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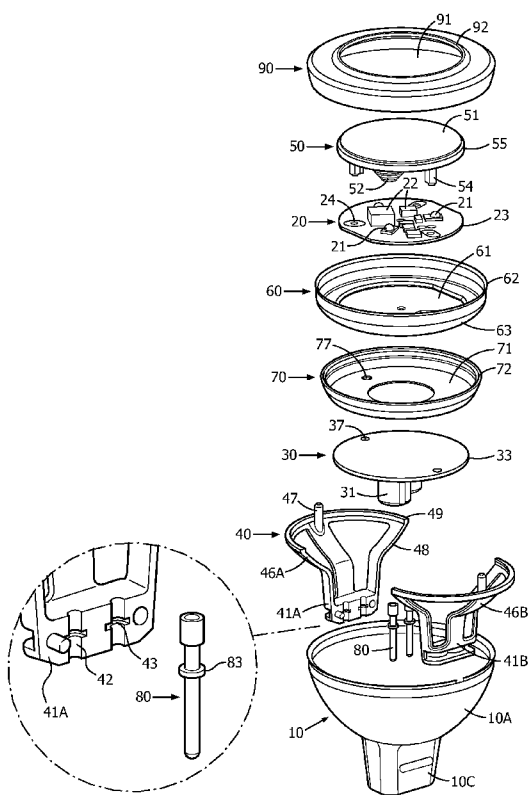


FIG. 2B

(57) Abstract: A lamp assembly (1) comprises: a housing (10); a lighting unit (20) arranged within the housing, the lighting unit comprising a lighting carrier, a light-generating element (21) and driving electronics (22; 31) for the light-generating element mounted on the lighting carrier; a transparent window covering the lighting unit; electrical contact terminals (80) for electrically coupling the assembly to a lamp socket. The light-generating element and/or driving electronics produce heat, and the housing has a heat-sink functionality, and heat-guiding means are provided for coupling the lighting carrier for heat transfer to the housing. The housing comprises at least two separate housing parts made of metal or a metal alloy. The lighting unit and the transparent window are not fixed with respect to each other, and are mechanically confined and held in place by the two housing parts. The housing parts are attached to each other mechanically by at least one form-fit joint.

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LAMP ASSEMBLY

FIELD OF THE INVENTION

5 The present invention relates in general to a lamp assembly comprising a housing, one or more LEDs mounted in the housing, and coupling terminals for electrically coupling the lamp assembly to a lamp socket.

BACKGROUND OF THE INVENTION

10 The term "lamp" may have several meanings. In the context of the present invention, the term "lamp" will be used to indicate the replaceable element that is to be mounted in a lamp socket. A conventional example of a lamp in this sense, suitable for general lighting purposes and powered from the mains, is an incandescent lamp, typically including a pear-shaped glass bulb with a filament within a confined space with an atmosphere of suitable
15 composition. In later embodiments, the lamp atmosphere contains a halogen, and the size of the bulb has decreased. In a further embodiment, the small bulb is mounted in a cone-shaped reflector housing with a transparent plate, typically of glass or quartz, covering the bulb. The bulb with this housing and the glass window, together with electrical terminals attached to the housing, form an integral unit which is to be replaced as a whole, and which is also indicated
20 by the term "lamp". Depending on the length scale used by the observer, the unit may be indicated as "light-generating unit", containing a bulb as "light-generating element", but within the bulb the actual light-generating element is the filament wire. In discharge lamps, no such element can be indicated: the light is generated by a plasma inside the bulb.

25 In a special type of lamp, the light-generating element is constituted by one or more LEDs, which is/are mounted, together with driving electronics, within a lamp housing that is equipped with electrical coupling terminals. This combination will in the context of the present invention be indicated as "lamp assembly". Typically, but not essentially, the assembly is shaped in conformity with the shape of for instance a halogen lamp, so that it is possible to exchange a halogen lamp with such a lamp assembly, or in any case the electrical
30 coupling terminals are designed to fit in existing lamp sockets. In any case, the lamp assembly as a whole constitutes a replaceable product, which is to be discarded when broken; for consumers, such a product is also indicated as "LED lamp".

SUMMARY OF THE INVENTION

5 The lamp assembly comprises a plurality of components. Externally, the lamp assembly comprises a housing, a transparent window, electrical contact pins. Internally, the assembly comprises one or more LEDs mounted on a carrier (typically a PCB), electronic driver circuitry mounted on a carrier, electrical connection wires, etc. These components are secured to one another by means of glueing, screwing, soldering or welding, such as to form a structural unit. Additionally and/or alternatively, components are encapsulated with epoxy or a thermosetting plastic or similar material, for protection against shock, vibration, moisture, etc. Such potting materials are also used for fixing components together, and/or for
10 conducting heat away from the heat sources to the housing, which acts as a heat sink and radiator. Also, plastics are used as structural materials.

While this is all very well with a view to the proper technical functioning of the LED lamp, the present invention was made with a view to improving the environmental
15 friendliness of the LED lamp. When LED lamps fail at the end of their useful life, they are discarded. If they are just thrown away, the constituent materials end up in the environment, which is undesirable. Thus, there is a desire to recycle the used materials, and actually regulations have been issued, and/or are expected to be issued in the near future, that make recycling of electronic equipment compulsory.

20 With the design of LED lamps as summarized above, recycling is problematic. For recycling to be feasible, it is highly desirable to recover the base materials of the product in as pure a form as possible. This means, for instance, that metals, polymers and minerals should be separated. This, in turn, means that methods need to be conceived for disassembling the lamp into its constituent parts, which will be complicated and costly, or the lamps are
25 shredded to very small pieces (millimeter scale) after which these pieces are separated. This shredding process is energy-consuming, and in the shredding process a portion of the material weight is lost as non-recoverable dust, this portion being larger as the shredded pieces are smaller. Further, the shredding-followed-by-separation process is based on the assumption that the resulting particles individually consist of one base material only, which in practice is
30 not 100% true, so that the resultant base materials are inevitably contaminated with foreign materials: for instance, metal is contaminated with polymers, or vice versa. It will be relatively expensive to remove this contamination.

Another problem with the current LED lamps is the use of many engineering plastics. Plastics containing many (different) additives are very difficult to recycle and are generally considered “waste”, and therefore imply recycle costs instead of profit.

Further, in the shredding process the driver and the LED PCB are destroyed as well. It would be highly desirable to be able to recover these, thereby minimizing the risk of material loss and contamination, and possibly enabling re-use of these valuable components.

Thus, an important objective of the present invention is to provide a design for an LED lamp that can very easily be recycled, with little or no waste. Particularly, the present invention aims to provide a design for an LED lamp that can be disassembled very quickly such as to yield a large portion of the base materials in 100% pure form.

In an important aspect, the present invention provides a lamp assembly in which the internal components are made from one base material as much as possible, and are simply stacked and pressed or clamped together by the housing. The use of screws and glue, and other permanent fixation means, is avoided. Consequently, when the housing is removed, for instance in a destructive process such as cutting, the internal components simply remain and the individual components can be picked up, thus providing an output stream of pure base material.

