gas-permeable membrane was fixed to the pump with a double-sided adhesive tape. The air permeability coefficient of this gas-permeable membrane was 0.01204 $cm^3/(Pa \cdot s \cdot cm^2)$. This permeability coefficient was determined by dividing the air volume $[cm^3/(cm^2 \cdot s)]$ obtained according to Frajour type method (Method A) specified in JIS L 1096:2010 by the pressure of 125 Pa indicated by the inclined barometer of a Frajour type testing machine. An opening portion formed at the upper left of the rear of the headlamp C and the discharge port of the pump according to the example were connected to each other via a flow path member that includes a polyvinyl chloride tube. A pressure gauge and a valve were attached to the flow path member at points along the flow path. An opening portion formed in the side portion of the housing of the headlamp C, positioned at the lower right in plan view of the rear of the headlamp C, was covered with a gas-permeable membrane a. The air permeability coefficient P of the gas-permeable membrane a was 0.01204 $cm^3/(Pa \cdot s \cdot cm^2)$. The permeability coefficient P of the gas-permeable membrane was determined by dividing the air volume $[cm^3/(cm^2 \cdot s)]$ obtained according to Frajour type method (Method A) specified in JIS L 1096:2010 by the pressure of 125 Pa indicated by the inclined barometer of a Frajour type testing machine. The permeable area A of the gas-permeable membrane a was 20.43 cm^2. In this manner, a lamp unit according to Example 1A was produced. FIG. 5A is a photograph of the front of the headlamp of Chery Tiggo 8, and FIG. 5B is a photograph of the bottom of this headlamp. FIG. 5C is a photograph of the rear of the lamp unit according to Example 1A. In these photographs, the region enclosed by the dashed line near the sign "p" indicates the position of the opening portion connected to the discharge port of the pump, and the region enclosed by the dashed line near the sign "m" indicates the position of the opening portion covered with the gas-permeable membrane.

<Example 1B>

[0050] A gas-permeable membrane b was used in place of the gas-permeable membrane a. Except for this, the same procedure as in Example 1A was performed to produce a lamp unit according to Example 1B. The permeability coefficient

P of the gas-permeable membrane b was 0.00127 $cm^3/(Pa \cdot s \cdot cm^2)$.

<Comparative Example 1>

[0051] The headlamp was not connected to the pump according to the example, did not use the gas-permeable membrane a, and was hermetically sealed. Except for this, the same procedure as in Example 1A was performed to produce a lamp unit according to Comparative Example 1.

<Example 2A>

[0052] Water was injected into the inside of the headlamp of GEELY Emgrand X7 (headlamp G) until the entire space inside the headlamp G was filled, and the above relationship $V = (W2 - W1)/\rho_w$ was applied to determine the spatial volume V inside the headlamp G. The result indicated that the spatial volume V inside the headlamp G was 8000 cm^2. All the valves attached to the housing of the headlamp G were detached and the headlamp was dried in an 80°C environment for 24 hours.

[0053] The dried headlamp G was transferred into a thermo-hygrostat maintained in an environment with a temperature of 40°C and a relative humidity of 90% and allowed to stand for 24 hours. Thus, the humidity control process for the headlamp G was performed. The headlamp G was taken out of the thermo-hygrostat and left in an environment with a temperature of 20°C and a relative humidity of 65% for 1 hour. Thus, the air inside the headlamp G was displaced. An opening portion formed at the left end portion of the rear of the headlamp G and the discharge port of the pump according to the example were connected to each other via a flow path member that includes a polyvinyl chloride tube. A pressure gauge and a valve were attached to the flow path member at points along the flow path. An opening portion formed in the housing of the headlamp G, positioned at the right end portion in plan view of the rear of the headlamp G, was covered with the gas-permeable membrane a. The permeable area A of the gas-permeable membrane a was 33.18 cm^2. In this manner, a lamp unit according to Example 2A was produced. FIG. 6A is a photograph of the front of the headlamp of GEELY Emgrand X7, and FIG. 6B is a photograph of the rear of this headlamp. FIG. 6C is a photograph of the rear of the lamp unit according to Example 2A. In these photographs, the region enclosed by the dashed line near the sign "p" indicates the position of the opening portion connected to the discharge port of the pump, and the region enclosed by the dashed line near the sign "m" indicates the position of the opening portion covered with the gas-permeable membrane.

<Example 2B>

[0054] The permeable area A of the gas-permeable membrane a was changed to 2.85 cm^2. Except for this, the same procedure as in Example 2A was performed to produce a lamp unit according to Example 2B.

