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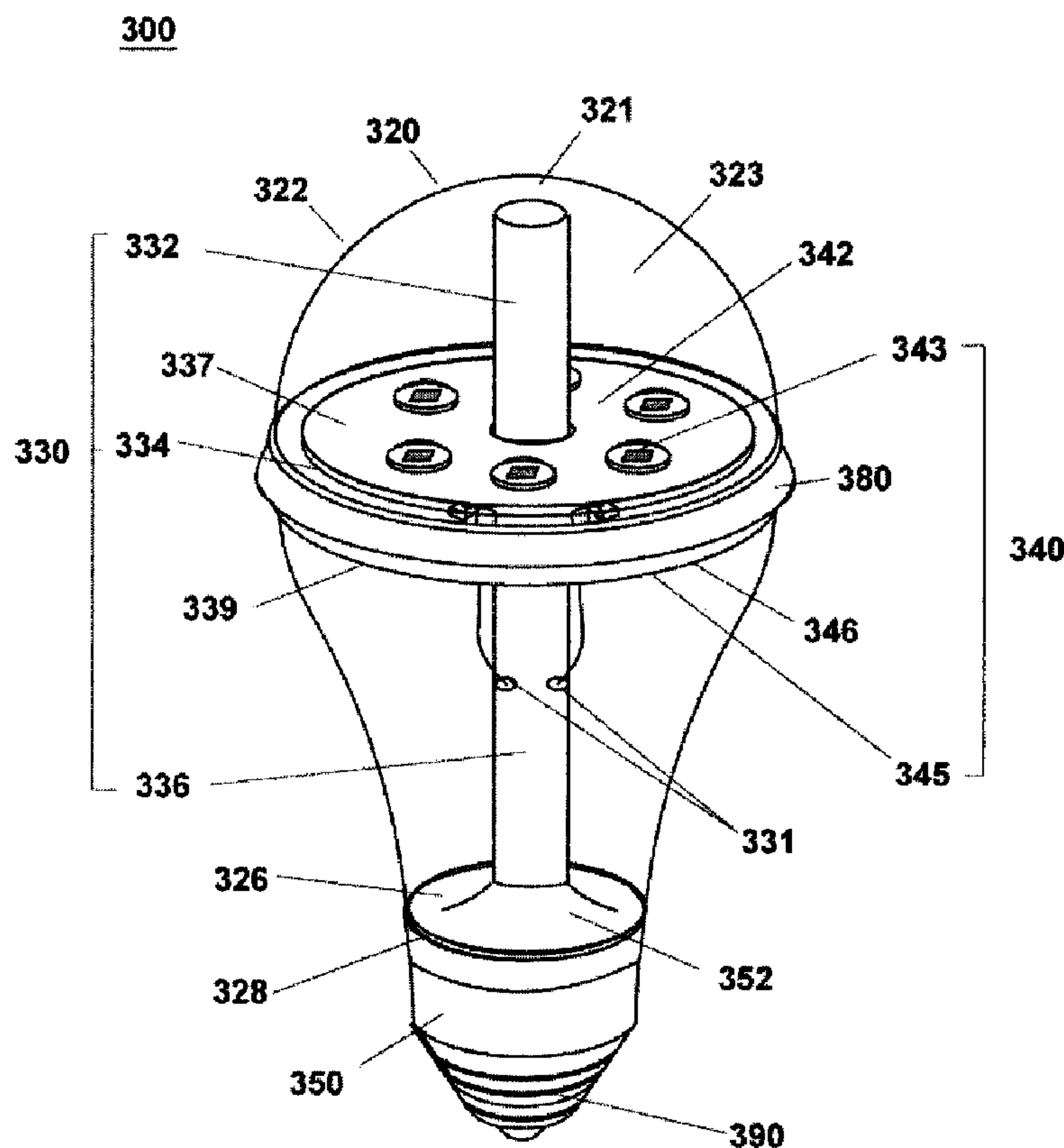
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(72) Inventeur/Inventor:
SU, ALLEN H. L., CA

(73) Propriétaire/Owner:
SU, ALLEN H. L., CA

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(54) Title: LED LIGHT BULB WITH IMPROVED ILLUMINATION AND HEAT DISSIPATION



(57) Abrégé/Abstract:

The present invention relates to an LED light bulb having a centralized light source with forward cooling and can be used as a replacement bulb. The LED light bulb (300) of the present invention comprises a light source (340) having first and second LED

(57) **Abrégé(suite)/Abstract(continued):**

modules (343, 345) arranged and mounted on opposite sides of a support block (334) such that a uniform lighting including up and down lights can be provided. As the light source (340) and the support block (334) are physically arranged toward the front portion of the light bulb and as conducive structures (332, 336) are provided to extend directly in front of the light source (340), heat originated from the light source (340) is effectively and efficiently dissipated to the ambient utilizing the space and structures configured at the front portion of the light bulb.

ABSTRACT OF THE SPECIFICATION

The present invention relates to an LED light bulb having a centralized light source with forward cooling and can be used as a replacement bulb. The LED light bulb (300) of the present invention comprises a light source (340) having first and second LED modules (343, 345) arranged and mounted on opposite sides of a support block (334) such that a uniform lighting including up and down lights can be provided. As the light source (340) and the support block (334) are physically arranged toward the front portion of the light bulb and as conducive structures (332, 336) are provided to extend directly in front of the light source (340), heat originated from the light source (340) is effectively and efficiently dissipated to the ambient utilizing the space and structures configured at the front portion of the light bulb.

(FIG. 10)

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LED LIGHT BULB WITH IMPROVED ILLUMINATION AND HEAT DISSIPATION

FIELD OF THE INVENTION

The present invention relates to a lighting apparatus and more particularly, to a light emitting diode (LED) light bulb having a centralized light source to provide up and down lights with an effective forward cooling. The LED light bulb of the present invention may be used as a replacement of existing bulbs for both indoor and outdoor applications, such as retrofits for incandescent and fluorescent light bulbs.

BACKGROUND OF THE INVENTION

As the public awareness and commitment to carbon reduction worldwide strengthen, solid state lighting or Light emitting diode (LED) lighting becomes one of the solutions to a greener world. Nevertheless, the problems in optical designs and thermal management associated with LED bulbs are common and yet to be improved. It is known that a significant percentage of the power supplied to LEDs is not being converted into light but waste heat that must be handled in order to prevent damages to the LEDs, especially for high power LEDs. Additionally, as LEDs are currently being packaged into modules having a single light emitting side of a relatively small area, designs of light bulbs utilizing LED module(s) must too consider the beam angles of the LED modules for a desired illumination.

With regard to the thermal management of LED light bulbs, especially for high power LED light bulbs, the design utilizing a “back” side or backward cooling with a

back-end heat sink is one solution (the analogy of “back” or backward and “front” or forward may also be interpreted with respect to the light emitting side of LED). For example, U.S. Pat. No. 6,864,513 to Lin, U.S. Pat. No. 7,524,089 to Park, U.S. Pat. No. 7,581,856 to Kang, EP. No. 2 065 633 to Konaka and JP. No. 2009-37995 to Morikawa disclose LED lamps having a heat sink attached to the back side of LED module(s) to dissipate the heat via the back heat sink to the ambient. One common problem associated with backward cooling, either passive or forced-air cooling, of existing LED bulbs is the insufficient room and/or air flow available to the heat sink as the back of the bulb is installed onto the socket of a lighting fixture. Therefore, such LED light bulb may not be optimal for existing lighting fixtures without modifications.

The limits to the angle of illumination of an LED light bulb having a back-side heat sink may be better understood with the illustration of a particular instance chosen only as an emphasis example. FIG. 1 shows a situation where a common lighting fixture of a ceiling-type chandelier having multiple LED bulbs B installed on the stands facing toward the ceiling. It can be perceived that as the LED bulbs B are installed facing toward the ceiling rather than downward to the floor of the room, due to the back-side heat sink occupying the lower portion of the bulb B, the illumination is significantly limited and the area directly below the light bulbs may in fact receive no direct lights.