Further advantageous elaborations are mentioned in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects, features and advantages of the present invention will be further explained by means of the following description of one or more preferred embodiments with reference to the drawings, in which same reference numerals indicate same or similar parts, and in which:

figures 1A-C schematically show cross-sections and an exploded view of a prior art lamp assembly;

figures 2A-B schematically show a cross-section and an exploded view of a lamp assembly according to the present invention;

figure 3A is a perspective view of an embodiment of a sleeve;

figure 3B schematically shows a cross-section of a first embodiment of a lamp assembly

according to the present invention;

figure 4 schematically shows a perspective view of a third embodiment of a lamp assembly according to the present invention, in taken-apart condition;

figure 5 schematically shows a perspective view of a fourth embodiment of a lamp assembly according to the present invention, in taken-apart condition.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1A-C show a schematic cross-section along a first longitudinal plane (Fig.1A), a schematic cross-section along a second longitudinal plane (Fig.1B), and an exploded view (Fig.1C) of a prior art lamp assembly 1, illustrating that the assembly comprises a plurality of components. It is noted that the shape of this lamp assembly corresponds to the well-known MR-16 design for halogen lamps, for which LED retrofits are commercially available, but it should be clear that the invention is not limited to this shape.

In general, the assembly 1 comprises a semi-spherical body 3, with an insulating base 2 carrying electrical terminals 12 which project from the base. The body 3 has a hollow interior, at the open end of which a transparent window 5 is fitted, for instance made of glass, plastic or quartz, and typically having lens-shaped portions at its inner surface. Typically, as shown, the transverse dimension at the base 2 is smaller than the transverse dimension at the window 5, which typically is circular. In the following, the combination of body 3 and base 2 will also be indicated as housing 10.

In figures 1A-B, the assembly 1 is shown with the base 2 at the bottom and the window 5 at the top. Behind the window 5 (i.e. below the window in the orientation of figure 1), the assembly 1 comprises a carrier plate 6 carrying the at least one LED 6a as well as other electronic components 6b; this plate will be indicated as LED carrier plate 6, and is typically implemented as a PCB.

Below the LED carrier plate 6, the assembly 1 comprises a second carrier plate 8 carrying electronic components of an electronic lamp driver; this plate will be indicated as driver carrier plate 8. The terminals 12 are electrically connected to respective inputs of the electronic lamp driver. Electrical connections between an output of the electronic lamp driver and the LED carrier plate 6 are not visible in these views.

The body 3 is designed to perform many functions. An important aspect of the body 3 is that it serves as a heat sink to remove the heat generated by the driver and the LEDs. In

cross section, the body 3 has a general H-shape with a central plane 3a, upper side wall 3b and lower side wall 3c. The figures show that the LED carrier plate 6 is mounted on the central plane 3a of the body 3. Heat generated in the LED unit is transferred to the body's central plane 3a (axial heat transfer) while the body's central plane 3a transfers the heat to the body's outer side wall 3b, 3c (radial heat transfer). For a good axial heat transfer, it is required that the LED carrier plate 6 is pressed firmly against the body's central plane 3a, which is achieved by means of a screw 6d extending through the LED carrier plate 6 and being screwed into a screw hole of the body's central plane 3a. To reduce the interface resistance, a layer of thermal interfacial material 6e is interposed between the LED carrier plate 6 and the body's central plane 3a.

The inner surface of the body's upper side wall 3b is threaded. A ring 4 has matching threading on its outer surface, and is screwed into the body 3 for locking the window 5 and pressing the window 5 onto the LED carrier plate 6.

The driver carrier plate 8 with the electronic driver is located in the lower half of the body 3. The driver carrier plate 8 and electronic components form an integral unit with the terminals 12 soldered thereto, and this unit is placed in the base 2, with the lower ends of the terminals projecting from the base 2. The base and said unit are jointly screwed to the lower side of the body's central plane 3a, by means of screws 8d that extend through holes in the body's central plane 3a and are screwed into screw holes of the base 2. A substantially cylindrical insulator 7 extends around the driver carrier plate 8 and the electronic driver components to provide sufficient electrical insulation between the electrical parts of the driver and the body's lower wall 3c.

In the design of figures 1A-C, a relatively large number of parts are used for attaching all parts firmly together. In some designs, glue or potting material is used, but not in the design of figures 1A-C. Disassembling the assembly as such is not difficult: one just needs to unscrew the mounting ring 4 and the screws 6d and 8d. Even then, the different parts do not yet disengage because the thermal interfacial material 6e is sticky. Apart from that, unscrewing the mounting ring 4 and the screws 6d and 8d requires manual labour, which is relatively expensive, or alternatively needs dedicated robotic equipment, which is also expensive. So, in practice, shredding is the remaining solution, with the associated problem that all base materials are mixed, as described above.

Figures 2A-B show a schematic cross-section (Fig.2A) and an exploded view (Fig.2B) of a first embodiment of a lamp assembly according to the present invention, generally indicated by reference numeral 101. It is noted that the shape of this lamp assembly corresponds to the well-known MR-16 design for halogen lamps, for which LED retrofits are commercially available, but it should be clear that the invention is not limited to this shape.

In general, the inventive lamp assembly 101 comprises eleven separate unitary components, which will be discussed below. It is noted that it will be possible to increase or decrease the number of components without deviating from the inventive concept of the present invention.

HOUSING

The assembly 101 comprises a housing 10 accommodating most of the other components. The housing 10 has a more or less semi-ball-shaped or dome-shaped shell 10A and a more or less block-shaped portion 10C extending from the centre of the shell 10A. The housing 10 is made of a metal or metal alloy, for instance aluminium or steel, preferably deep-drawn plate material. The housing 10 is designed to perform many functions. Apart from forming a protective casing around the components within the housing, an important aspect of the housing 10 is that it serves as a heat sink to remove the heat generated by the driver and the LEDs.

CONTACT PINS

The assembly 101 comprises two electrical terminals 80 which project from the block-shaped housing portion 10C for making electrical contact in a lamp socket, as will be clear to a person skilled in the art. The terminals 80 are shown as elongate pins of constant cross-section, but other configurations are also possible. The terminals 80 are made of a metal or metal alloy, for instance brass.

BASE

In the lowermost part of the cylindrical housing portion 10C, a base 41 holds the terminals 80 in place. The base 41 is made of an insulating material, typically a plastic. For easy assembly and disassembly, the base 41 consists of two substantially identical halves 41A, 41B, each half having two mutually parallel recesses 42 for receiving the respective pins

80, and each of those recesses 42 having at least one portion 43 of wider diameter matching with a circumferential flange 83 of a contact pin 80. Thus, when the two base halves 41A, 41B are fitted together with the two contact pins 80 in between, these contact pins 80 are positively held in place by the base 41. Subsequently, the base 41 is placed within the cylindrical housing portion 10C, in which it fits snugly so that the two base halves 41A, 41B cannot become detached. During recycling, when the housing 10 is opened, the base 41 becomes exposed, the two base halves 41A, 41B become detached, and the two contact pins 80 are released. Thus, with one simple action, two plastic components 41A, 41B, two pin components 80 and one housing component 10 are provided separately, each consisting of one base material only.

