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(54) Vehicle lighting device with an annular reflector, and relative improved reflector

(57) A vehicle lighting device (1), typically a headlamp or signal lamp, including a casing (2); a light source (3) and a reflector (4) housed inside the casing; and a transparent cover (5) closing the casing and positioned opposite the light source. The reflector is defined by a ring (20) made of material pervious to light, and constituting an internal-reflection lens. And the ring is bounded by a front surface (21) facing the transparent cover and located inside the casing, on the opposite side to the light source; by an inner lateral surface (22), e.g. defining a geometrical figure of revolution having an axis of symmetry (A) defining an optical axis of the lighting device, along which the light source is located; and by an outer lateral surface (23) which is concentric with the inner lateral surface, defines with the inner lateral surface an interface bounding the internal-reflection lens defined by the ring, and includes at least one inclined surface (24) forming such an angle with the optical axis that the light rays inside the internal-reflection lens defined by the ring (20) are reflected totally onto the front surface (21).

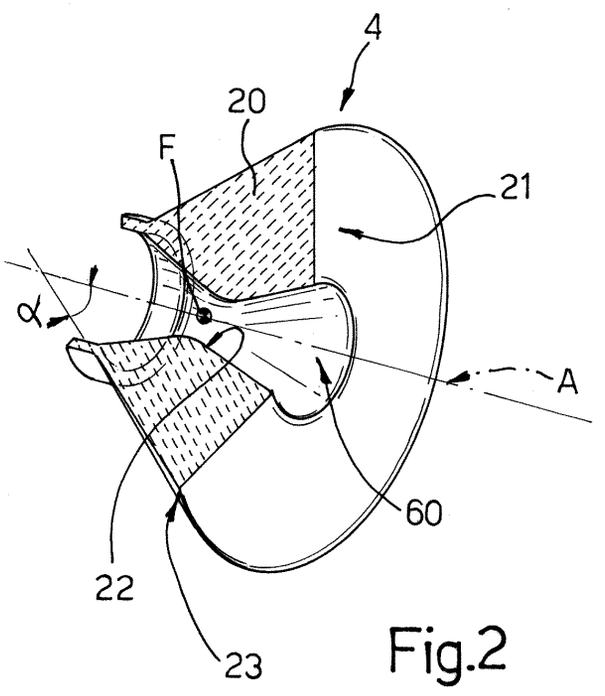

Fig.2

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Description

[0001] The present invention relates to a road vehicle lighting device - which may be either a headlamp, particularly a low-beam or fog lamp, or a signal lamp such as a parking, stop, or turn lamp - featuring an innovative, compact, high-efficiency reflector.

[0002] Here, in the following disclosure, and in the Claims, the term "lighting device" therefore also refers to a light signalling device such as a signal lamp.

[0003] As is known, to light the cover or cover lens of a vehicle headlamp or signal lamp by turning on a light source, there are substantially two methods: a direct-light method (normally used for signal lamps) in which the light source, either directly or by means of a light guide (e.g. optical fibre), directly illuminates at least part of an outer lens having appropriate prisms; or the rays produced by the light source are gathered and directed by a reflector onto the lens (or part of it) to be illuminated.

[0004] Using the first method, the lighting device may be easy to produce, but the beam must be shaped (i.e. the rays emitted through the lens, or part of it, must be distributed) by the lens itself, which, on the one hand, greatly increases the cost of the lens, and, on the other, imposes a given geometric configuration of the lens which is often unacceptable, particularly for design reasons.

[0005] Using the second method, and in particular so-called "complex-surface" reflectors, transparent lenses of any shape can be used, and which are very popular with both consumers and vehicle body designers, but the reflector is extremely expensive to produce.

[0006] Moreover, having metalized surfaces, reflectors are non-ecological, and cannot be recycled when the vehicle is scrapped.

[0007] In both cases, the light source may be visible from outside the vehicle, and, to emit coloured light (as, for example, in the case of signal lamps), coloured filters must be used, and are also visible from the outside, especially when using transparent lenses.

[0008] It is an object of the present invention to provide a lighting device designed to eliminate the aforementioned drawbacks, and which is "fully transparent" in appearance and therefore stylistically neutral with respect to the vehicle body, while at the same time being compact, cheap to produce, and highly efficient.