Different approaches and designs intended to achieve greater angle of illumination can be found in other known LED light apparatus; however, the abovementioned thermal problem associated with LEDs still commonly exists. A known solution for wider illumination is to spread the distribution of a plurality of LEDs or modules within a lamp such that the outcome of the illumination covers larger angles. U.S. 5,688,042 to Madadi, U.S. Pat. No. 6,425,678 to Verdes, U.S. Pat. No. 6,709,132 to Ishibashi; U.S.

Pat. No. 7,086,756 to Maxik and U.S. Pat. No. 7,086,767 to Sidwell disclose LED lamps having LEDs spatially arranged in multiple axes in the lamp to shine lights in different directions to achieve greater angle of illumination. Nevertheless, in terms of thermal management, the design of cooling to the back of the LED substrates and heat sinks may not be sufficient, especially for high power LEDs that require better heat dissipation. These light bulbs with spread out light sources may be further treated as “frosted” lamps since human eyes in general (being long adapted to lights from tradition bulbs in many aspects) may need to be adjusted to adapt to a light source having point lights spaced apart to such extend that may not be perceived as a uniform light source. Therefore, it may be significant that the angle of illumination of an LED light bulb is to be considered along with thermal management.

In view of the forgoing, the challenge is to provide an LED light bulb that can effectively dissipate the waste heat generated by the LED light source in the light bulb while providing a greater illumination angle relatively similar to that of a traditional lamp including at least up and down lights. In addition, it is preferable to provide an effective and efficient cooling mechanism utilizing available spaces within the light bulb and preferably with passive cooling involving less moving parts to prevent or reduce the likelihood of component failures.

SUMMARY OF THE INVENTION

The present invention provides a novel lighting apparatus. According to one aspect of the present invention, an LED light bulb capable of effectively dissipating waste heat generated by an LED light source with forward cooling utilizing the space and/or structure directly in front of the light emitting side(s) of the light source is provided.

Another aspect of the present invention is to provide an LED light bulb having an LED light source such that the angle of illumination of the LED light bulb is increased and the light distribution is uniform to include at least up and down lights and preferably without excess use of reflective means or modification to existing fixtures.

A further aspect of the present invention is to provide an LED light bulb having an upper lighting unit and a lower lighting unit capable of providing both up and down lights from a light source with an effective forward cooling utilizing the front space and structures arranged and configured at a front portion of the light bulb to dissipate heat to the front of the light source and via the entire surface of the bulb as a whole rather than to the back or the base socket of the light bulb.

According to one embodiment of the present invention, an LED light bulb capable of providing at least up and down lights with a forward cooling comprises a light transmissive shell, a stem assembly having conductive structures extending away from a support block toward both the upper and lower portions of the shell respectively and an LED light source arranged and mounted on opposite sides of the support block to provide at least up and down lights toward the upper and lower portions of the shell along the conductive structures extending directly to a front of light emitting sides of the LED light source. The heat originated from the LED light source may then be dissipated away from the support block via the conductive structures toward both the upper and lower portions of the shell by a way of forward cooling that utilizes the structures and the inner space in the front portion of the light bulb as well as directly toward the front of the light emitting sides of the light source.

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According to another embodiment of the present invention, an LED light bulb having a centralized light source with forward cooling comprises a light transmissive shell; a stem assembly having first and second conductive structures extending away from a support block and toward upper and lower portions of the shell respectively; an LED light source comprising LED rings arranged and mounted on opposite sides of the support block to provide a uniform lighting including up and down lights; wherein the LED rings include light emitting sides toward the upper and lower portions of the shell and along the first and second conductive structures extending directly to a front thereof and joined to the upper and lower portions of the shell respectively such that heat originated from the LED light source is conducted away from the support block via the first and second conductive structures to the shell and subsequently the entire surface of the shell in the front portion of the light bulb as a whole.

According to still another embodiment of the present invention, an LED light bulb capable of providing at least up and down lights with a forward cooling comprises an upper lighting part and a lower lighting part attached to a thermally conductive support block disposed therebetween and arranged at a front portion of the light bulb. The upper lighting part comprises a light transmissive upper envelope, a first conductive structure extending away from the support block toward a top portion of the upper envelope and a first LED light source comprising a plurality of LEDs facing toward the upper envelope to provide up lights. The lower lighting part comprises another light transmissive lower envelope, a second conductive structure extending away from the support block toward a bottom portion of the lower envelope and a second LED light source comprising a plurality of LEDs facing toward the lower envelope to provide down lights. As the first and second conductive structures of the stem assembly extend directly to a front of the first and second LED light sources, heat originated from the LED light sources may be

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conducted away to the front thereof toward both the upper and lower envelopes and dissipated to the ambient by a way of forward cooling that utilizes the conductive structures as well as the support block physically arranged and configured at the front portion of the light bulb rather than the back.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features and advantages of the invention will be more fully understood from the following descriptions of various embodiments of the invention and the accompanying drawings. In the drawings like reference numerals generally refer to similar elements throughout. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. 1 is a schematic illustration showing a common chandelier installed with existing LED bulbs having back-side heat sinks and facing toward a ceiling;

FIG. 2 is a side view of an embodiment of an LED light bulb of the invention;

FIG. 3 is an exploded view of an embodiment of the LED light bulb in FIG. 2;

FIG. 4 is an exploded view of another embodiment of the LED light bulb in FIG. 2;

FIG. 5 is an exploded view of another embodiment of the LED light bulb in FIG. 2;

FIG. 6 is a side view of an embodiment of an LED light bulb of the invention;

FIG. 7A is a side view of an embodiment of a stem assembly of an LED light bulb of the invention;

FIG. 7B is a side view of another embodiment of a stem assembly of an LED light bulb of the invention;

FIG. 8 is a side view of another embodiment of an LED light bulb of the invention;

FIG. 9 is an exploded view of an embodiment of the LED light bulb in FIG. 8;

FIG. 10 is a perspective view of another embodiment of an LED light bulb of the invention;

FIG. 11 is an exploded view of an embodiment of an LED light bulb in FIG.10;

FIG. 12 is an exploded view of an embodiment of an LED light bulb in FIG. 10;

FIG. 13 is a side view of an LED light bulb in FIG. 10 in an upright position;

FIG. 14A shows a plan layout of an LED light source;

FIG. 14B shows another plan layout of an LED light source;

FIG. 14C shows another plan layout of an LED light source; and

FIG. 15 shows a schematic perspective view of an LED stem assembly.

(Amended on May 2nd, 2010)DESCRIPTION OF EMBODIMENTS OF THE INVENTION

An LED light bulb of the present invention is compatible with existing sockets for incandescent, filament or fluorescent light bulb. According to one embodiment of the present invention as shown in FIG. 2 and 3, an LED light bulb 10 comprises a shell 20 defining an inner space 23 enclosed by a light transmissive upper envelope 22 and a lower sealing member 26 along a central axis A; an axially extending, thermally conductive stem assembly 30 comprising a first conductive structure 32 and a second conductive structure 36 attached to opposite sides 37, 39 of a support block 34; said first conductive structure 32 extending toward the upper envelope 22 and said second conductive structure 36 extending toward the lower sealing member 26 and attached thereto along the central axis A of the shell 20; an LED light source 40 arranged and mounted on said support block 34 of the stem assembly 30, comprising a plurality of LEDs 43, 45 centralized around a center C of the support block 34 and including a first light emitting side 42 and a second light emitting side 46 facing toward the upper envelope 22 and the lower sealing member 26 of the shell 20 respectively to provide up and down lights along the first and second conductive structures 32, 36 of the stem assembly 30 extending directly in front of the first and second light emitting sides 42, 46 of the LED light source 40; and a base 50 attached to the shell 20 and configured to receive an internal circuitry 70 therein; said internal circuitry being electrically connected to the LED light source 40. The sealing member 26 may be joined or sealed to the upper envelope 22 by means of for example, thermal fusion or heat, or adhesives. The base 50 may further comprise an end cap 90, such as an Edison/contact socket. In addition, the base 50 may further include a flange 56 to be attached to an opening of the upper envelope 22 of the shell 20, preferably beneath the sealing member 26 of the shell

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20, by means of for example, adhesives, fastening threads and so forth.