<Comparative Example 2>

[0055] The headlamp was not connected to the pump according to the example, did not use the gas-permeable membrane a, and was hermetically sealed. Except for this, the same procedure as in Example 2A was performed to produce a lamp unit according to Comparative Example 2.

<Example 3A>

[0056] Water was injected into the inside of the headlamp of Ford Escape (headlamp F) until the entire space inside the headlamp F was filled, and the above relationship $V = (W2 - W1)/\rho_w$ was applied to determine the spatial volume V inside the headlamp F. The result indicated that the spatial volume V inside the headlamp F of Ford Escape was 13400 cm^2. All the valves attached to the housing of the headlamp F were detached and the headlamp was dried in an 80°C environment for 24 hours.

[0057] The dried headlamp F was transferred into a thermo-hygrostat maintained in an environment with a temperature of 40°C and a relative humidity of 90% and allowed to stand for 24 hours. Thus, the humidity control process for the headlamp F was performed. The headlamp F was taken out of the thermo-hygrostat and left in an environment with a temperature of 20°C and a relative humidity of 65% for 1 hour. Thus, the air inside the headlamp F was displaced. An opening portion formed at the lower right end portion of the rear of the headlamp F and the discharge port of the pump according to the example were connected to each other via a flow path member that includes a polyvinyl chloride tube. A pressure gauge was attached to the flow path member at a point along the flow path. An opening portion formed in the housing of the headlamp F, positioned at the upper left end portion in plan view of the rear of the headlamp F, was covered with the gas-permeable membrane a. The permeable area A of the gas-permeable membrane a was 20.43 cm^2. In this manner, a lamp unit according to Example 3A was produced. FIG. 7A is a photograph of the front of the headlamp of Ford

Escape, and FIG. 7B is a photograph of the rear of this headlamp. FIG. 7C is a photograph of the rear of the lamp unit according to Example 3A. In these photographs, the region enclosed by the dashed line near the sign "p" indicates the position of the opening portion connected to the discharge port of the pump, and the region enclosed by the dashed line near the sign "m" indicates the position of the opening portion covered with the gas-permeable membrane.

<Example 3B>

[0058] The permeable area A of the gas-permeable membrane a was changed to 10.21 cm^2. Except for this, the same procedure as in Example 3A was performed to produce a lamp unit according to Example 3B.

<Example 3C>

[0059] The gas-permeable membrane b was used in place of the gas-permeable membrane a, and the permeable area A of the gas-permeable membrane b was adjusted to 38.48 cm^2. Except for this, the same procedure as in Example 3A was performed to produce a lamp unit according to Example 3C. The permeability coefficient P of the gas-permeable membrane b was 0.00127 $cm^3/(Pa \cdot s \cdot cm^2)$.

<Example 3D>

[0060] The permeable area A of the gas-permeable membrane a was changed to 2.10 cm^2. Except for this, the same procedure as in Example 3A was performed to produce a lamp unit according to Example 3D.

<Comparative Example 3>

[0061] The headlamp was not connected to the pump according to the example, did not use the gas-permeable membrane a, and was hermetically sealed. Except for this, the same procedure as in Example 3A was performed to produce a lamp unit according to Comparative Example 3.

[Evaluation of ventilation performance]

[0062] Ventilation performance was evaluated for the lamp units according to the examples and comparative examples. The lamp units produced were each placed in an environment with a temperature of 20°C and a relative humidity of 65%, and eight beam lamps were arranged in front of the lens of each lamp unit. The beam lamps used were the diffusing beam lamp BRF 110V 120W Type 150 manufactured by Kyokko Electric Industrial Co., Ltd. The distance between each lamp unit and the eight beam lamps was adjusted to approximately 700 mm. The eight beam lamps were lighted, and each lamp unit was illuminated with light emitted from the eight beam lamps for 2 hours. The temperature of the lens surface of each lamp unit increased from the start of lighting of the eight beam lamps. Approximately 60 minutes after the start of lighting of the eight beam lamps, the temperature of the lens surface of each lamp unit was maintained at approximately 40 to approximately 60°C. Additionally, provided that each lamp unit is warmed as described above, the evaluation of ventilation performance may employ a method for warming each lamp unit other than the method using beam lamps.