[0009] According to the present invention, there is provided a road vehicle lighting device as claimed in Claim 1.

[0010] There is also provided an improved, compact, high-efficiency, annular reflector as claimed in Claim 18.

[0011] More specifically, the reflector according to the invention is defined by a single transparent block in the form of an annular member, which constitutes an internal-reflection lens and comprises three boundary interfaces, defined by the inner and outer lateral surfaces and the front surface of the annular member, and a rear mounting collar.

[0012] In the lighting device according to the invention, the reflector according to the invention is therefore mounted to laterally surround the light source - defined, for example, by a bulb in the centre of the reflector - so that the inner lateral surface of the reflector gathers the light rays emitted by the source, and collimates them into a radial beam directed onto the outer lateral surface, which is designed to totally reflect the beam, inside the internal-reflection lens defined by the reflector, onto the annular front surface, which is illuminated to generate a beam directed onto the transparent lens or cover closing the device casing.

[0013] The main advantage of the lighting device and reflector according to the invention lies in their compactness depth-wise, i.e. in the general direction of the axis of symmetry of the reflector, which, from the above description, therefore also defines the lighting device optical axis lying, in use, in the travelling direction of the vehicle. Moreover, there is no need to metalize the reflector, thus greatly reducing cost, simplifying manufacture, and reducing pollution. The lighting device and reflector so formed can also be fully recycled, provide for a high degree of light-gathering efficiency, and, not least importantly, have an innovative transparent look which should be very popular with designers and consumers.

[0014] Finally, it should be stressed that, here and in the following disclosure, the term "annular" is used in a non-limiting sense, and therefore includes not only reflectors bounded by lateral surfaces defined by figures of revolution, but also reflectors bounded by lateral surfaces defined by prismatic figures, symmetrical or not, generated by translation of a polygon along the optical axis of the reflector.

[0015] A non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows an elevation, sectioned along a vertical longitudinal plane, of a road vehicle lighting device in accordance with the invention;

Figure 2 shows a three-quarter front view in perspective of an improved annular reflector, in accordance with the invention, forming part of the Figure 1 lighting device.

[0016] With reference to Figures 1 and 2, number 1 indicates as a whole a road vehicle lighting device of the type comprising a casing 2; a light source 3 and a reflector 4 housed inside casing 2; and a transparent cover 5 closing casing 2 and positioned facing light source 3.

[0017] Depending on the shape of reflector 4, on the presence or not of known optical elements on cover 5, on the type of light source 3 used, and on the presence or not of known accessory elements (lenses, coloured filters, etc.) not shown for the sake of simplicity, device 1 may be used either as a headlamp, e.g. a low-beam or fog lamp, or as a signal lamp, e.g. a turn, stop, or parking lamp; which applications differ solely as regards

the "conformation", in terms of intensity and direction (slope), of a beam 6 issuing from device 1 through cover 5.

[0018] In the non-limiting example shown, casing 2 has a back wall 7 having a seat 8 and a removable plug 9, which has electric contacts 10 and supports light source 3 defined by a bulb with an axial filament 11 lying along an axis A defining, in use, the optical axis of device 1. In use, optical axis A is parallel to the travelling direction of the vehicle (known and not shown) to which device 1 can be fitted.

[0019] Seat 8 is fitted through with bulb 3 and a mounting and support element (a collar) 14 of reflector 4. Bulb 3, which may emit either "white" or colourless light or coloured light, may have an integrated known blinder 15 at the front (i.e. towards cover 5), or a known blinder (not shown for the sake of simplicity) may be housed in known manner inside casing 2, between bulb 3 and cover 5; in both cases, the purpose being to intercept the "direct" rays emitted by bulb 3 in the direction of cover 5, so that filament 11 can only emit rays 33 directed radially with respect to axis A.

[0020] Obviously, if device 1 is a signal lamp, the above limitation is not compulsory, and blinder 15 may be replaced with a known lens for gathering the "direct" rays emitted by bulb 3, and directing them, e.g. in a parallel beam, onto cover or outer lens 5.

[0021] According to the invention, reflector 4 is defined by at least one at least partly annular member 20. As already stated, the term "annular" is intended to include not only members bounded by lateral surfaces defined by figures of revolution, but also members bounded by lateral surfaces defined by prismatic figures, symmetrical or not, generated by translation of a polygon along optical axis A.