The first and second light emitting sides 42, 46 of the LED light source 40 are preferably on a plane substantially perpendicular to the central axis A of the shell 20 such that up and down lights may be provided directly toward the upper envelope and the lower sealing member 22, 26 of the shell 20 along the first and second conductive structures 32, 36 of the stem assembly 30 disposed in front of the light emitting sides 42, 46 of the LED light source 40. A first LED module 43 of the LED light source 40 may include first light emitting side 42 facing toward the upper portion 22 of the shell 20 and a second LED module 45 may include the second light emitting side 46 facing toward the lower portion 26 of the shell 20; wherein the first and second modules 43, 45 may comprise a plurality of LEDs or emitters soldered onto substrates 47, 49 and arranged to centralize and surround the center C of the support block 34. In addition, it is preferably that the LED light source 40 may further comprise side-view LEDs or emitters 41 having a lateral light emitting side 44 on a plane substantially parallel to the central axis A of the shell 20 and facing toward a side of the shell 20 to provide lateral lights.

In one embodiment, the first conductive structure 32 of the stem assembly 30 comprises an elongated column axially extending away from support block 34 toward the upper envelope 22 of the shell 20. The second conductive structure 36 of the stem assembly 30 comprises an axially extending column, preferably a hollow column, attached to one protruded end 24 of the lower sealing member 26 of the shell 20. The first and second conductive structures 32, 36 may effectively conduct the heat generated by the LED light source 40 away from the support block 34 by a way of forward cooling to the front of the light source 40, and particularly to the front of the light emitting sides 42, 26. While utilizing said first and second conductive structures 32, 36

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of the stem assembly 30, the shell 20 and the inner space 23 of the shell 20 in the front portion of the light bulb 10, the light bulb 10 may effectively dissipate the heat to the ambient via for example, heat radiation, conduction and/or convection of an internal gas in the inner space 23 as well as the circumferential surface of the shell 20 as a whole. In another embodiment, the first and/or second conductive structure 32, 36 of the stem assembly 20 may too include a heat pipe envelope or structure extending away from the support block 34 to facilitate the heat dissipation away from a hot end or heat source (light source) to a cooler end near the shell away from the heat source.

In terms of the means of attachment and securement of parts, the support block 34 of the stem assembly 30 may further comprise a center mounting hole 38 to receive a portion 33, 35 of the first conductive structure 32 and second conductive structure 36 attached thereon. The support block 34 of the stem assembly 30 may be further provided with a threaded portion 38' preferably at an inner surface of the center mounting hole 38 to fasten said ends 33, 35 of the first and/or second conductive structures 32, 36 attached thereon. It can be understood that the first and second conductive structure 32, 36 may be affixed to the support block 34 to form a stem assembly 30 by means of for example, adhesives, press-fitting, fixations such as screws and bolts and so forth; in addition, the stem assembly 30 may too be integrally formed as one piece by means of for example, thermal fusion by heat or molding, such as injection or rotation molding.

FIG. 4 and 5 depict further explanatory variations and embodiments of an LED light bulb 10 of the invention. As mentioned previously, the first and second conductive structures 32, 36 of the stem assembly 30 may be integrally formed as one piece of an elongation. According to one embodiment of the present invention as shown in FIG. 4,

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the second conductive structure 36 of the stem assembly 30 may be joined to the lower sealing member 26 as well as the base 50, which may too be integrally formed as one piece. It may be preferably that the stem assembly 30 is joined to the base 50 via the sealing member 26 and integrally formed. The support block 34 onto which the LED light source is mounted may be attached to the conductive structures 32, 36 by means of for example, fastening threads 38' and/or adhesives, press-fitting, fixations such as screws and bolts. FIG. 5 shows another embodiment in which the first conductive structure 32 extending away from the support block 34 may be joined to a top portion 21 of the upper envelope 22 of the shell 20 by means of for example, adhesives, fixations such as screws and bolts and so forth; it may too be preferably that the first conductive structure 32 and the upper envelope 22 are integrally formed by means of for example, molding or thermal fusion by heat. As the first and second conductive structures 32, 36 may be integrally formed as an elongated column, the support block 34 may also be further secured to conductive structures via for example, fastening threads 38'. Such explanatory variations in structure and configuration are provided as examples to demonstrate possible embodiments of the invention having a reduced or combined number of separated parts for a reliable and cost-effective design in terms of for example, material and manufacturing costs. It too can be understood that the first and second conductive structures may be of other shapes and configurations of elongated bodies including winding, spirals and so forth.

Additionally, the stem assembly 30 may further comprise at least one perforation 31 fluidly connected to the inner space 23 of the shell 20. The sealing member 26 may be joined to the upper envelope 22 of the shell at the top portion 21 or a bottom portion 28 thereof, making the inner space 23 an airtight closure. The inner space 23 of the shell 20 may be evacuated to contain at least a partial vacuum and/or filled with a high

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thermal conductive medium or internal gas such as helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof, preferably via a perforation 29 formed on the lower sealing member 26 of the shell 20 or via the perforations 31 formed on the stem assembly 30 such that heat dissipation is enhanced by the conduction/convection of the internal gas. In another embodiment, a shear thickening fluid with the property of increased viscosity in relation to the rate of shear or having a significant increase in the resistance to flow while subject to a sudden impact on its surface such as, a silicon oil solution with a non-conductive particle of starch suspensions, may be filled into the inner space 23 of the shell 20 to enhance heat dissipation via fluid conduction/convection and to prevent sudden leakage of the fluid upon accidental impacts to the bulb. Additionally, an electric connector 48, such as lead wire, is provided to form part of the electrical connection between the first and second LED modules 43, 45 of the LED light source 40. Said perforations 31 may too facilitate electrical connectors 58, such as lead wires, from the base 50 to pass therethrough to connect to the LED light source 50.

FIG. 6 shows another embodiment of an LED light bulb 100 of the present invention; wherein the first and second conductive structures 132, 136 of the stem assembly 130 may comprise a plurality of axially extending fins attached to the support block 134 and radiating away from the center C of the support block 134. It is preferably that the first and second conductive structures 132, 136 may be joined as elongated bodies of fins having one end extending toward the top portion of the upper envelope 122 of the shell 120 and the other end extending toward the lower sealing member 126 of the shell 120 and attached thereto via a fixation collar 160. The support block 134 and the fixation collar 160 may further comprise a plurality of slots 161 to receive and secure the first and/or second conductive structures 132, 136 thereon. The

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LED light source 140 may include first and second LED modules 143, 145, having first and second light emitting sides 142, 146 facing toward the upper envelope 122 and the lower sealing member 126 of the shell 120 respectively. It is also preferably to include side-view LED emitters 141 to provide lateral lights in addition to said up and down lights. The base 150 may further include an end cap 190, such as an Edison/contact socket, electrically connected to the internal circuitry 170 enclosed therein.

FIG. 7A and 7B shows further explanatory embodiments of a stem assembly 130 comprising variations and combinations of first and second conductive structures. In a further embodiment as shown in FIG. 7A, a stem assembly 130 for an LED light bulb of the invention comprises a first conductive structure 132 of an elongated column extending away from the support block 134 and a second conductive structure 136 of a plurality of fins radiating away from the support block 134 and attached to corresponding slots 161 of a fixation collar 160 on one protruded end of a sealing member 126. Likewise FIG. 7B shows another embodiment of a stem assembly 130 having a reversed first and second conductive structures 132, 136 of the ones of FIG. 7A. The first conductive structure 132 extending away from the support block 134 and toward the top portion may be a plurality of fins attached to the support block 134 with slots (not shown); whereas the second conductive structure 136 may be an elongated column extending away from the support block 134 and attached to a protruded end 124 of the sealing member 126. The LED light source 140 includes a first LED module 143 having a first light emitting side 142 facing away from a second light emitting side 146 of a second LED module 145. The first and second LED modules 143, 145 may be of dissimilar (or similar) output powers or arrangements while providing up and down lights from said light emitting sides 142, 146 in a direction along said first and second conductive structures 132, 136 of the stem assembly 130.