LED DRIVER UNIT

Above the base 41, the lamp assembly 101 comprises an LED driver unit 30, comprising a number of electronic components of an electronic lamp driver 31 mounted on a carrier plate that will be indicated as driver carrier plate 33. Typically, driver carrier plate 33 is mounted in the housing shell 10A, at some distance from the base 41, with the electronic components of the electronic lamp driver 31 directed towards the base 41 such as to make useful use of the space between base 41 and carrier plate 33.

For electrically connecting the lamp driver 31 to the terminals 80, use is made of wiring. Figure 2A clearly shows that the upper end of the terminal pin 80 may have a central recess for receiving the end of a wire. In practice, two wires (not shown for the sake of simplicity) will be connected to the driver carrier plate 33, for instance by soldering, and a terminal pin 80 will be connected, for instance by soldering, to the opposite free end of such a wire.

Alternatively, the terminal pins 80 may for instance be hollow over their entire length, the connection wire may be inserted into the pins, and the pins may be clamped into contact with the wire by exerting an external pinching force. In such a case, the later removal of the wires from the pins does not require the removal of solder.

In any case, after being connected in this way, the pins 80 with the connecting wires may form an integral unit with the LED driver unit. The connecting wires may be relatively stiff, thereby assisting in positioning the pins 80 during the assembly process, and helping the wires maintain their shape and position, during operation of the lamp assembly, at a

sufficiently large distance from each other and from the housing, such that an insulating wire coating may be dispensed with, which in turn dispenses with the need of removing such a coating during the recycling process. On the other hand, it is also possible that the connecting wires are not soldered to the driver unit 30 but are connected to it via small plug-in connectors, enabling the wires to be easily separated during the recycling process.

DRIVER HEAT SPREADER

In use, the LED driver 31 generates heat, which has to be transferred to the housing 10. At best, the driver carrier plate 33 could have its outer rim contacting the housing, however, this would be inadequate for the purpose of heat transfer. Therefore, with a view to achieving fast and efficient heat transfer from the LED driver 31 to the housing 10, the driver carrier plate 33 is, over a large part of its surface area, in close contact with a heat guide or heat spreader 70, indicated as driver heat spreader. The driver heat spreader 70 is made of a metal or metal alloy, for instance aluminium or steel, preferably deep-drawn plate material. The driver heat spreader 70 has a general saucer-shape, with a flat bottom 71 contacting the driver carrier plate 33 and an upright circumferential rim 72. The rim 72 has an oblique portion 73 adjoining the bottom 71. When the driver heat spreader 70 is placed into the housing shell 10A, it will assume a position determined by the diameter of its bottom 71. The oblique portion 73, which may be flat or slightly convex, makes an angle with the bottom 71 corresponding to the angle of the housing shell 10A at the precise spot where the heat spreader 70 touches the housing shell 10A. In this way, an increased contact area between heat spreader 70 and housing shell 10A is provided, allowing for a good thermal transfer from heat spreader 70 to housing shell 10A.

DRIVER CLAMP

For a good thermal transfer from LED driver 31 to housing shell 10A, it is also necessary to have a good thermal transfer from LED driver 31 to heat spreader 70. In the prior art design discussed above, the driver carrier plate is not thermally connected to the housing, but if the same principle would be applied as that behind the mounting of the LED unit, then the driver carrier plate 33 would be pressed against the heat spreader by screwing the driver carrier plate to the heat spreader, and/or some heat-conducting paste would be applied between the driver carrier plate and the heat spreader. As mentioned, this requires additional

assembly activities, and complicates recycling. According to the present invention, this problem is solved by a driver clamp 46 that mechanically presses the driver carrier plate 33 towards the heat spreader 70. More particularly, the driver clamp 46 is implemented as a hollow cone-shaped item resting against the housing shell 10A in the space between the driver carrier plate 33 and the base 41, around the electronic components of the driver 31, and having its outer rim 49 contacting the driver carrier plate 33 and forming a seat for the outer peripheral edge of the driver carrier plate 33.

In principle, the driver clamp 46 could be implemented as a one-part component.

Further, at least in principle, the driver clamp 46 could be made of metal, thus contributing to the heat transfer from the driver carrier plate 33 to the housing shell 10A.

However, in the embodiment shown, the driver clamp 46 is implemented as a two-part component, each part 46A, 46B being made of plastic and integrated with a base part 41A, 41B. Thus, a manufacturer only needs to provide a single plastic component 40, of which two are needed in the lamp assembly, each component 40 combining the function of base 41A, 41B and clamp 46A, 46B.

It is noted that the clamp 46 may be provided with one or more positioning pins 47, cooperating with a positioning hole 37 in the driver carrier plate 33 and a positioning hole 77 in the heat spreader bottom 71.

It is further noted that the clamp 46 does not have to be a solid material object. As clearly illustrated in the drawing, the clamp 46 may comprise a plurality of mutually spaced legs 48 connecting the outer rim 49 to the base 41. These legs 48 may be slightly resilient such as to conform to the shape of the housing shell 10A and the housing cylinder 10C, and to compensate for tolerances.

LED UNIT

The assembly 101 further comprises one or more LEDs 21, mounted on an LED carrier plate 23 together with any other necessary electronic components 22. The LED carrier plate 23 is typically implemented as a PCB. The LED carrier plate 23 together with the LED or LEDs 21 and any other necessary electronic components 22 forms a structural unit indicated as LED unit 20.

LED HEAT SPREADER

In use, the LEDs 21 generate heat, which has to be transferred to the housing 10. With a view to achieving a fast and efficient heat transfer from the LEDs 21 to the housing 10, in a similar manner as described with respect to the LED driver, the LED carrier plate 23 is, over a large part of its surface area, in close contact with a heat guide or heat spreader 60, indicated as LED heat spreader. The LED heat spreader 60 is made of a metal or metal alloy, for instance aluminium or steel, preferably deep-drawn plate material. The LED heat spreader 60 has a general saucer shape, with a flat bottom 61 contacting the LED carrier plate 23 and an upright circumferential rim 62. The rim 62 has an oblique portion 63 adjoining the bottom 61. When the LED heat spreader 60 is placed into the housing shell 10A, it will assume a position determined by the diameter of its bottom 61. The oblique portion 63, which may be flat or slightly convex, makes an angle with the bottom 61 corresponding to the angle made by the housing shell 10A at the precise spot where the LED heat spreader 60 touches the housing shell 10A. In this way, an increased contact area between LED heat spreader 60 and housing shell 10A is provided, allowing for a good thermal transfer from LED heat spreader 60 to housing shell 10A.

LENS UNIT

Above the LED or LEDs, the lamp assembly 101 comprises a transparent window 51, typically circular, having lens-shaped portions 52 at its inner surface, the positions of the lens-shaped portions 52 corresponding with the positions of the LEDs 21. This window 51 is integrated with the lens-shaped portions 52 to form a structural unit, indicated as lens unit 50. The lens unit 50 is for instance made of glass, plastic or quartz. For maintaining a correct positioning of the lens unit 50 with respect to the LED unit 20, the lens unit 50 comprises a number of support legs 54 fitting into corresponding recesses 24 of the LED carrier plate 23. It is noted that these support legs 54 are integral with the window 51 and lens portions 52, and are made of the same material, so that the lens unit 50 is a one-material unit.