[0063] In the evaluation of ventilation performance for each of the lamp units according to the examples, at the point in time when the power to the beam lamps was switched off to extinguish the beam lamps, the pump in the lamp unit was activated. At a given point in time after the power to the beam lamps was switched off, a 90-second water pouring was performed on the lens surface of each lamp unit. The temperature of the water used for the water pouring was approximately 11°C. After the water pouring was completed, the lens surface was checked for the presence or absence of fogging. In the case where fogging was observed, the time T required for the fogging to be removed was measured. Additionally, in the case where no fogging was observed, the time was determined to be 0 minutes. In the pump units according to the examples, at the point in time when the power to the beam lamps was switched off, the pump was activated and operated according to the following Pattern I or Pattern II. The pressure p inside the housing of the lamp unit during operation of the pump was read from the pressure gauge. The pressure p is a gauge pressure. Table 1 shows the pump unit used for each evaluation, the operation pattern of the pump, the pressure p [kPa] inside the housing of the lamp unit during operation of the pump, the discharge time t [s] of the pump, and the time T [min] required for fogging to be removed. FIG. 8 shows the relationship between the time T required for fogging to be removed and the value of $1000 \cdot p \cdot t \cdot P \cdot A/V$ in each evaluation.

[0064] Pattern I: Operate the pump for a given discharge time t before water pouring, and stop the pump immediately before the start of water pouring.

[0065] Pattern II: Operate the pump during water pouring as well, and stop the pump 1 minute after the start of water pouring.

[0066] As shown in Table 1, the times T in the evaluation of ventilation performance using the pump units according to the examples (Evaluation Nos. 1 to 14) were shorter than the times T in the evaluation of ventilation performance using the pump units according to Comparative Examples 1 to 3 (Evaluation Nos. 15 to 17). Therefore, it is understood that the pump units according to the examples can exhibit better ventilation performance than the pump units according to Comparative Examples 1 to 3.

[0067] According to FIG. 8, it is understood that satisfying the requirement $1000 \cdot p \cdot t \cdot P \cdot A/V \geq 3.0$ causes no occurrence of fogging or removes fogging on the lens surface with a shorter time.

[0068] A first aspect of the present invention provides a lamp unit including:

a body housing including: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
a light source disposed inside the body housing; and
a pump having a gas discharge port connected to the first opening portion.

[0069] A second aspect of the present invention provides the lamp unit according to the first aspect, further including a ventilation member for ventilation between the body housing and the external space, wherein
the ventilation member is provided at the second opening portion.

[0070] A third aspect of the present invention provides the lamp unit according to the first or second aspect, wherein the pump has a maximum discharge pressure of 0.5 to 20.0 kPa.

[0071] A fourth aspect of the present invention provides the lamp unit according to the second aspect, wherein

the body housing, the pump, and the ventilation member form a combination satisfying requirements represented by the following expressions (Ia) and (Ib)

$$1000p \cdot t \cdot P \cdot A/V \geq 3.0 \qquad \text{(Ia)}$$

$$0 < t \leq 300 \qquad \text{(Ib)}$$

where p is a pressure [kPa] inside the body housing during operation of the pump, t is a discharge time [s] of the pump, P is an air permeability coefficient [$cm^3/(Pa \cdot s \cdot cm^2)$] of the ventilation member, A is a permeable area [cm^2] of the ventilation member, and V is a spatial volume [cm^3] inside the lamp unit.

[0072] A fifth aspect of the present invention provides the lamp unit according to the second aspect, wherein
the air permeability coefficient of the ventilation member is 0.00008 to 0.80293 $cm^3/(Pa \cdot s \cdot cm^2)$.

[0073] A sixth aspect of the present invention provides the lamp unit according to the second aspect, wherein
the permeable area of the ventilation member is 0.03142 to 50.26548 cm^2.

[0074] A seventh aspect of the present invention provides the lamp unit according to any one of the first to sixth aspects, wherein
the spatial volume inside the lamp unit is 1000 to 20000 cm^3.

[0075] An eighth aspect of the present invention provides the lamp unit according to any one of the first to seventh aspects, being for a vehicle.

[0076] A ninth aspect of the present invention provides a ventilation method for a body housing of a lamp,

the lamp including a lamp unit,
the lamp unit including:

the body housing including: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
a light source disposed inside the body housing;
a pump having a gas discharge port connected to the first opening portion; and
a ventilation member for ventilation between the body housing and the external space, and
the ventilation method including:

allowing the pump to discharge a gas toward the body housing such that requirements represented by the following expressions (IIa) and (IIb) are satisfied,

$$1000p \cdot t \cdot P \cdot A/V \geq 3.0 \qquad \text{(IIa)}$$

$$0 < t \leq 300 \qquad \text{(IIb)}$$

where p is a pressure [kPa] inside the body housing during operation of the pump, t is a discharge time [s] of the pump, P is an air permeability coefficient [$cm^3/(Pa \cdot s \cdot cm^2)$] of the ventilation member, A is a permeable area [cm^2] of the ventilation member, and V is a spatial volume [cm^3] inside the lamp unit.