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According to another embodiment of the present invention as shown in FIG. 8 and 9, an LED light bulb 200 comprises a shell 220 defining an inner space 223 enclosed by a light transmissive upper envelope 226 and a lower sealing member 226 along a central axis A; an axially extending, thermally conductive stem assembly 230 comprising a first conductive structure 232 and a second conductive structure 236 attached to a first surface 237 and a second surface 239 of a support block 234; wherein the first surface 237 is preferably to be directly opposite to the second surface 239. The first conductive structure 232 extends toward the upper envelope 222; whereas, the second conductive structure 236 extends toward the lower sealing member 226 and is attached to a protruded end 224 thereof along the central axis A of the shell. The first conductive structure 232 may be further joined to a top portion 221 and the lower sealing member 126 may further joined to a bottom portion 228 of the upper envelope 222. The LED light bulb 200 also comprises an LED light source 240 arranged and mounted on said support block 234 of the stem assembly 230; said LED light source 240 includes a first LED module 243 and a second LED module 245 configured around a center C of the support block 234, having a first light emitting side 242 and a second light emitting side 246 facing toward the upper envelope 222 and the lower sealing member 226 of the shell 220 respectively to provide up and down lights along the first and second conductive structures 232, 236 of the stem assembly 230 extending directly in front of the light source 240 and particularly, in front of the light emitting sides 242, 246. A connection mans 248, such as lead wire, may be further provided, forming part of the electrical connection between the first and second LED modules 243, 245 of the LED light source 240. The sealing member 226 may be sealed to the bottom portion 228 of the upper envelope 222 by means of for example, thermal fusion or heat, or adhesives. An inert or dielectric base 250 configured to receive an internal circuitry 270 therein is

attached to the bottom portion 228 of the shell 220; wherein the internal circuitry 270 is electrically connected to the LED light source 240 via for example, lead wires 258 from the bases 250. The base 250 includes an end cap 290, such as an Edison/contact socket, electrically connected to the internal circuitry 270 enclosed therein.

The LED light source 240 may be arranged and configured to surround the center C of support block 240 to provide both up and down lights. In addition, the first and second light emitting sides 242, 246 of the first and second LED modules 242, 246 of the LED light source 240 mounted on opposite sides 237, 239 of the support block 240 are preferably to be on a plane substantially perpendicular to the central axis A of the shell 220. In one embodiment, the first and second LED modules 243, 245 comprising a plurality of LEDs may be in a form of LED rings. The first and second LED rings 243 and 245 may be formed on ring-shaped substrates surrounding the center C of the support block 234 as for example, multi-chip modules on PCB or MCPCB (metal core PCB) utilizing flip-chip packaging technology or chip on board (COB) or surface mount technology (SMT) connecting a plurality of LEDs to form an area light source.

In addition, it may be preferable that the first and second LED rings 243, 245 are formed of dissimilar diameters away from the center C of the support block 234 to avoid overlapping the LED rings on opposite sides 237, 239 of the support block 234 for a uniform distribution of heat on the support block 234. For example, the first LED ring 243 may be an inner ring having an outer diameter D_{1-out} and an inner diameter D_{1-in} , capable of providing up lights while the second LED ring 245 may be an outer ring having an outer diameter D_{2-out} and an inner diameter D_{2-in} capable of providing down lights; in one instance, D_{1-out} of the first LED ring 243 may be less than or equal to D_{2-in} ($D_{1-out} \leq D_{2-in}$) and another example such as, $D_{2-out} \leq D_{1-in}$ is also possible.

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The stem assembly 230 comprises first and second thermally conductive structures 232, 236 extending away from the support block 234. In one embodiment, the first conductive structure 232 of the stem assembly 230 may comprise an elongated column axially extending away from support block 234. It may too be preferable that the first conductive structure 232 of the stem assembly 230 extends toward the upper envelope 222 of the shell 220 and joined to a top portion 221 of the upper envelope 222 of the shell 220 to conduct heat originated from the LED light source 240 away from the support block 234 toward the top portion 221 of the shell 220 and subsequently the circumferential surface area of the shell 220 as a whole for heat dissipation to the ambient. The second conductive structure 236 of the stem assembly 230 may too comprise an axially extending column, preferably a hollow column, attached to one protruded end of said sealing member 226. In a further embodiment, the heat from the LED light source 240 may be conducted away from the support block 234 to the shell 220 via both the upper and lower portions 222, 226 of the shell 220 via the top portion 221 and bottom portion 228 joined to the conductive structures 232, 236 of the stem assembly 230 such that the heat is transmitted to the entire circumferential surface of the shell 220 for dissipation to the ambient. As the first conductive structure 232 extending toward the upper envelope 222 of the shell 220 is joined to the top portion 221 and the lower sealing member 226 of the shell 220 onto which the second conductive structure 236 is attached is further sealed to the bottom portion 228 of the upper envelope 222, heat from the LED light source 240 is effectively and efficiently conducted away from via the first and second conductive structures 232, 236 to the shell for heat dissipation.

Similarly, the heat dissipation may be further enhanced by an internal gas or fluid filled into the inner space 223 of the shell 220 of an LED light bulb 200 of the present invention. In one embodiment, the stem assembly 230 further comprises a perforation

231 fluidly connected to the inner space 223 of the shell 220. As the sealing member 226 may be joined to the upper portion 222 of the shell 220, making the inner space 223 an airtight closure, the inner space 223 of the shell 220 may then be evacuated to contain at least a partial vacuum, which may also be filled with a high thermal conductive medium or internal gas such as helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof, via a perforation 229 formed on the lower sealing member of the shell or the perforation 231 formed on the stem assembly 230. The heat may then be further dissipated by way of for example, conduction/convection of said internal medium and subsequently via the shell 220 to the ambient. As mentioned previously, in another embodiment, a shear thickening fluid with may too be filled into the inner space 223 of the shell 220. The perforation 231 may too facilitate electrical connectors such as lead wires 258 from the base 250 to pass therethrough to the LED light source 250.

The base may be configured to receive an internal circuitry in accordance with the types of LEDs used, including for example, direct current (DC) and alternate current (AC) LEDs. As shown in FIG. 8 and 9, in one embodiment, the LED light source 240 may be an AC LED module such that the dimension of the base 250 of the light bulb 200 may be reduced to include electronic component(s) such as resistor, capacitor and/or positive temperature coefficient (PTC) thermistor. For DC LED light source of an LED light bulb of the present invention, the base of the light bulb may include an internal circuitry having a power supply, AC/DC-converter, driver and/or bridge.

According to still another embodiment of the present invention as shown in FIG. 10 and 11, an LED light bulb 300 having a dual lighting including an upper lighting part and a lower lighting part is capable of providing a uniform illumination including at

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least up and down lights from an LED light source 340 with an effective forward cooling. As the support block 343 onto which the LED light source 340 may be mounted is physically positioned at a front portion of the light bulb 300 a distance away from the base 350, heat dissipation via the front may be facilitated in addition to the fact that the heat is also being conducted away from the support block 334 directly to the front of the light emitting sides 342, 346 of the LED light source 340 rather to the back.

In one embodiment of the LED light bulb 300, the LED light bulb 300 comprises a light transmissive upper envelope 322 having an enclosed top portion 321 and a bottom opening 324 along a central axis A; a light transmissive lower envelope 326 having a top opening 325 and a bottom portion 328, arranged away from the bottom opening 324 of the upper envelope 322 along the central axis A thereof. A support block 334 is further provided and includes a first side 337 attached to the bottom opening 324 of the upper envelope 322 to enclose an upper inner space 323 and a second side 339 attached to the top opening 325 of the lower envelope 326. Said first side 337 of the support block 334 further comprises a first conductive structure 332 extending toward the top portion 321 of the upper envelope 322 and said second side 339 further comprises a second conductive structure 336 extending toward the bottom portion 328 of the lower envelope 326.