TOP RING

When assembling the lamp assembly 101, the components described above are basically just stacked upon each other. Thus, the clamp/base components 40 are fitted together with the terminal pins 80 in between and the LED driver unit resting on the rim 49, and the combination is placed into the housing 10. The driver heat spreader 70 is placed onto

the LED driver unit 30. The LED heat spreader 60 is placed onto the driver heat spreader 70; it is noted that the LED heat spreader 60 will be resting on the free upper edge 74 of the rim 72 of the driver heat spreader 70. The LED unit 20 is placed onto the LED heat spreader 60. And finally the lens unit 50 is placed onto the LED unit 20.

5 It is noted that no fixing elements such as screws or the like are used to actually fix the components onto each other. With respect to the electrical connection between the LED driver unit 30 and the LED unit 20, this may for instance be provided by pins (not shown) protruding downwards from the LED unit 20 through corresponding holes in the LED heat spreader 60 and making contact with corresponding receiving sockets of the LED driver unit 30, so that
10 this contact is made automatically when the LED unit 20 is put in place, while the friction of the pins in the sockets may be sufficient to more or less keep the components in place. Alternatively, such pins may be mounted on the LED driver unit 30, extending upwards from the LED driver unit 30 and protruding through corresponding holes in the LED heat spreader 60 and making contact with corresponding receiving sockets of the LED unit 20, for instance
15 metallized holes in the PCB.

For completing the lamp, the lamp assembly 101 comprises a front plate 90 with at least one opening for allowing the emitted light to pass. The front plate may have several openings, aligned with the corresponding LEDs, respectively. It is also possible that the front plate has a single central opening 91 having an inner contour corresponding to the outer
20 contour of the window 51 of the lens unit 50, as shown. Since this opening 91 is typically circular, and since the radius of this opening is not much smaller than the front radius of the housing shell 10A, the front plate 90 in this embodiment is also indicated as front ring.

The front ring 90 is made of a metal or metal alloy, for instance aluminium or steel, preferably deep-drawn plate material.

25 The figures clearly show that, on the side facing away from the LED unit 20, i.e. the outer side, the lens window 51 has a stepped circumferential edge 55, into which the inner edge 92 of the front ring 90, i.e. the rim of the opening 51, fits.

The front ring 90 further has a circumferential skirt 93 directed towards the housing shell 10A and having an inner diameter corresponding to the outer diameter of the housing
30 shell 10A.

The front ring 90 is placed over the housing shell 10A, with its inner edge 92 engaging the circumferential edge 55 of the lens unit 50. Next, the front ring 90 is firmly

pressed down onto the housing shell 10A. As a result, the lens unit 50 is pressed onto the LED unit 20, which is pressed onto the LED heat spreader 60, which is pressed onto the driver heat spreader 70, which is pressed onto the driver unit 30, which is supported by the clamp 40.

With all components pressed firmly together, a pinching tool is used to pinch the skirt 93 inwards such as to form a circumferential seam with the front edge 11 of the shell 10A. For improved stability, the front edge 11 of the shell 10A may be bent outwards, as shown.

The front ring 90 is now mechanically fixed to the housing shell 10A, and can in fact be considered as part of the housing. As an additional advantage, the front ring 90 contributes to the heat sinking function of the housing.

When it is desired to recycle the lamp assembly 101, the front ring 90 is removed, for instance by destroying the skirt 93. After that, all structural units can simply be removed or may even become detached by themselves, automatically providing large units of one base material only, plus two electronic units.

It is noted that, in this design, the LED heat spreader 60, on the one hand, exerts pressure on the driver heat spreader 70 and, on the other hand, bears against the housing shell 10A for heat transfer. To make sure that both contacts simultaneously perform in an adequate manner, it is for instance possible that the upright rim 72 of the driver heat spreader 70 is deliberately sized so as to be slightly too high and is elastically bent when pressed down by the LED heat spreader 60, thus allowing the LED heat spreader 60 to be lowered further until it touches the housing. To facilitate such bending of the rim 72, the rim 72 may be provided with axial slits. In another approach, it is possible that the housing shell 10A has a cylindrical portion with a diameter corresponding to the driver heat spreader 70 and/or a cylindrical portion with a diameter corresponding to the LED heat spreader 60, so that the driver heat spreader 70 and/or the LED heat spreader 60, respectively, still have some axial play with respect to the housing while nevertheless being in good thermal contact with the housing. Alternatively and/or additionally, the rim 72 of the driver heat spreader 70 and/or the rim 62 of the LED heat spreader 60 may be provided with axial slits, so that the rim portions between such slits can be directed obliquely outwards and can be resiliently pushed inwards when fitted into the housing, thereby providing a resilient clamping force with respect to the housing.

Instead of the front ring 90 being clamped onto the shell 10A, it is possible to close the housing in a secure manner and confine all internal components in another manner.

Figure 3B is a schematic cross-section of a second embodiment of a lamp assembly according to the present invention, indicated by reference numeral 201. All internal
5 components may be identical to the components of the first embodiment, therefore these internal components are not shown again. The figure only shows the housing 10, the front ring 90 and the lens unit 50. The lamp assembly 201 of the second embodiment is distinguished by the presence of a resilient and preferably elastic sleeve 150 which tightly fits
10 around the housing 10. Figure 3A is a perspective view of the separate sleeve 150, shown as a semi-transparent entity, although an actual embodiment does not necessarily have to be transparent.

At the front side (upper side in the figure) of the lamp assembly, the sleeve 150 has an opening 153 leaving the lens unit 50 unobstructed, such as not to hinder the light output. At the rear side (lower side in the figure) of the lamp assembly, the sleeve 150 does not cover the
15 electrical terminals 80. Apart from these unobstructed/uncovered regions, the sleeve 150 may extend over the entire outer surface of the housing 10, i.e. extend over the shell 10A as well as the block portion 10C. However, it is also possible that the sleeve 150 does not cover the block portion 10C. In any case, the sleeve's function is to hold the front ring 90 and the housing 10 together, by exerting an axial pressure force, without the need to form a seam.
20 When the assembly is to be recycled, the sleeve can easily be removed, again resulting in a one-material object itself, and then ring 90 and housing 10 can easily be taken apart.

The material of the sleeve can for instance be a polymer or a silicone or a rubber.

The sleeve can be made as a moulded piece by injection moulding of polymer(s) or silicone(s) or rubber(s). Alternatively, the sleeve can be made by dip-moulding. The sleeve
25 may have a proper size smaller than the outside dimensions of the lamp housing, and may be elastically stretched to fit around the housing. It is also possible that the sleeve is made as a shrink foil, for instance of PE or PET material, that is shrunk around the housing by a heat treatment, which foil is made by extrusion. It is also possible that the sleeve is made as a relatively small, shapeless sock that is elastically stretched to fit around the housing.