[0022] Member 20 according to the invention is made of materials pervious to light (i.e. is fully transparent), and therefore constitutes an internal-reflection lens bounded by : a first interface defined by a front surface 21 of member 20; a second interface defined by at least part of an inner lateral surface 22 of member 20; and a third interface defined by at least part of an outer lateral surface 23 of member 20, preferably concentric with and facing said at least part of inner lateral surface 22 defining the second interface.

[0023] At the rear, i.e. towards back wall 7 of casing 2, member 20 has mounting collar 14.

[0024] With reference to Figures 1 and 2, which show a preferred, non-limiting embodiment of the invention, reflector 4 is defined by a single continuous annular member 20 defined by a block formed in one piece from materials pervious to light, so as to constitute said internal-reflection lens, and has one axis of symmetry, indicated A in Figure 2, which, in the non-limiting embodiment shown, is therefore coincident with the optical axis of device 1.

[0025] Single annular member 20 is bounded by surfaces 21, 22 and 23, which are all annular and continuous; surface 21 being flat and substantially perpendicular to axis of symmetry A; lateral surfaces 22 and 23 both being coaxial with axis A; radially inner surface 22 being a surface of revolution about axis A; and radially outer surface 23 facing and being substantially concentric with surface 22, and defining, towards surface 22, at least one inclined surface 24 forming a given angle α with axis A, so that, when surface 22 is illuminated, the rays gathered by surface 22 are reflected totally onto front surface 21, thus illuminating surface 21.

[0026] As shown, annular member 20 is in the form of a single solid continuous block of transparent material selected from a group comprising: glass (vitreous material), synthetic plastic (e.g. Plexiglas or polycarbonate), and a combination of these. In a variation not shown for the sake of simplicity, annular member 20 may be in the form of a sealed continuous hollow shell made from one of the above-listed materials and filled with any type of transparent fluid having a refraction index substantially similar to that of the transparent material from which the shell defining member 20 is made.

[0027] Once reflector 4 according to the invention, as described above, is fitted inside device 1 (Figure 1), surface 21 is housed inside casing 2, facing transparent cover 5 and on the opposite side to light source 3; and the whole of annular surface 22 defines said second interface, and is positioned inside casing 2 so that its axis of symmetry, as stated, coincides with optical axis A of device 1.

[0028] Bulb 3, which is positioned with filament 11 aligned with axis of symmetry A of reflector 4, is therefore located in the centre of annular member 20, and is fully surrounded laterally by an axial portion of predetermined length of annular member 20. At the same time, said third interface of the internal-reflection lens is defined by the whole of annular surface 23, which slopes with respect to axis A.

[0029] Surface 22 defining said second interface is so shaped as to gather all the rays 33 emitted laterally by bulb 3, and to collimate rays 33 into a beam 34 directed radially, and perpendicularly to axis A, onto surface 23 defining said third interface of the internal-reflection lens.

[0030] That is, when filament 11 is energized, the second interface defined by the whole of surface 22 gathers the rays 33 produced by source 3, and collimates them into beam 34 directed onto surface 23.

[0031] Surface 23, in the embodiment shown in the bottom half of Figure 1, may be a conical surface defining a single inclined plane (surface) 24 towards the second interface defined by surface 22; or, in the embodiment shown in the top half of Figure 1, may comprise a number of step-like projections 44, each bounded, radially outwards with respect to axis A, by two sides, at least one of which is defined by an inclined plane (surface) 24.

[0032] In the latter case, the angles formed between inclined planes (surfaces) 24 of projections 44 and axis

A may obviously differ.

[0033] In both cases, the angle/s formed by inclined surface/s 24 is/are so selected that, inside the internal-reflection lens defined by member 20, collimated beam 34 is reflected totally onto front surface 21 defining said first interface, so that front surface 21 is illuminated, and beam 6 is emitted through front surface 21 onto transparent cover 5.

[0034] Obviously, in the second variation described, beam 6 can only be shaped as required by appropriately selecting the angles formed between inclined surfaces 24 of projections 44 and axis A.

[0035] In addition to or instead of the above characteristic, front surface 21 defining the first interface of the internal-reflection lens defined by member 20 - and which, as stated, is defined by a flat annular surface perpendicular to axis A (as shown in the bottom half of Figure 1) - may be at least partly provided (as shown in the variation in the top half of Figure 1) with prisms and/or other elements 50, e.g. cylindrical or bicylindrical prisms, for shaping beam 6.