[Table 1]

Eval. No.	Pump unit	Pressure p [kPa]	Pump discharge time t [s]	Pump operation pattern	Gas-permeable membrane permeability coefficient P [$cm^3/(Pa \cdot s \cdot cm^2)$]	Gas-permeable membrane permeable area A [cm^2]	Ventilation volume 1000p•t•P•A [cm^3]	Lamp type	Spatial volume V inside lamp [cm^3]	1000p•t•P•A/-V	Eval. result [min]
1	Ex. 1A	2.0	90	I	0.01204	20.43	44272.01	C	9400	4.7	0
2	Ex. 1B	3.0	90	I	0.00127	20.43	7004.83			0.7	24
3	Ex. 2A	0.8	150	I	0.01204	33.18	47942.90	G	8000	6.0	0
4		1.8	150	I			107871.53			13.5	0
5	Ex. 2B	4.0	150	I	0.01204	2.85	20588.40			2.6	10
6	Ex. 3A	2.0	90	I	0.01204	20.43	44272.01	F	13400	3.3	15
7 -		2.0	150	I			73786.68			5.5	0
8		2.0	150	II			73786.68			5.5	0
9		1	150	II			36893.34			2.8	3.5
10	Ex. 3B	2.5	150	I	0.01204	10.21	46116.68			3.4	0.75
11	Ex. 3C	3.5	300	I	0.00127	38.48	51319.09			3.8	0
12	Ex. 3D	3.5	120	I	0.01204	2.10	10619.28			0.8	22
13		1	120	II			3034.08			0.2	12
14		4	120	II			12136.32			0.9	6
15	Comp. Ex. 1	0.0	0	I	Hermetically sealed	0.00	0	C	9400	0.0	40
16	Comp. Ex. 2	0.0	0	I	Hermetically sealed	0.00	0	G	8000	0.0	55
17	Comp. Ex. 3	0.0	0	I	Hermetically sealed	0.00	0	F	13400	0.0	45

I: Operate pump for given discharge time t before water pouring, and stop pump immediately before start of water pouring. II: Operate pump during water pouring as well, and stop pump 1 minute after start of water pouring.

Claims

1. A lamp unit comprising:

   a body housing comprising: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
   a light source disposed inside the body housing; and
   a pump having a gas discharge port connected to the first opening portion.

2. The lamp unit according to claim 1, further comprising a ventilation member for ventilation between the body housing and the external space, wherein
   the ventilation member is provided at the second opening portion.

3. The lamp unit according to claim 1, wherein
   the pump has a maximum discharge pressure of 0.5 to 20.0 kPa.

4. The lamp unit according to claim 2, wherein

   the body housing, the pump, and the ventilation member form a combination satisfying requirements represented by the following expressions (Ia) and (Ib)

   $$1000p \cdot t \cdot P \cdot A/V \geq 3.0 \qquad (Ia)$$

   $$0 < t \leq 300 \qquad (Ib)$$

   where p is a pressure [kPa] inside the body housing during operation of the pump, t is a discharge time [s] of the pump, P is an air permeability coefficient [$cm^3/(Pa \cdot s \cdot cm^2)$] of the ventilation member, A is a permeable area [cm^2] of the ventilation member, and V is a spatial volume [cm^3] inside the lamp unit.

5. The lamp unit according to claim 2, wherein
   the air permeability coefficient of the ventilation member is 0.00008 to 0.80293 $cm^3/(Pa \cdot s \cdot cm^2)$.

6. The lamp unit according to claim 2, wherein
   the permeable area of the ventilation member is 0.03142 to 50.26548 cm^2.

7. The lamp unit according to claim 1, wherein
   the spatial volume inside the lamp unit is 1000 to 20000 cm^3.

8. The lamp unit according to claim 1, being for a vehicle.

9. A ventilation method for a body housing of a lamp,

   the lamp comprising a lamp unit,
   the lamp unit comprising:

      the body housing comprising: a light-transmitting member; a body wall joined to the light-transmitting member to form a housing; and a first opening portion and a second opening portion positioned in the body wall and each forming an opening communicating with an external space of the housing;
      a light source disposed inside the body housing;
      a pump having a gas discharge port connected to the first opening portion; and
      a ventilation member for ventilation between the body housing and the external space, and
      the ventilation method comprising:

         allowing the pump to discharge a gas toward the body housing such that requirements represented by the following expressions (IIa) and (IIb) are satisfied

$$1000p \cdot t \cdot P \cdot A/V \geq 3.0 \qquad \text{(IIa)}$$

$$0 < t \leq 300 \qquad \text{(IIb)}$$

where p is a pressure [kPa] inside the body housing during operation of the pump, t is a discharge time [s] of the pump, P is an air permeability coefficient [$cm^3/(Pa \cdot s \cdot cm^2)$] of the ventilation member, A is a permeable area [cm^2] of the ventilation member, and V is a spatial volume [cm^3] inside the lamp unit.