30 Within the concept of the present invention, several variations are possible.

In the embodiment described with reference to figures 1A-B, the housing shell 10A extends to the front plate 90, and the front plate 90 is fixed to the housing shell 10A, while the heat spreaders 60 and 70 are loosely arranged in the shell and maintained in place by pressing them between the top plate 90 and the shell 10A. Alternatively, or additionally, it is possible to have a direct clamping connection between a heat spreader and the shell by pinching the shell at the location of such a heat spreader. In both cases, the outer wall of the lamp assembly is constituted by the shell 10A. However, it is also possible that the outer wall of the lamp assembly is constituted by the upright rims of the heat spreaders directly. Figure 4 illustrates an embodiment where the shell 10A extends just to the driver heat spreader 470. The outer rim 472 of the driver heat spreader 470 is stepped, comprising an inner portion 473 that fits within the shell 10A and an outer portion 474 having a diameter corresponding to or even larger than the diameter of the shell edge. After insertion of the inner portion 473 into the shell 10A, the shell 10A is pinched to form deformations 10D in the shell and corresponding deformations 475 in the heat spreader 470 such that the heat spreader 470 is clamped by the shell.

In a similar manner, the outer rim 462 of the LED heat spreader 460 is stepped, comprising an inner portion 463 that fits within the outer portion 474 of the driver heat spreader 470, and an outer portion 464 having a diameter corresponding to or even larger than the diameter of the edge of the outer portion 474 of the driver heat spreader 470. After insertion of the inner portion 463 into the driver heat spreader 470, the outer portion 474 of the driver heat spreader 470 is pinched to form deformations 476 in the outer portion 474 of the driver heat spreader 470 and corresponding deformations 465 in the inner portion 463 of the LED heat spreader 460 such that the LED heat spreader 460 is clamped by the driver heat spreader 470.

With reference to figure 2, the base 41 has been replaced by a block-shaped pin carrier 441, for instance made of plastic, that, after insertion in the housing, is fixed by pinching the housing foot portion 10C to form deformations 10E in the housing foot portion 10C that exert pressure on the material of the pin carrier 441 or enter strategically placed openings in the pin carrier 441.

It is noted that in such an embodiment, the outer surface is not as smooth as in the embodiment of figures 2A-B, but this aspect is less important and in any case does not play any role if the sleeve 150 discussed with reference to figures 3A-B is applied.

Figure 5 illustrates an embodiment where the LED heat spreader 560 is held positively by the shell 10A. In its outer surface, the rim 562 of the LED heat spreader 560 has a circumferential groove 564, while the shell 10A has a corresponding circumferential ridge 10F formed on its inner surface. The heat spreader 560 is pushed into the shell 10A such that the ridge 10F snaps into the groove 564.

It is noted that, instead of one contiguous groove and ridge extending through 360°, the heat spreader may have a plurality of recesses distributed along the perimeter while the shell may have a corresponding plurality of projections, which solution would have the additional advantage of providing a positive locking against mutual rotational displacement.

It is further noted that such a snap-connection may be applied in the embodiment of figure 4 instead of pinch deformations. Nevertheless, whether pinch deformations or snap connections are used, on recycling, when the assembly is shredded or when the heat spreader 560 is pulled out, the components fall apart without contaminating each other.

If the LED heat spreader is positively fixed to the shell, by pinching or snap fitting or any other form-fit way, it is possible that the front plate and the heat spreader are integrated or, in other words, that the heat spreader is designed to hold the lens unit. This feature is also illustrated in figure 5. At its free end, the rim 562 of the LED heat spreader 560 is bent inwards to form an inward flange 566. In its side face, the lens unit 550 has a partial groove 555. More precisely, the lens unit 550 has a layered design, comprising, seen from outside to inside, a front portion 551, a neck portion 552 having a reduced diameter as compared to the front portion 551, and a rear portion 553 having an oval contour, i.e. its diameter in one direction is larger (see 553A) than its diameter in a second direction (see 553B) at 90° with respect to the first direction.

The largest diameter of the rear portion 553 (553A) is larger than the inner diameter of the flange 566. In the condition of rest, the flange 566 engages behind the rear portion 553 to hold the lens unit.

The diameter of the neck portion 552 is smaller than the inner diameter of the flange 566. Further, the smallest diameter of the rear portion 553 is smaller than the inner diameter of the LED heat spreader 560. Consequently, it is possible to deform the heat spreader 560 as a whole by applying inward pressure at mutually opposed pressure positions so that the heat

spreader 560 assumes an oval shape: when the inward pressure (see arrow B) is applied at pressure positions corresponding to the positions of smallest diameter (553B) of the rear portion 553, the flange 566 of the heat spreader 560 can move inwards while simultaneously the flange 566 of the heat spreader 560 will move outwards (see arrow A) at positions
5 displaced through 90° with respect to said pressure positions, thus releasing the rear portion 553 so that the lens unit 550 can be removed from the shell 10A.

While the invention has been illustrated and described in detail in the drawings and foregoing description, it should be clear to a person skilled in the art that such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention is
10 not limited to the disclosed embodiments; rather, several variations and modifications are possible within the protective scope of the invention as defined in the appended claims.

In the above, the invention has been described for a lamp assembly having a shape corresponding to the MR-16 design, and having axial connector pins of constant diameter.
15 However, it is also possible that the lamp assembly has a different shape, for instance the shape of a classical bulb, and/or it is possible that the electrical terminals have a different shape, for instance connector pins with a T-shaped cross section for a twist-lock, or even Edison threading or a bayonet-type mount is possible.

Further, it may be possible to have the LED and driver electronics mounted on a
20 single carrier, in which case only one heat spreader may be needed.

Further, although the invention has been described in the context of an LED lamp, the invention can also be applied in the case of lamp assemblies comprising one or more light-generating elements of a different type. Even if a light-generating element is used of a type that does not generate much heat so that the assembly housing does not need to function as a
25 heat sink, and/or if the assembly housing is not made of metal, the designs as described are still advantageous in view of the multiple advantages described in the assembly process, reduced assembly costs, and easier recycling.

Other variations to the disclosed embodiments can be understood and effected by
30 those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The

mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

1. Lamp assembly (1) comprising:
5 a housing (10);
a lighting unit (20) arranged within the housing, the lighting unit comprising a lighting carrier
and at least one light-generating element (21) and possibly driving electronics (22; 31) for the
light-generating element mounted to the lighting carrier;
at least one transparent window covering the lighting unit;
10 electrical contact terminals (80) for electrically coupling the assembly to a lamp socket;
wherein the light-generating element (21) and/or driving electronics (22; 31) produce heat,
wherein the housing has a heat-sink functionality, and wherein heat-guiding means are
provided coupling the lighting carrier for heat transfer to the housing;
wherein the housing comprises at least two separate housing parts made of metal or a metal
15 alloy;
wherein the lighting unit and the transparent window are not fixed with respect to each other,
and are mechanically confined and held in place by the housing parts;
and wherein the housing parts are attached to each other mechanically by at least one form-fit
joint.
20
2. Lamp assembly according to claim 1, wherein the housing parts are made of easily
deformable metal or metal alloy, and wherein the form-fit joint comprises a mechanical
deformation of at least one of the housing parts.
- 25 3. Lamp assembly according to claim 1, wherein the housing parts are made of deep-
drawn metal.
4. Lamp assembly according to claim 1, wherein the housing comprises a shell (10A)
having an open front end, and a front plate (90) covering the open front end of the shell, and
30 having a circumferential skirt (93) directed substantially perpendicularly to the front plate and
extending around the front end of the shell;
wherein the skirt of the front plate exerts a clamping force on the front end of the shell.