[0036] To obtain the characteristics described, the radially inner annular lateral surface 22 of member 20, defining the second interface of the internal-reflection lens defined by member 20, is defined by a curved generating line, and in particular comprises at least one segment of a parabola or ellipse; in which case, light source 3 is positioned with filament 11 located substantially at the focus F of the parabola or ellipse, and inner surface 22 of member 20 defines an axial, venturi-tube-shaped through hole 60 of member 20.

[0037] To obtain a desired shape of beam 6, surface 22 may obviously be formed symmetrical with respect to axis A, or may be of complex shape asymmetrical with respect to axis A.

[0038] A coloured beam 6 can be produced either using a coloured source 3, as stated, or using reflector 4 itself as a colour filter for a "white" source 3.

[0039] As stated, for easy assembly of reflector 4, annular member 20 is provided, on the light source 3 side, with a cylindrical mounting collar 14 connecting and spacing said surfaces 22, 23 defining the second and third interface. For which purpose, mounting collar 14 is provided with known, e.g. bayonet, connecting means 70 for connection to back wall 7 of casing 2.

Claims

1. A road vehicle lighting device (1), typically a headlamp or signal lamp, of the type comprising a casing (2); a light source (3) and a reflector (4) housed inside the casing (2); and a transparent cover (5) closing the casing and positioned opposite the light source; **characterized in that** the reflector (4) is defined by at least one at least partly annular member (20) made of materials pervious to light, and constituting an internal-reflection lens bounded by:
   - a first interface defined by a front surface (21) of said at least partly annular member (20), located inside the casing, facing said transparent cover, and on the opposite side to said light source which is located along an optical axis (A) of the device;
   - a second interface defined by at least part of an inner lateral surface (22) of said at least partly annular member (20), and positioned, with respect to said light source, to gather light rays (33) emitted by said light source; and
   - a third interface defined by at least part of an outer lateral surface (23) of said at least partly annular member (20), and positioned facing said at least part of an inner lateral surface of said at least partly annular member defining said second interface;

   said outer lateral surface (23) of said at least partly annular member (20) being so formed as to produce, when said inner lateral surface (22) of said at least partly annular member (20) is illuminated, a total reflection onto said front surface (21), so as to illuminate the front surface.

2. A lighting device (1) as claimed in Claim 1, **characterized in that** said outer lateral surface (23) of said at least partly annular member (20) defines, towards the second interface, at least one inclined surface (24) forming such an angle with the optical axis (A) that, inside the internal-reflection lens defined by said at least partly annular member (20), the light rays gathered by the second interface are reflected totally onto said front surface (21) defining said first interface, so as to illuminate the front surface and so emit a light beam (6) through the front surface and onto said transparent cover.

3. A lighting device (1) as claimed in Claim 1 or 2, **characterized in that** said reflector (4) is defined by a single annular member (20); said light source being located in the centre of said annular member, so as to be fully surrounded laterally by an axial portion of predetermined length of the annular member.

4. A lighting device (1) as claimed in Claim 3, **characterized in that** said front surface (21) defining said first interface is defined by a flat annular surface perpendicular to the optical axis (A).

5. A lighting device (1) as claimed in Claim 3 or 4, **characterized in that** at least part of said front surface (21) defining said first interface has prisms (50) and/or other elements for shaping said light beam (6).

6. A lighting device (1) as claimed in Claim 5, **characterized in that** said prisms (50) are cylindrical or

bicylindrical.

7. A lighting device (1) as claimed in any one of the foregoing Claims, **characterized in that** said annular member (20) is in the form of a single solid continuous block of transparent material selected from a group comprising: glass (vitreous material), synthetic plastic, and a combination of these.

8. A lighting device (1) as claimed in any one of Claims 1 to 6, **characterized in that** said annular member (20) is in the form of a sealed continuous hollow shell made of transparent material selected from a group comprising: glass(vitreous material), synthetic plastic, and a combination of these; said hollow shell being filled with a transparent fluid having a refraction index substantially similar to that of the transparent material from which said hollow shell is made.