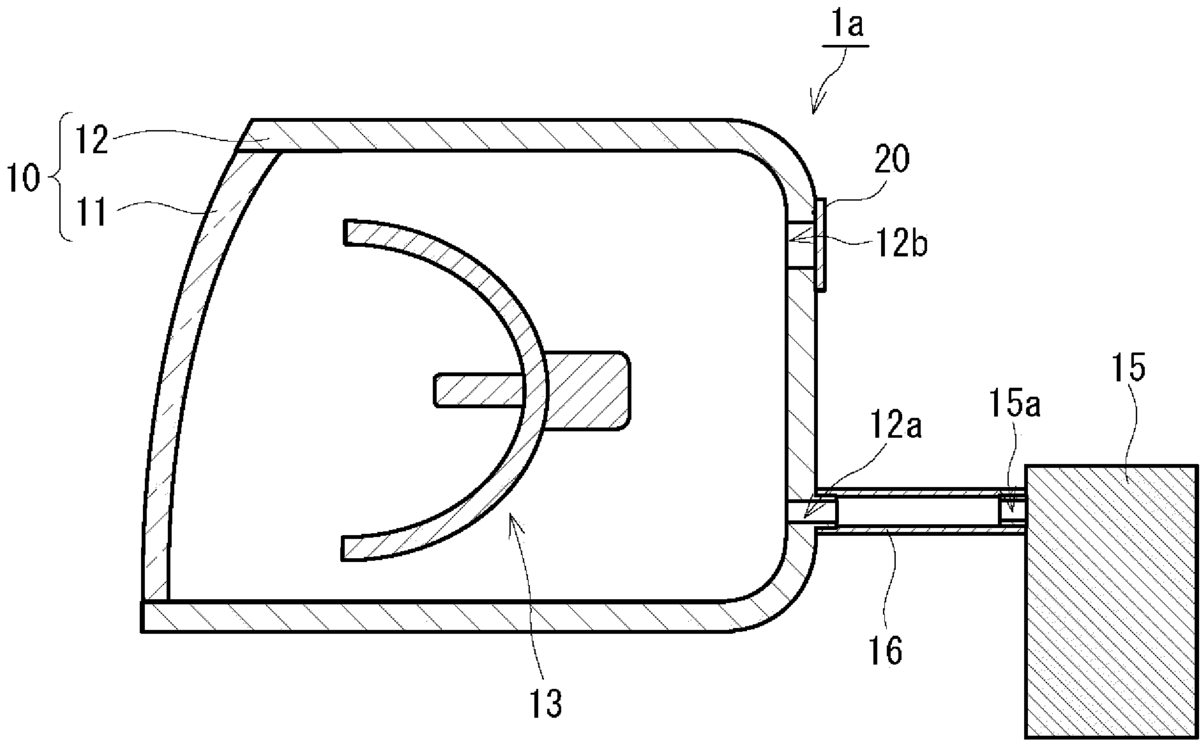


FIG.1

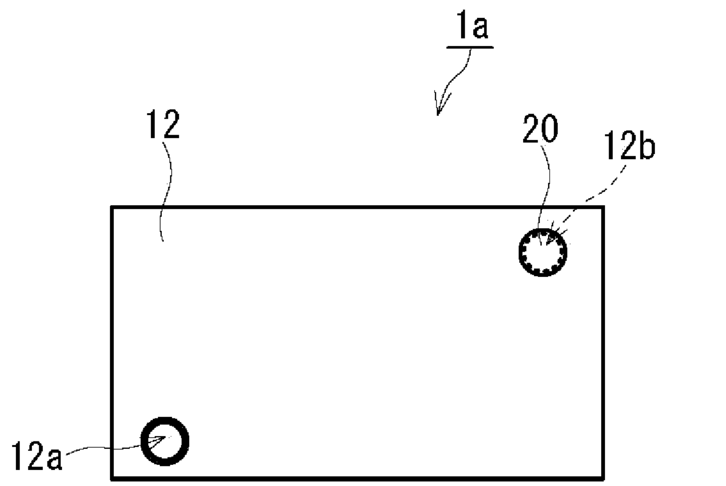


FIG.2A