The support block 334 is preferably configured and arranged to be at a front portion of the LED light bulb 300. In one embodiment, the support block 334 having an diameter D_s may be positioned at the front portion of the LED light bulb 300 and a distance or height H away from an end 356 of the base 350 and wherein the end 356 is attached to the lower envelope 326 such that said D_s may be substantially equivalent to or greater than a bulb diameter D_B of the light bulb 300; wherein the bulb diameter D_B

refers to the diameter of the largest cross sectional area of the light bulb 300. As shown in FIG. 11 and 12, said H may too refer to height of said lower envelope 326. In another embodiment, said distance H of the support block 334 positioned on top of the lower envelope 326 may be at least greater than or equal to $1/2$ of the total length L of the LED light bulb 300 and preferably, said H may be of $2/3$ of the total length L of the bulb. Furthermore, the bottom opening 324 of the upper envelope 322 and the top opening 325 of the lower envelope 326 may too be of diameters substantially equivalent to the D_s of the support block 334. In a further embodiment, the support block 334 may be configured and positioned at a height H greater than or equal to $4/5$ of the total length L of the bulb 300 such that D_s of the support block 334 may be less than said bulb diameter D_B . In addition, the thickness T_s of the support block 334 may be suitably selected in accordance with the height H to allow optimal heat dissipation as well as up and down lights. It can be understood that the upper and lower envelopes 322, 326 together with the support block 334 may form a bulb shape according to various standards including A/G/PS type bulbs.

As shown in FIG. 10 and 11 again, the LED light bulb 300 further comprises an LED light source 340, which may be for example, AC or DC LED module(s) as previously mentioned. The LED light source 340 further comprises a first LED module 343 and a second LED module 345 arranged and mounted on said first and second sides 337, 339 of the support block 334 respectively; wherein said first LED module 343 having a first light emitting side 342 facing toward the top portion 321 of the upper envelope 322 to provide up lights along the first conductive structure 332 extending directly in front of the first light emitting side 342, and said second LED module 345 having a second light emitting side 346 facing toward bottom portion 328 of the lower envelope 326 to provide down lights along the second conductive structure 336

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extending directly in front of the second light emitting side 346. In addition, to provide direct up and down lights, the first and second light emitting sides 342, 346 of the first and second LED modules 343, 345 may preferably be on a plane substantially perpendicular to the central axis A of the upper envelope 322. A connection means, such as lead wire 348, may be further provided to connect the LED modules 343, 345.

According to one embodiment of an LED light bulb 300 of the present invention, various shapes of the first and second conductive structures 332, 336 and the support block 334 disposed therebetween may form a stem assembly 330. In one embodiment, the first conductive structure 332 may be an axially extending column, and the second conductive structure 336 may too be an axially extending column, preferably a hollow column. The first and second conductive structures 332, 336 may be attached to the support block 334, preferably at the center C of the support block 334 by means of for example, fastening threads, adhesives, fixations such as screws and bolts and so forth. Furthermore, it can be understood that the first and second conductive structures 332, 336 may be of different configurations of elongated bodies including radiating fins as mentioned previously or winding, spirals and so forth.

Furthermore, an inert or dielectric base 350 may be attached to the bottom portion 328 of the lower envelope 326 on one end 356 to enclose a lower inner space 329 of the lower envelope 326 and may too be configured to receive an internal circuitry 370 therein; the internal circuitry 370 is also electrically connected to the LED light source 340. As shown in the figures, in one embodiment, the base 350 may further comprise a sealing member 352 joined to the bottom portion 328 of the lower envelope 326 and attached to one end of the second conductive structure 336 of the support block 334 by means of for example, thermal fusion or heat, or adhesives. To facilitate the electrical

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connections such as lead wires 358 from the base 350 to the LED light source 340, the support block 334 may also include an opening P connecting both upper and lower inner spaces 323, 329 of the envelopes; it may too be a cut-out or notch on an edge portion of the support block 334 fluidly connected to both sides 337, 339 thereof. The opening P may too facilitate electrical connectors 358 such as, lead wires from the base 350 to pass therethrough to the LED light source 340. The base 350 further includes an end cap 390 such as, an Edison/contact socket, electrically connected to the internal circuitry 370.

The upper and lower inner spaces 323, 329 of the upper and lower envelopes 322, 326 may be evacuated to contain at least a partial vacuum and/or filled with a high thermal conductive medium selected from any one of the following gases: helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof. The evacuation of air and filling of an internal gas may be achieved via perforations 331 provided on the stem assembly 330 or the second conductive structure 336. Furthermore, in another embodiment, the upper and lower inner spaces of the upper and lower envelopes may be filled with a shear thickening fluid as mentioned previously to enhance heat dissipation via fluid conduction/convection and to prevent sudden leakage of the fluid upon sudden impacts to the bulbs.

FIG. 12 shows another embodiment of an LED light bulb 300 of the present invention. The upper and lower envelopes 322, 326 may be integrally formed with the first and second conductive structures 332, 336 respectively of a material selecting from any one of the following: transparent ceramics, glass and silicon based material. The first conductive structure 332 may be joined or attached to the top portion 321 of the upper envelope 322 and may preferably be formed as one piece by means of for example, molding or thermal fusion by heat. Similarly, the second conductive structure

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336 may be joined or attached to the bottom portion 328 of the lower envelope 326 and preferably be formed together with the abovementioned sealing member 356 as one piece. A fastening threaded portion 338 may too be provided on the portions of the conductive structures and the support block 334 for securement thereto. The heat from the LED light source 340 may then be conducted away from the support block 334 toward both the top and bottom of the envelopes 322, 326 via the first and second conductive structures 332, 336 and subsequently utilizing the entire surface of the envelopes and structures at the front portion of the light bulb for forward cooling to dissipate the heat to the ambient effectively and efficiently.

In one embodiment, an outer ring 380 may be further provided on the light bulb 300 and preferably surrounding or enclosing the outer circumferential surface of the support block 334. The outer ring 380 may be of an inner diameter D_R substantially equivalent to abovementioned D_S of the support block 334. The outer ring 380 may be made of a dielectric material as a safety measure to prevent possible leakage of current from the LED light source 340 to the support block 334. The outer ring 380 may too be of a material of relatively good thermal conductivity to facilitate the heat dissipation away from the support block 334 to the ambient; for example, the outer ring 380 may be made of a ceramics and/or transparent ceramics.

FIG. 13 is explanatory illustration showing heat dissipation from an LED light source of an LED light bulb in an upright position. As shown by the “arrows” in FIG. 13, heat generated by the LED light source 340 during operation may be dissipated via conduction C_C , convection C_V of an internal gas and radiation C_R . By means of conduction C_C , the heat is conducted away toward the shell body 320 comprising an upper envelope 322 and a lower envelope 326, via the thermally conductive structures

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332, 336 extending in front of the light source 340. As hot air tends to travel in an upward direction (relative to the ground), the first and second conductive structures 332, 336 provide an effective conduction means allowing the heat to be transmitted away from the heat source (light source) toward the shell 320 and subsequently utilizing the entire surface thereof, preferably including the circumferential surface of the support block 334, for further dissipation to the ambient via the front portion of the light bulb that may be oriented in an upright or upside-down position. It may be preferably that the tips or ends 333, 335 of the first and second conductive structures 332, 336 are joined to the upper and lower portions of the envelopes 322, 326 of the shell 320 to facilitate the heat conduction to the front portion of the light bulb including the structures and the shell as a whole. As mentioned previously, the inner front spaces 323, 329 may too be filled with an internal gas G of high thermal conductivity to enhance heat dissipation via convection C_V in addition to the heat radiation C_R away to the ambient via the shell 320.