9. A lighting device (1) as claimed in any one of Claims 1 to 8, **characterized in that** said second interface is so shaped as to form said light rays (33) from the light source into a collimated light beam (34) directed radially, and perpendicularly to said optical axis (A), onto said third interface.

10. A lighting device (1) as claimed in Claim 9, **characterized in that** said second interface is defined by a radially inner annular lateral surface (22) of said annular member (20), which is a surface of revolution having an axis of symmetry coincident with the optical axis (A) of the lighting device (1).

11. A lighting device (1) as claimed in Claim 10, **characterized in that** said radially inner annular lateral surface (22) of said annular member (20) is defined by a curved generating line.

12. A lighting device (1) as claimed in Claim 10 or 11, **characterized in that** said curved generating line comprises at least one segment of a parabola or ellipse; said light source (3) being located substantially at the focus (F) of said parabola or ellipse.

13. A lighting device (1) as claimed in any one of Claims 1 to 12, **characterized in that** said third interface is defined by a radially outer annular lateral surface (23) of said annular member.

14. A lighting device (1) as claimed in Claim 13, **characterized in that** said radially outer annular lateral surface (23) is a conical surface.

15. A lighting device (1) as claimed in Claim 13, **characterized in that** said radially outer annular lateral surface (23) comprises a number of step-like projections (44), each of which is defined, radially outwards with respect to the optical axis, by two sides, at least one of which is defined by at least one inclined surface (24).

16. A lighting device (1) as claimed in any one of the foregoing Claims, **characterized in that**, on the said light source side, said at least partly annular member (20) has a mounting collar (14) connecting and spacing said surfaces (22; 23) defining said second and said third interface.

17. A lighting device (1) as claimed in Claim 16, **characterized in that** said mounting collar (14) has connecting means for connection to a back wall of said casing.

18. An improved reflector (4) for a lighting device (1), **characterized by** being defined by an at least partly annular member (20) formed in one piece from materials pervious to light, so as to constitute an internal-reflection lens; said annular member having a single axis of symmetry (A), and being bounded by:

- a front surface (21) substantially perpendicular to said axis of symmetry (A);
- an inner lateral surface (22) for gathering light rays (33) generated at said axis of symmetry (A); and
- an outer lateral surface (23) facing and concentric with said inner lateral surface (22), and defining means by which said light rays gathered by said inner lateral surface (22) are totally reflected onto said front surface (21).

19. A reflector (4) as claimed in Claim 18, **characterized in that** said inner lateral surface (22) is a surface of revolution about said axis of symmetry (A); and said outer lateral surface (23) is concentric with and faces said inner lateral surface (22), and defines, towards the inner lateral surface, at least one inclined surface (24) forming such an angle with said axis of symmetry (A) that, when said inner lateral surface (22) is illuminated, the light rays gathered by the inner lateral surface are reflected totally onto said front surface (21) to illuminate the front surface.

20. A reflector (4) as claimed in Claim 18 or 19, **characterized in that** said annular member (20) is in the form of a single solid continuous block of transparent material selected from a group comprising: glass (vitreous material), synthetic plastic, and a combination of these.

21. A reflector (4) as claimed in Claim 18 or 19, **characterized in that** said annular member (20) is in the form of a sealed continuous hollow shell made of transparent material and filled with a transparent

fluid having a refraction index substantially similar to that of the transparent material from which said shell is made.

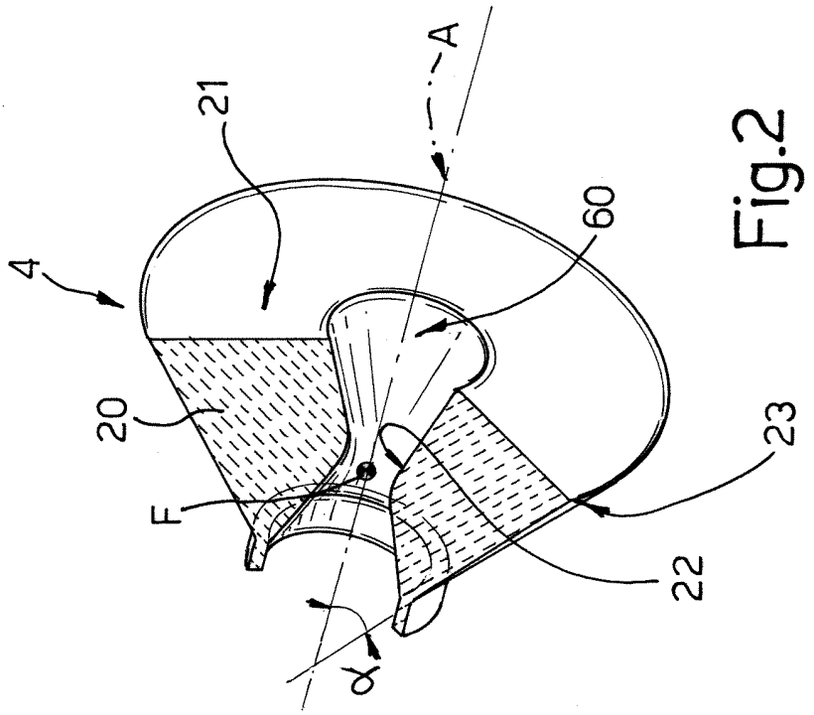
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Fig.2