5. Lamp assembly according to claim 4, further comprising a disc-shaped heat spreader (60) for the lighting unit, having an upright peripheral edge (62) in heat-transferring contact with the inner wall of the shell, wherein the lighting carrier and the transparent window are stacked between the heat spreader and the front plate, and wherein the heat spreader and the front plate exert a pressure force on said stack so that the lighting carrier is pressed onto the heat spreader by the transparent window.
6. Lamp assembly according to claim 4, wherein the shell is provided with pinch-deformations exerting a clamping force on the upright peripheral edge of the lighting unit heat spreader.
7. Lamp assembly according to claim 1, wherein the electrical contact terminals (80) are attached to the lighting carrier.
8. Lamp assembly according to claim 1, wherein at least part of the driving electronics (22; 31) for the light-generating element is mounted on a driver carrier separate from the lighting carrier.
9. Lamp assembly according to claim 8, wherein the electrical contact terminals (80) are attached to the driver carrier.
10. Lamp assembly according to claim 8, further comprising a second disc-shaped heat spreader (70) for the driver unit, having an upright peripheral edge (72) in heat-transferring contact with the inner wall of the shell, and having its upper edge in contact with the first heat spreader such as to be confined between the first heat spreader and the shell wall.
11. Lamp assembly according to claim 8, wherein the shell is provided with pinch-deformations exerting a clamping force on the upright peripheral edge of the driver unit heat spreader.

12. Lamp assembly according to claim 10, further comprising pressing means for pressing the driver carrier against the second heat spreader.

13. Lamp assembly according to claim 12, further comprising at least one insulating unit (40) made of an electrically insulating material, for providing electrical insulation between the electrical contact terminals (80) with respect to each other and/or between the electrical contact terminals (80) and the housing.

14. Lamp assembly according to claim 13, wherein said insulating unit also fulfils the pressing function of said pressing means.

15. Lamp assembly according to claim 1, wherein the housing comprises;
a shell (10A) having an open front end;
a disc-shaped heat spreader for the lighting unit, having an upright peripheral edge in heat-transferring contact with the shell, said peripheral edge having an open front end;
and a front plate (90) covering the open front end of the heat spreader, and having a circumferential skirt directed substantially perpendicularly to the front plate and extending around the front portion of the peripheral edge of the heat spreader;
wherein the skirt of the front plate exerts a clamping force on the front portion of the peripheral edge of the heat spreader;
wherein the open front end of the shell extends around a rear portion of the peripheral edge of the heat spreader;
and wherein the open front end of the shell exerts a clamping force on the rear portion of the peripheral edge of the heat spreader.

16. Lamp assembly according to claim 15, wherein the peripheral edge of the heat spreader is stepped

17. Lamp assembly according to claim 15, wherein the lighting carrier and the transparent window are stacked between the heat spreader and the front plate, and wherein the heat spreader and the front plate exert a pressure force on said stack so that the lighting carrier is pressed onto the heat spreader by the transparent window.

18. Lamp assembly according to claim 1, wherein at least part of the driving electronics (22; 31) for the light-generating element is mounted on a driver carrier separate from the lighting carrier;

5 wherein the housing comprises;

a shell (10A) having an open front end;

a first disc-shaped heat spreader (470) for the driving unit (30), having an upright peripheral edge in heat-transferring contact with the shell, said peripheral edge (472) having an open front end;

10 a second disc-shaped heat spreader (460) for the lighting unit (20), having a second upright peripheral edge (462) in heat-transferring contact with the first heat spreader, said second peripheral edge having an open front end;

and a front plate (90) covering the open front end of the second heat spreader, and having a circumferential skirt directed substantially perpendicularly to the front plate and extending around the front portion (464) of the peripheral edge of the second heat spreader;

15 wherein the skirt of the front plate exerts a clamping force on the front portion of the peripheral edge of the second heat spreader;

wherein the open front end of the shell extends around the rear portion (473) of the peripheral edge of the first heat spreader;

20 wherein the open front end of the shell exerts a clamping force on the rear portion of the peripheral edge of the first heat spreader;

wherein the open front end (474) of the first heat spreader extends around the rear portion (463) of the peripheral edge of the second heat spreader;

25 and wherein the open front end of the first heat spreader exerts a clamping force on the rear portion of the peripheral edge of the second heat spreader.

19. Lamp assembly according to claim 1, wherein two adjoining housing parts are connected to each other by pinch-deformations (10D, 475; 476, 465).

30 20. Lamp assembly according to claim 1, wherein two adjoining housing parts are connected to each other by a snap-connection (10F, 564).