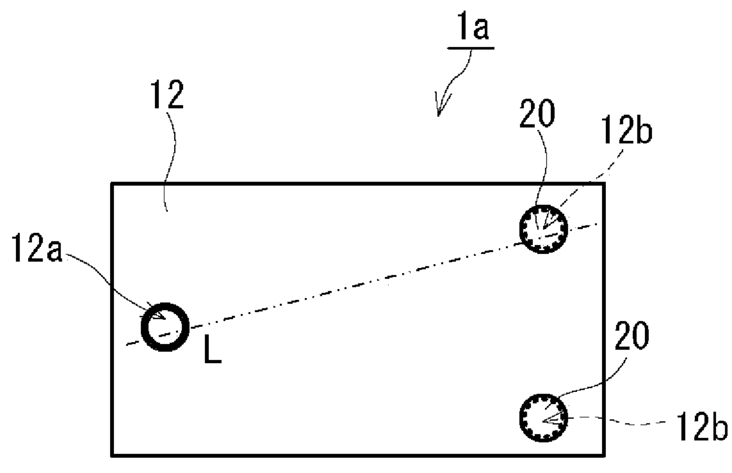


FIG.2B

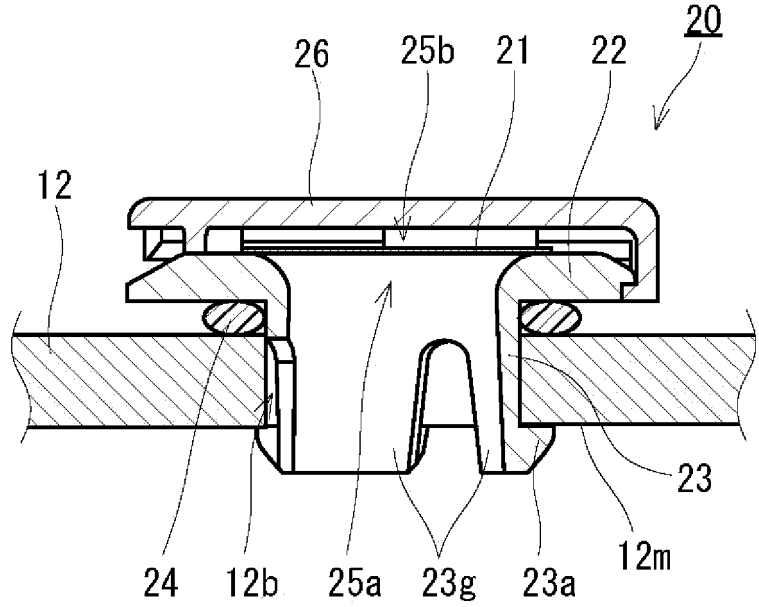
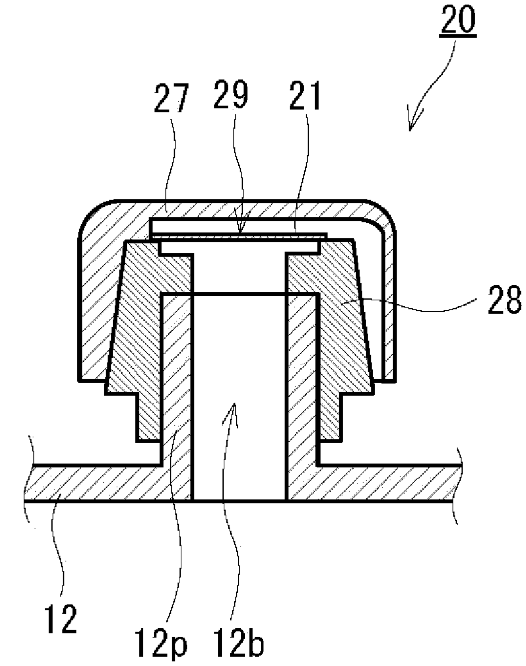