FIG. 14A~14C show further details of an LED light source according to embodiments of an LED light bulb of the present invention. As mentioned previously, the LED light source may be either DC or AC LED module; For DC LED modules, the internal circuitry in the base may include power supply, AC/DC-converter, driver and/or bridge; whereas for AC LED modules, the internal circuitry may including component(s) such as resistor, capacitor and/or positive temperature coefficient (PTC) thermistor. As shown in the figures, “a, b, c, c’, d, e” may refer to electrodes and may be connected in series with “a” and “e” attached to an internal circuitry of an LED light bulb.

FIG. 14A is an explanatory circuit layout of an embodiment of an LED light source 40. The right and left sides of the figure refer to first and second modules 43, 45 of an LED light bulb of the invention (“up” toward the upper portion of the shell; “down”

toward the lower portion thereof). As shown on the right, a first LED module 43 comprising a plurality of LEDs or LED emitters may be affixed to a first substrate 47 and electrically connected to each other, preferably in series; likewise, the left shows a second LED module 45 affixed to a second substrate 49. The LED modules may be multi-chip modules on PCB or MCPCB utilizing flip-chip packaging technology or may be provided via chip on board or surface mount technology. The LED emitters are arranged preferably to be centralized and surrounding the center C (or around the abovementioned central axis A of the shell 20) on the first and second substrates 47, 49 of the LED modules 43, 45. It may be preferable that the LEDs are arranged spaced apart in an alternate manner such that they may not directly overlap in a longitudinal or vertical direction on the opposite sides of the support block. Additionally, side-view LEDs or emitters 41 may be further provided surrounding the center C. It can be understood that the first LED module 43 and the second LED module 45 may be axially symmetrical having the same power; e.g. each of the first and second modules 43, 45 is a 4.2W module consisting of three 1W LED emitters and six 0.2W side-view LED emitters in series and further connected to each other, preferably in series, to provide an LED light source 40 with a total output power of 8.4W. In another example, the first and second LED modules are connected in parallel to produce a designed or desired output; furthermore, the first and second LED modules may too be of dissimilar powers.

FIG. 14B shows an LED light source 340 according to another embodiment of an LED light bulb of the invention. The LED light source 340 comprising a plurality of LEDs or emitters affixed on a first substrate 347 and a second substrate 349 to form a first LED module 343 (right) and a second LED module 345 (left) to provide up and down lights respectively may preferably be centralized around the center C in an alternate manner. The first LED module 343 and the second LED module 345 may be

axially symmetrical to be of the same power; e.g. each of the first and second modules 343, 345 is a 5W module consisting of a plurality of LED emitters all in series to provide an LED light source 340 with a total output power of 10W. It can be understood that the first and second LED modules may too be connected in parallel depending on the desired output; in another example, they may be of dissimilar powers, e.g. the first module 343 is a 6W module and whereas the second module 45 is a 4W module together forming a 10W LED light source 340.

FIG. 14C shows another embodiment of an LED light source 540 includes a plurality of LEDs electrically connected to each other on substrates 547 and 549 to form a first LED ring 543 (right) and a second LED ring 545 (left) surrounding the center C; wherein the first LED ring and a second LED ring are formed of dissimilar diameters away from the center of the support block. The first and second LED rings 543, 545 may preferably be provided as an area light source and for example, multi-chip modules on PCB or MCPCB utilizing flip-chip packaging technology or may be provided via chip on board or surface mount technology. For an even distribution of heat during operation of the LED light source 540, in one embodiment, the first LED ring 543 may be of an inner diameter D_1 , and the second LED ring 545 may be of an outer diameter D_2 such that in one embodiment, D_1 may be less than or equal to D_2 (i.e. $D_1 \leq D_2$) as mentioned previously. The first and second LED rings 543, 545 may be axially symmetrical modules packaged to be of the same power; e.g. they may each be a 5W LED ring connected in series to provide an output of 10W; or in parallel for a total output of 5W; in still another embodiment, the first and second LED rings 543, 545 may be modules of dissimilar powers.

Furthermore, the support block of the stem assembly onto which the LED light

source is mounted may be of various shapes and forms, comprising a plurality of surfaces joined to form any one of the following shapes of: disc column, cube, pyramid and diamond. FIG. 15 shows an LED light source 640 according to a further embodiment of an LED light bulb of the present invention. The LED light source 640 may too be attached to a support block 634 of a geometric shape having multiple surfaces, such as a diamond-like shape. A number of first and second substrates 647, 649 may be mounted and connected on the supporting block 634. Again, the LEDs on the first and second substrates 647, 649 may be provided as a plurality of area light sources formed by means of for example, multi-chip LED modules on PCB or MCPCB utilizing flip-chip packaging technology or may be provided via chip on board or surface mount technology. A stem assembly 630 having a plurality of thermally conductive structures 632 in a form of such as plates or tubes may extend away from the center C of the supporting block 634 toward a bulb shell. It can be understood that other shapes are possible such as cube, sphere and so forth.

The materials disclosed herein are for illustrative purposes and aimed to facilitate the realization of various explanatory embodiments of the present invention only, which shall not be treated as limitations to the present invention.

The shell or envelope of an LED light bulb of the present invention may be formed of a transparent material with or without surface treatment. The transparent material of the shell may include glass, silicon based material, plastic, or transparent ceramics such as transparent alumina (Al_2O_3). An example of a transparent ceramic is provided by General Electric Company (GE) and marketed as Lucalox® ceramic, a polycrystalline translucent aluminum oxide ceramic. The Lucalox® ceramic is hard and capable of withstanding to a high pressure (25, 000 psi) and melting point (1800° C). It also

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exhibits high dielectric strength as insulation. The Lucalox® ceramic is also capable of transmitting a wide spectrum of wavelengths including visible spectrums. The thermal conductivity of Lucalox® ceramic is found to be equally good or better than some metals. While subject to heat, the ceramic also shows a relatively uniform thermal expansion in all directions. The shell may also be of various forms and shapes according to different standards including, A/G/PS type bulbs and tubular bulbs. In one embodiment, the outer surface of the shell may be further treated or coated with surface irregularities to reflect, refract and/or deflect lights for a more uniform light distribution.

The stem assembly including the conductive structures and support block may too be made of materials of high or relatively good thermal conductivity, for example, ceramic, carbon composite, metal or metal alloy and a combination thereof, to facilitate the heat transferred from the LED light source. It may also be preferable that the conductive structures are made of a dielectric material such that it acts as an insulation to prevent reaction with an internal gas and/or to prevent possible electric leakage conducted from the LED light source or the supporting block; in one example, the thermally conductive material is a ceramic with good thermal conductivity such as aluminum nitride (AlN). It may too be preferable that the conductive structures are made of transparent ceramics, such as the abovementioned Lucalox® ceramic from GE.

In another embodiment, carbon composites may too be used for the stem assembly including thermally conductive structures. One further advantage to the use of carbon composites is that they are structurally destructible under certain impacts such that the elongated bodies of the conductive structures may not physically endanger others and the environment as sharpened objects, especially in the case of accidental breakages of the bulb from a height. In another embodiment, the stem assembly and the conductive

structure may too be formed of a metallic material such as copper, aluminum and so forth, with high thermal conductivity. In still a further embodiment, the conductive structures of the stem assembly may also comprise heat pipe envelope(s), such as heat pipe or flat plate heat pipe, attached to the supporting block as mentioned previously. Furthermore, the outer surface of the conductive structures of the stem assembly may be coated with a thin reflective film on the surface thereof to enhance light reflection rather than absorption. The inner surface of hollow columns of conductive structures of the stem assembly, on the other hand, may be coated with a dielectric film to prevent possible leakages of current from the light source and/or lead wires.

As shown in various embodiments of an LED light bulb of the present invention, parts and elements of the LED light bulb may be integrally formed as one piece of a material. In one embodiment, the stem assembly including the conductive structures and the support block may be integrally formed by means of for example, molding including injection, rotation molding and so forth. Likewise, in another embodiment, the shell and the conductive structures of the stem assembly may be integrally formed. Furthermore, the base may be formed of a dielectric material such as plastic with a metal Edison contact socket as the end cap.