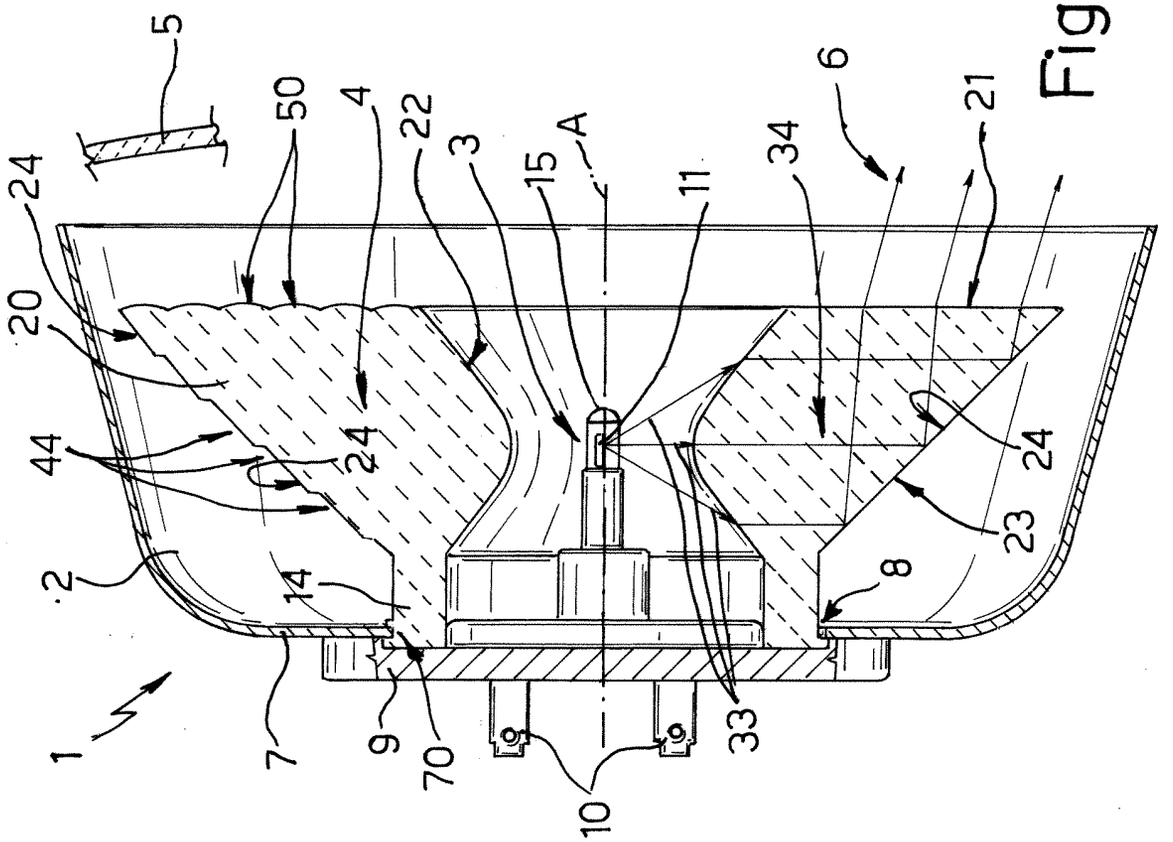
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Fig.1