20
26
25b
21
22
12
23
24
12b
25a
23g
23a
12m

FIG.3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28
12
12p
12b

FIG.4

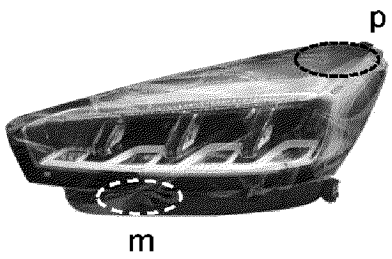

FIG.5A

FIG.5B

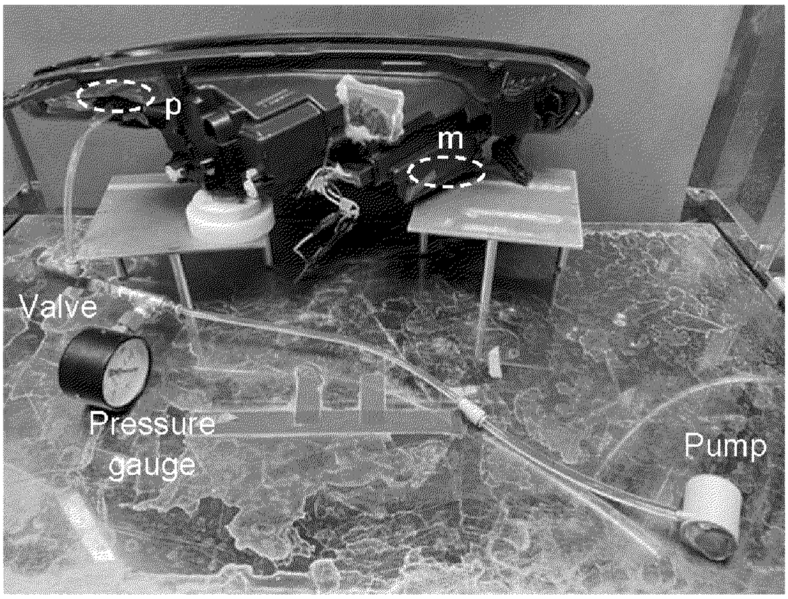

FIG.5C

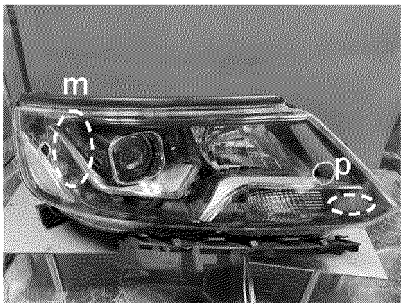

FIG.6A

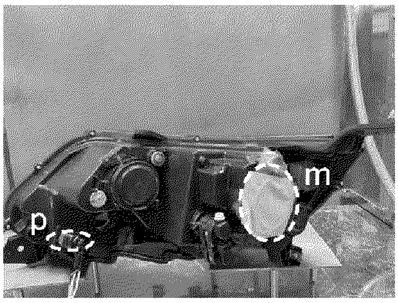

FIG.6B

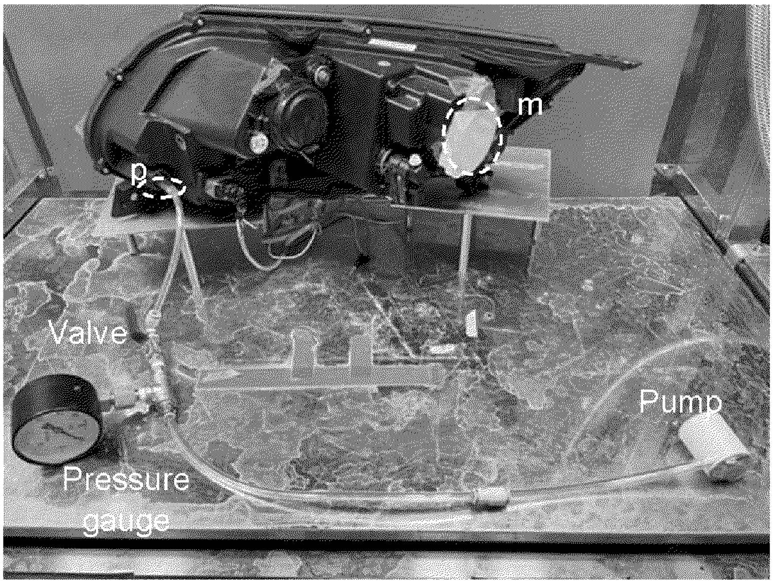

FIG.6C

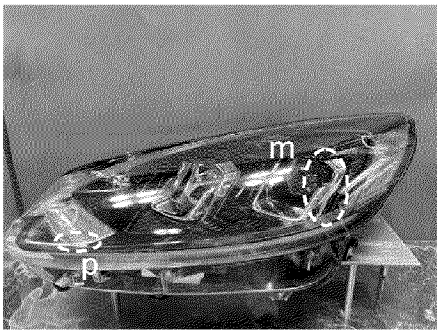

FIG.7A

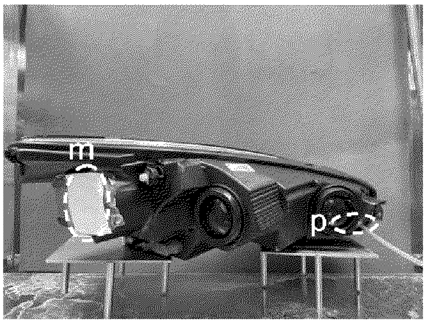

FIG.7B

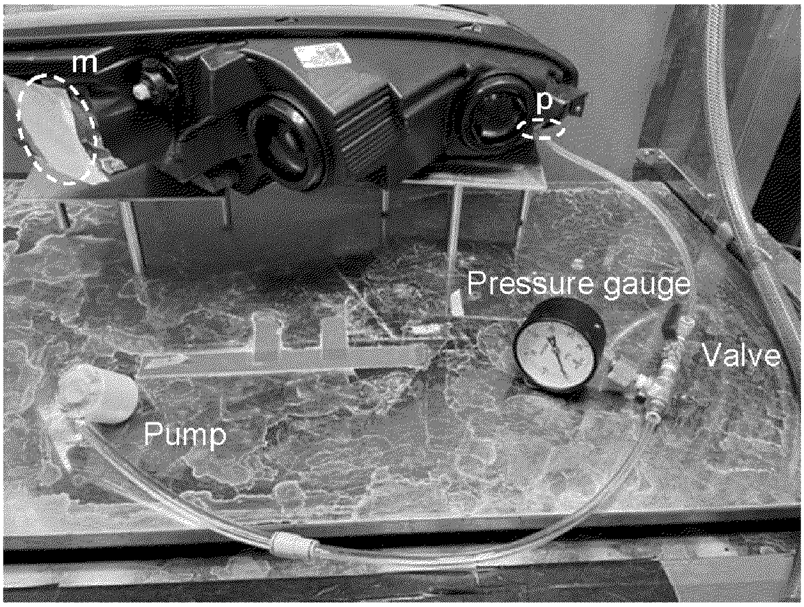

FIG.7C

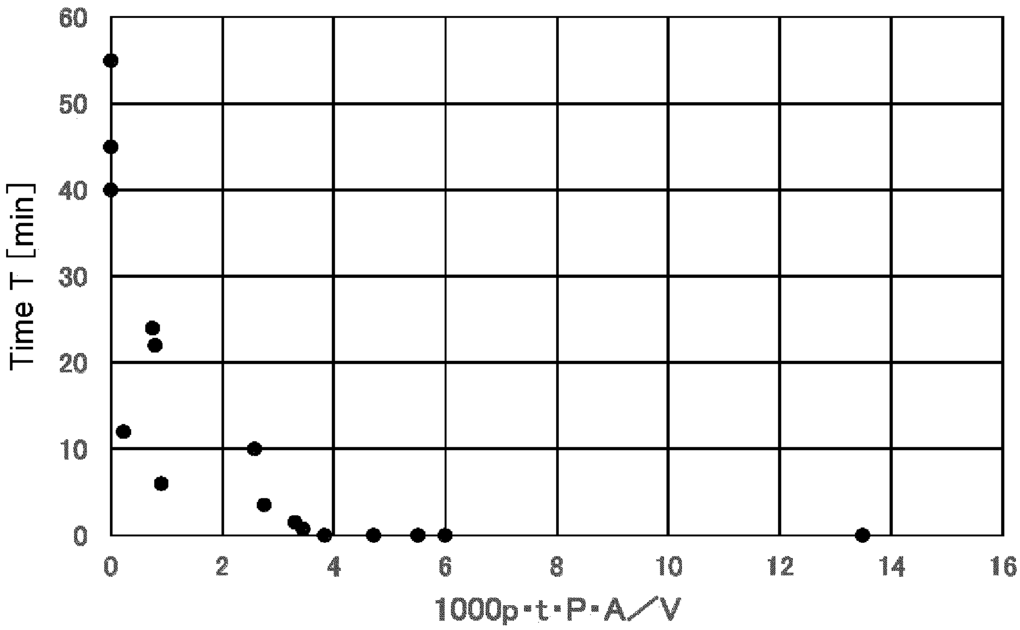

FIG.8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/020370

A. CLASSIFICATION OF SUBJECT MATTER

F21S 45/30(2018.01)i; ***F21V 15/01***(2006.01)i; ***F21V 31/03***(2006.01)i; *F21W 102/00*(2018.01)n; *F21Y 101/00*(2016.01)n; *F21Y 115/10*(2016.01)n
FI: F21S45/30; F21V31/03; F21V15/01 380; F21Y101:00 300; F21Y115:10; F21W102:00

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)

F21S45/30; F21V15/01; F21V31/03; F21W102/00; F21Y101/00; 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 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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 2013-229281 A (NITTO DENKO CORP) 07 November 2013 (2013-11-07) paragraphs [0010]-[0035], fig. 1-7	1-3, 5-8
A	paragraphs [0010]-[0035], fig. 1-7	4, 9
A	JP 2016-097339 A (NITTO DENKO CORP) 30 May 2016 (2016-05-30) entire text, all drawings	1-9
A	JP 2022-025042 A (ZHEJIANG JINYE AUTO PARTS CO LTD) 09 February 2022 (2022-02-09) entire text, all drawings	1-9

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
22 June 2023	**11 July 2023**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/020370

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