According to one embodiment of an LED light bulb of the present invention, an outer ring may be further provided on the light bulb and preferably surrounding or enclosing the outer circumferential surface of the support block. The outer ring may be made of a metal or metal alloy to assist heat transfer; it may too be a dielectric material such as ceramics or transparent ceramics to provide better safety measures to prevent possible leakage of current from the LED light source to the support block. The ring may also be further coated with paints and/or markings for decorative purposes.

As the inner space of the shell may be evacuated to contain at least a partial vacuum and filled with an internal gas or fluid of relatively high thermal conductivity to enhance heat dissipation, in one embodiment, said internal gas or medium may be selected from any one of the following: helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof such that the heat may be transferred via conduction/convection of the internal gas to the shell and to the ambient; and in another embodiment, the filled fluid may be a shear thickening fluid such as a silicon oil with non-conductive suspensions including for example, starch to also prevent sudden leakages of fluids under impacts to the light bulb. The non-conductive suspensions in the fluid may too be nano-sized to prevent aggregations and precipitation of these particles over time.

The claims in the subsequent content should not be read as limitations to the described order or elements unless stated to that effect. While the invention has been particularly shown and described with reference to specific illustrative embodiments, it should be understood that various changes in form and detail may be made without departing from the spirit and scope of the invention as defined by the appended claims. Furthermore, as an example, any of the disclosed features may be combined with any of the other disclosed features to form a stem assembly for an LED light bulb with or without a base and/or shell attached thereon in accordance with the invention; a supporting block may too refer to a portion on a thermal conductive structure for the attachment of an LED light source and may be with or without substrates in accordance with the invention. Therefore, all embodiments that come within the scope and spirit of the following claims and equivalents thereto are claimed as the invention.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An LED light bulb, comprising:

a shell defining an inner space enclosed by a light transmissive upper envelope and a lower sealing member along a central axis;

an axially extending, thermally conductive stem assembly comprising a first conductive structure and a second conductive structure attached to opposite sides of a support block; said first conductive structure extending toward the upper envelope and said second conductive structure extending toward the lower sealing member and attached thereto along the central axis of the shell;

an LED light source arranged and mounted on said support block of the stem assembly, comprising a plurality of LEDs centralized around a center of the support block and including a first light emitting side and a second light emitting side facing toward the upper envelope and the lower sealing member of the shell respectively to provide up and down lights along the first and second conductive structures of the stem assembly extending directly in front of said first and second light emitting sides; and

a base attached to the shell and configured to receive an internal circuitry electrically connected to the LED light source.

2. The LED light bulb according to Claim 1, wherein the first and second light emitting sides of the LED light source are on a plane substantially perpendicular to the central axis of the shell.

3. The LED light bulb according to Claim 1, wherein said plurality of LEDs of the LED light source further comprises a plurality of side-view LEDs having a lateral light emitting side on a plane substantially parallel to the central axis of the shell and facing toward a lateral side thereof .
4. The LED light bulb according to Claim 1, wherein the first conductive structure of the stem assembly comprises an axially extending, elongated column.
5. The LED light bulb according to Claim 1, wherein the first conductive structure of the stem assembly comprises a plurality of axially extending fins radiating away from the center of the support block.
6. The LED light bulb according to Claim 1, wherein the second conductive structure of the stem assembly comprises an axially extending, hollow column attached to one end of the sealing member of the shell.
7. The LED light bulb according to Claim 1, wherein the second conductive structure of the stem assembly comprises a plurality of axially extending fins radiating away from said center of the support block and attached to a fixation collar on one end of the sealing member of the shell.
8. The LED light bulb according to Claim 1, wherein the first conductive structure of the stem assembly extending toward the upper envelope of the shell is joined to a top portion of the upper envelope.
9. The LED light bulb according to Claim 1, wherein the stem assembly further

comprises a heat pipe structure extending away from the support block.

10. The LED light bulb according to Claim 1, wherein the support block of the stem assembly further comprises a threaded portion to fasten the first and second conductive structures attached thereon.

11. The LED light bulb according to Claim 1, wherein the stem assembly further comprises at least one perforation fluidly connected to the inner space of the shell.

12. The LED light bulb according to Claim 1, wherein the inner space of the shell is evacuated to contain at least a partial vacuum and filled with a high thermal conductive medium selected from any one of the following gases: helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof.

13. The LED light bulb according to Claim 1, wherein the inner space of the shell is filled with a shear thickening fluid.

14. The LED light bulb according to Claim 1, wherein the support block comprises a plurality of surfaces joined to form any one of the following shapes of: disc column, cube, pyramid and diamond.

15. The LED light bulb according to Claim 1, wherein the stem assembly is integrally formed of any one of the following materials: ceramic, carbon composite, metal, metal alloy and a combination thereof.

16. An LED light bulb, comprising:

a shell defining an inner space enclosed by a light transmissive upper envelope

and a lower sealing member along a central axis;

an axially extending, thermally conductive stem assembly comprising a first conductive structure and a second conductive structure attached to opposite surfaces of a support block; said first conductive structure extending toward the upper envelope and said second conductive structure extending toward the lower sealing member and attached thereto along the central axis of the shell; and wherein the first conductive structure and the lower sealing member further joined to a top portion and a bottom portion of the upper envelope respectively;

an LED light source arranged and mounted on said support block of the stem assembly, comprising a first LED module and a second LED module configured around a center of the support block and having a first light emitting side and a second light emitting side facing toward the upper envelope and the lower sealing member of the shell respectively to provide up and down lights along the first and second conductive structures of the stem assembly extending directly in front of said first and second LED modules; and

a base attached to the shell and configured to receive an internal circuitry electrically connected to the LED light source.

17. The LED light bulb according to Claim 16, wherein the first and second light emitting sides of the first and second LED modules of the LED light source are on a plane substantially perpendicular to the central axis of the shell.

18. The LED light bulb according to Claim 16, wherein said first and second LED modules comprises a plurality of LEDs on ring-shaped substrates to form a first LED ring and a second LED ring surrounding the center of the support block and wherein the first and second LED rings are formed of dissimilar diameters away from the center of

the support block.

19. The LED light bulb according to Claim 16, wherein the first and second conductive structures of the stem assembly comprise an elongated column axially extending away from the support block.

20. The LED light bulb according to Claim 16, wherein the stem assembly is integrally formed of any one of the following materials of: ceramic, carbon composite, metal, metal alloy and a combination thereof.

21. An LED light bulb, comprising:

- a light transmissive upper envelope having an enclosed top portion and a bottom opening along a central axis;

- a light transmissive lower envelope having a top opening and a bottom portion, arranged away from the bottom opening of the upper envelope along the central axis thereof;

- a thermally conductive support block having a first side attached to the bottom opening of the upper envelope to enclose an upper inner space and a second side attached to the top opening of the lower envelope, wherein said first side further comprising a first conductive structure extending toward the top portion of the upper envelope and said second side further comprising a second conductive structure extending toward the bottom portion of the lower envelope;

- an LED light source comprising a first LED module and a second LED module arranged and mounted on the first and second sides of the support block respectively; wherein said first LED module having a first light emitting side facing toward the top portion of the upper envelope to provide up lights along the first conductive structure

extending directly in front of the first light emitting side, and said second LED module having a second light emitting side facing toward the bottom portion of the lower envelope to provide down lights along the second conductive structure extending directly in front of the second light emitting side; and

a base attached to the bottom portion of the lower envelope to enclose a lower inner space and configured to receive an internal circuitry electrically connected to the LED light source.

22. The LED light bulb according to Claim 21, wherein the first and second light emitting sides of the first and second LED modules are on a plane substantially perpendicular to said central axis of the upper envelope.

23. The LED light bulb according to Claim 21, wherein the support block is of a diameter substantially equivalent to a bulb diameter of the LED light bulb and positioned at a front portion of the LED light bulb.

24. The LED light bulb according to Claim 21, wherein the first and second conductive structures of the support block comprise an axially extending column.

25. The LED light bulb according to Claim 21, wherein the base further comprises a sealing member joined to the bottom portion of the lower envelope and attached to one end of the second conductive structure of the support block.