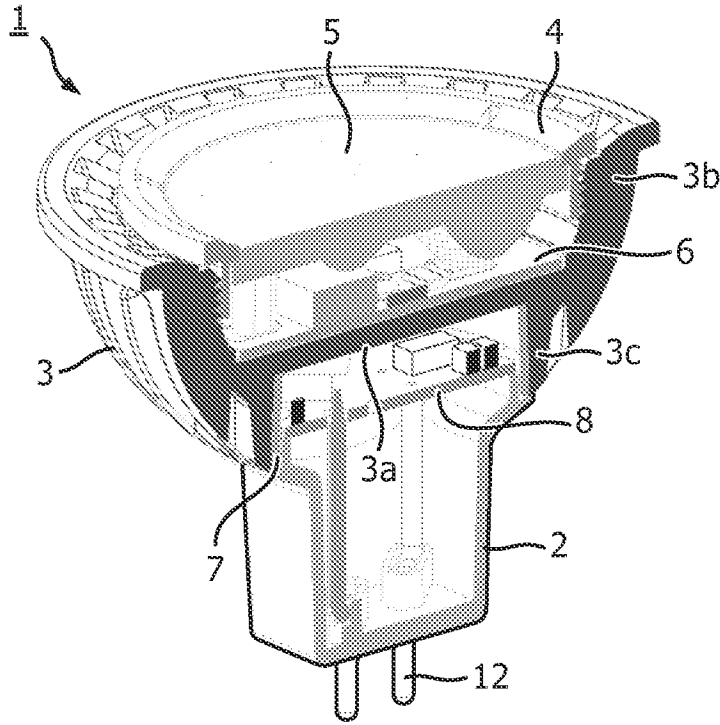


FIG. 1A

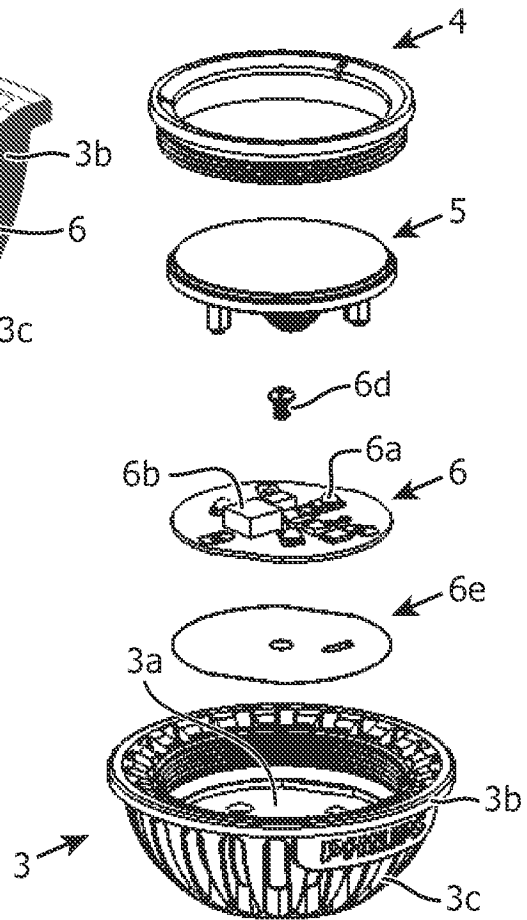


FIG. 1B

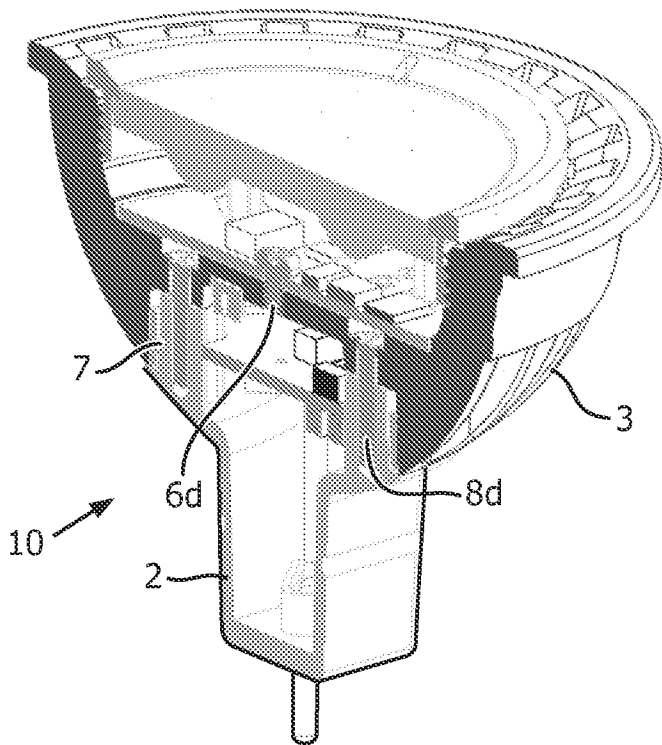


FIG. 1C

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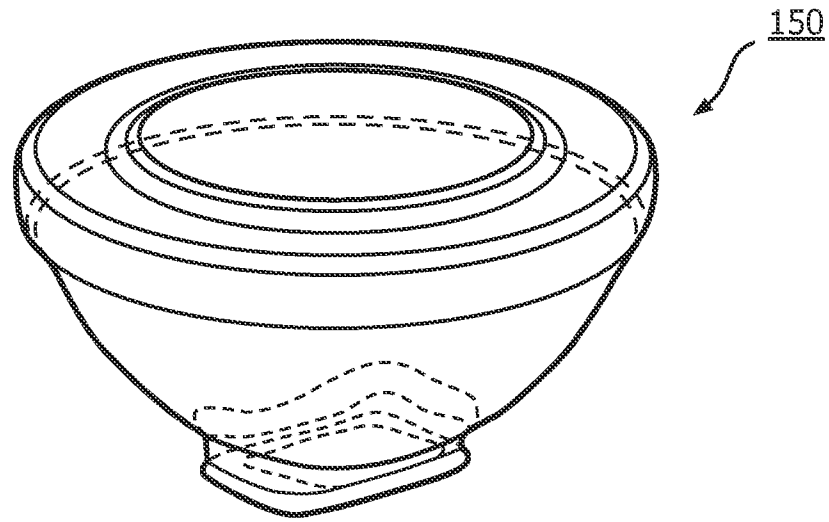


FIG. 3A

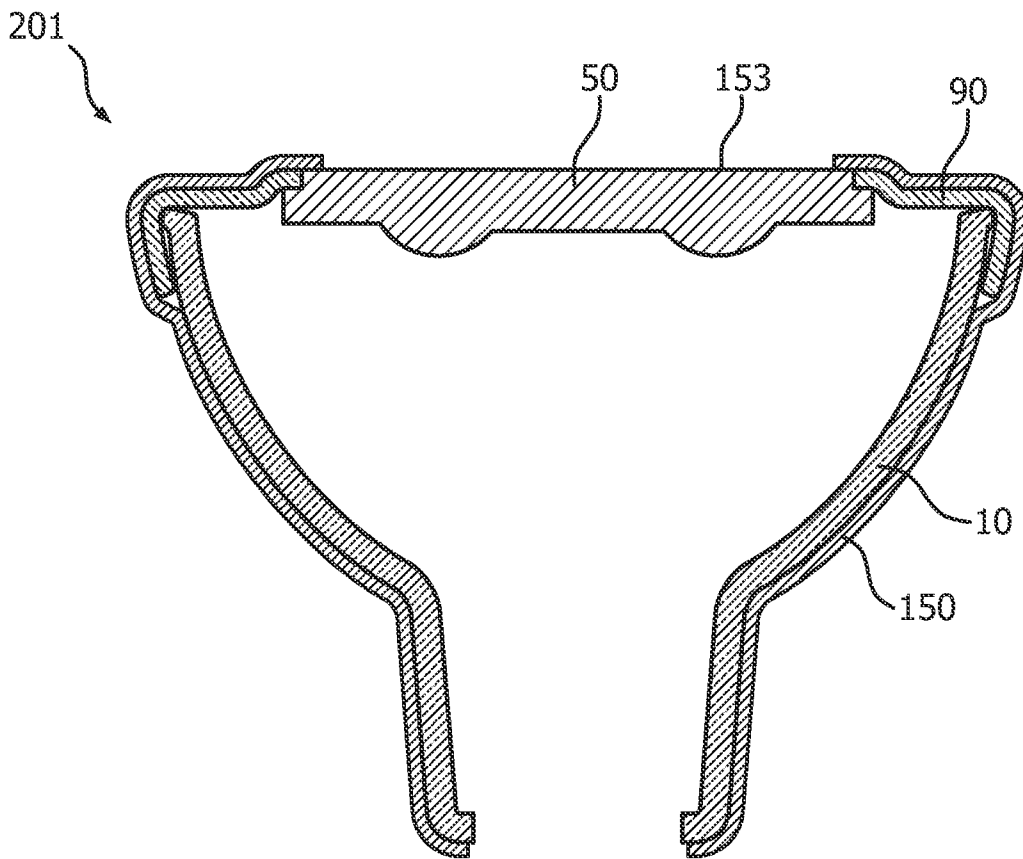


FIG. 3B

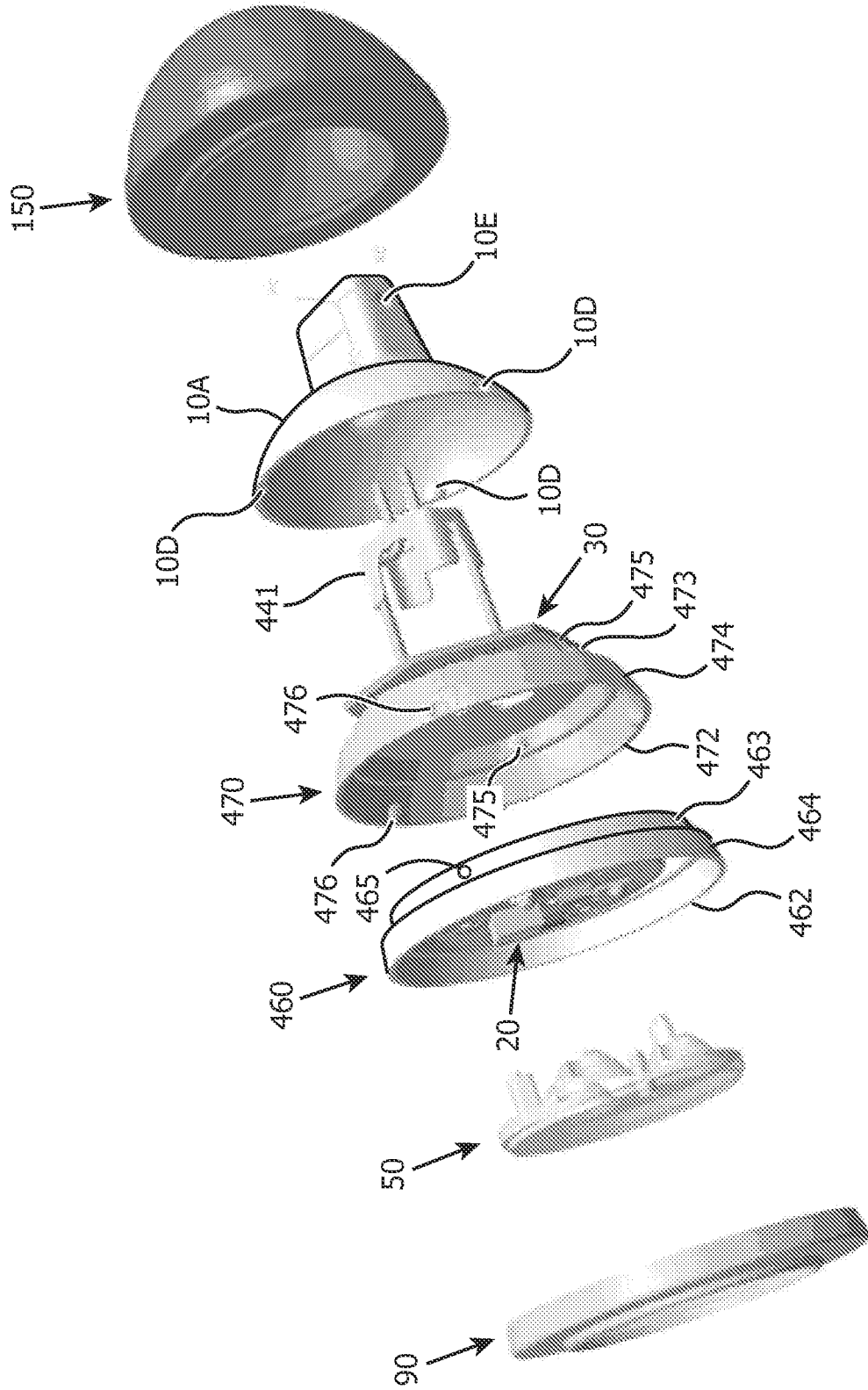


FIG. 4

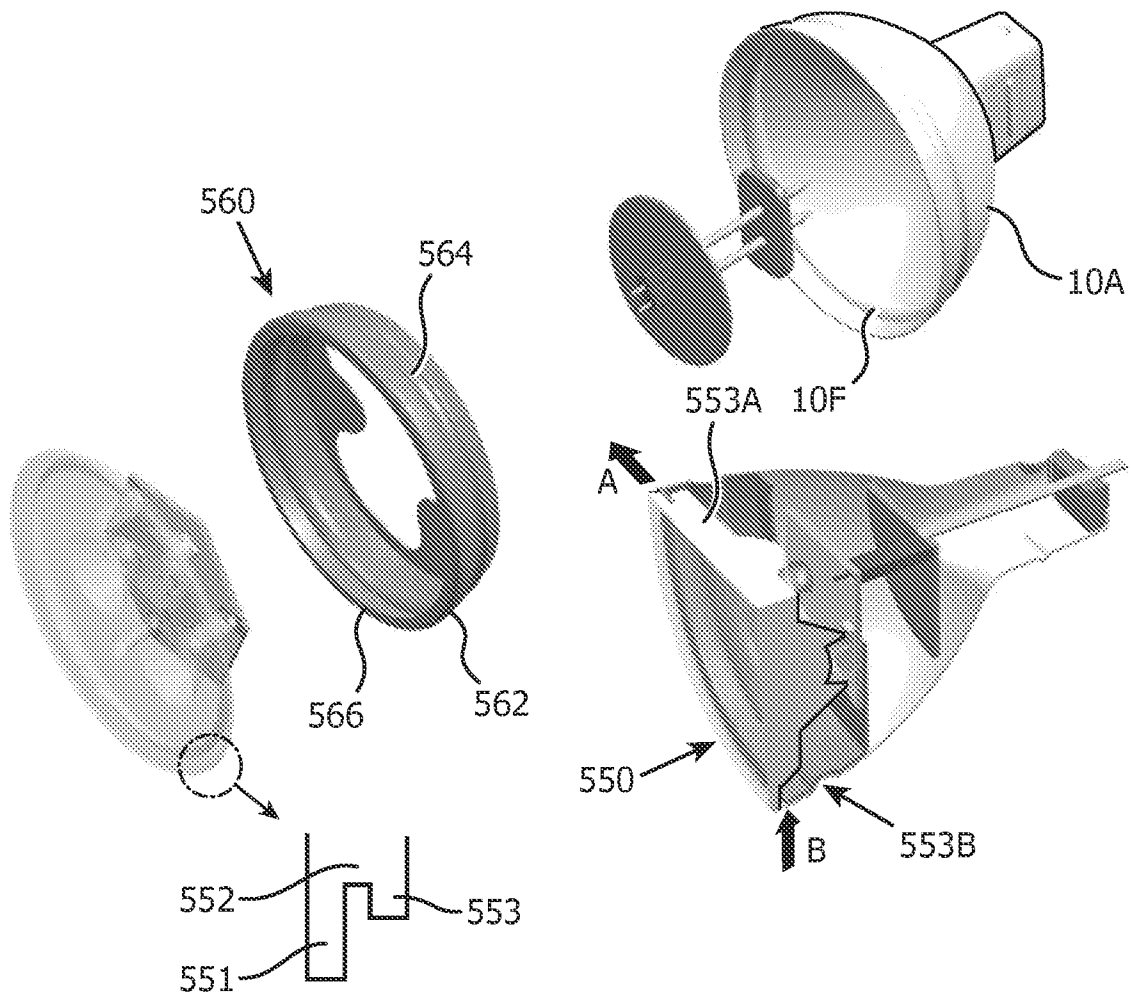


FIG. 5