26. The LED light bulb according to Claim 21, wherein the first conductive structure extending toward the upper envelope is joined to the top portion thereof and the second conductive structure extending toward the lower envelope is joined to the bottom

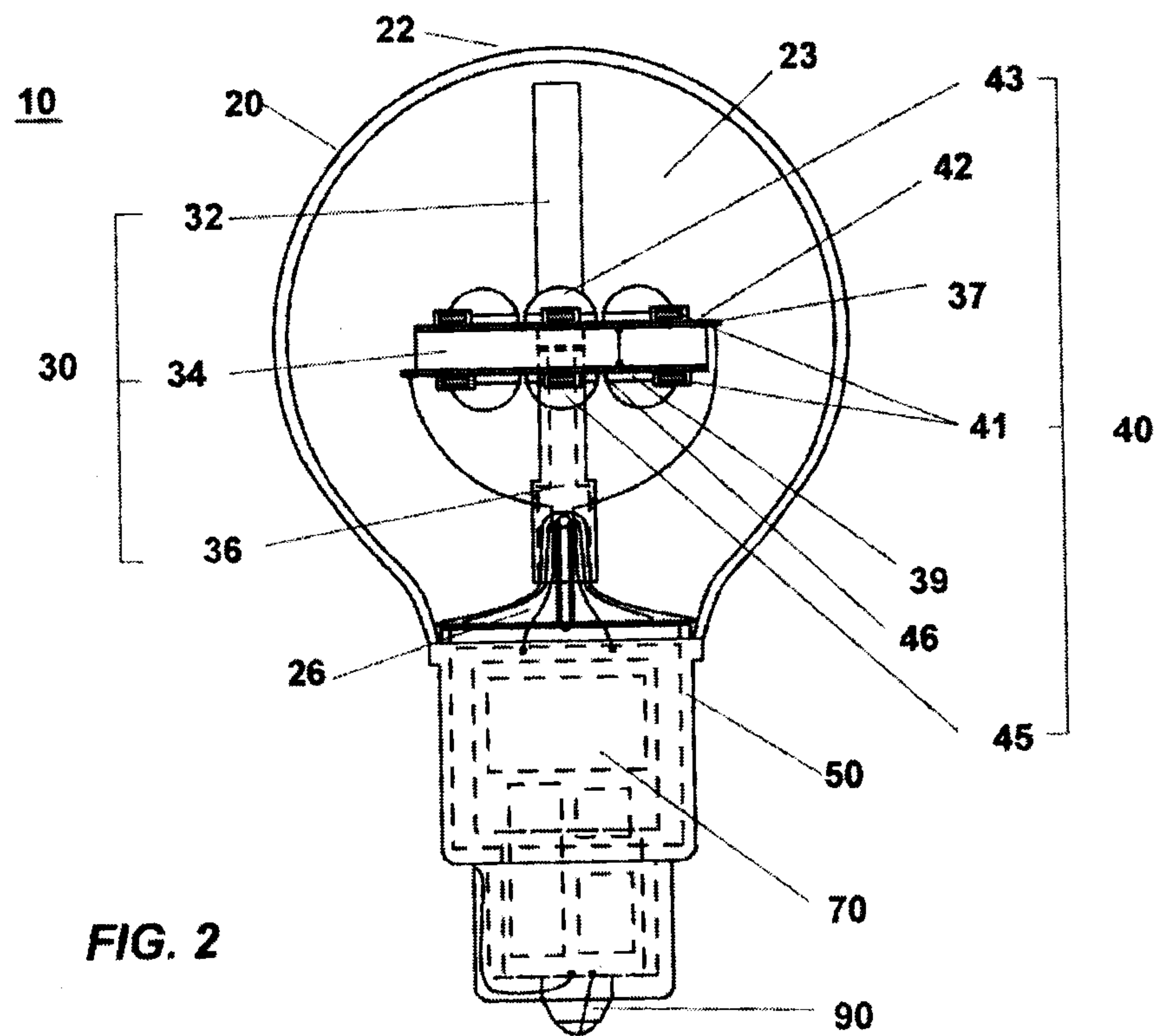
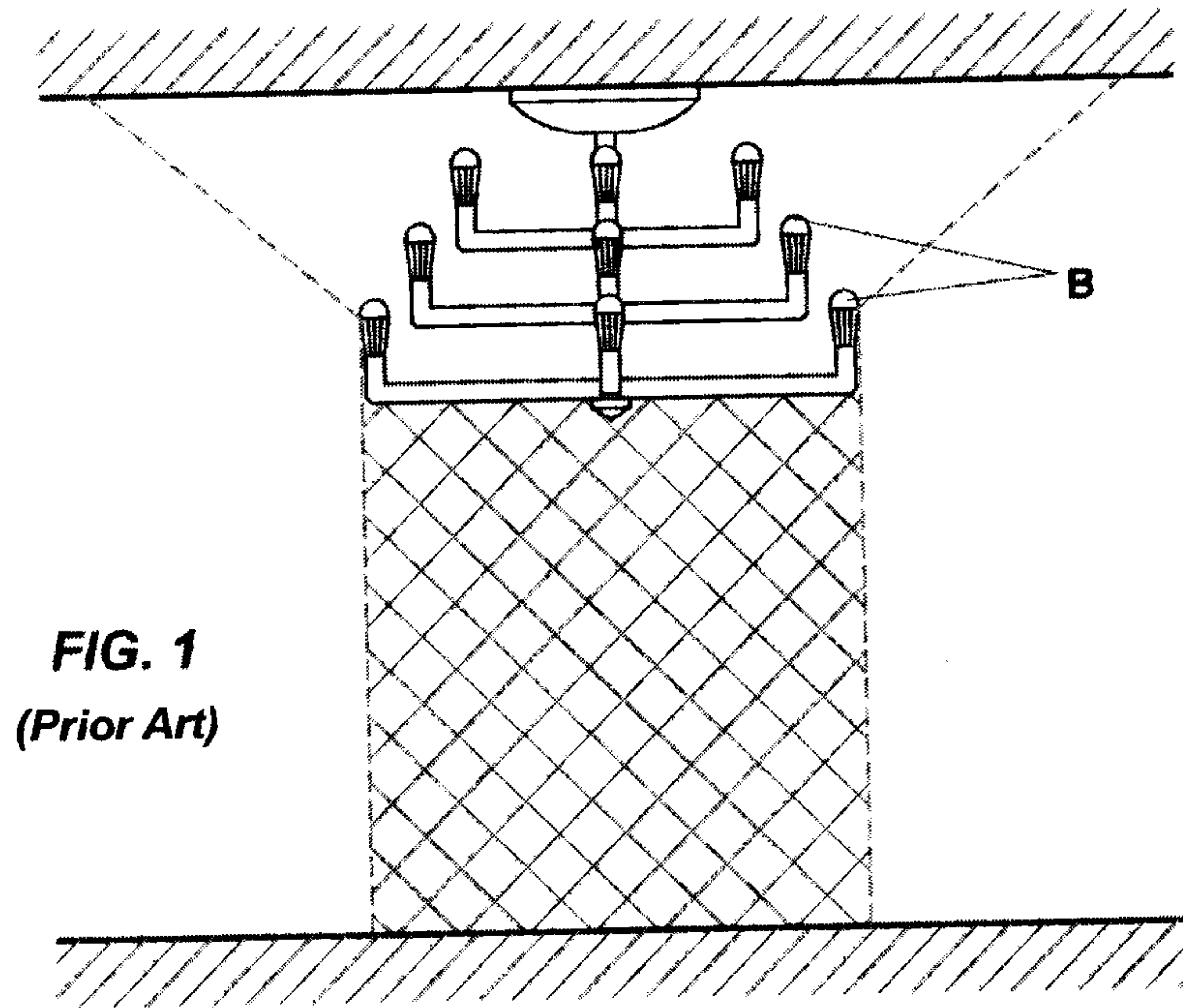
portion thereof such that heat from the LED light source is conducted away from the support block via the first and second conductive structures to the upper and lower envelopes.

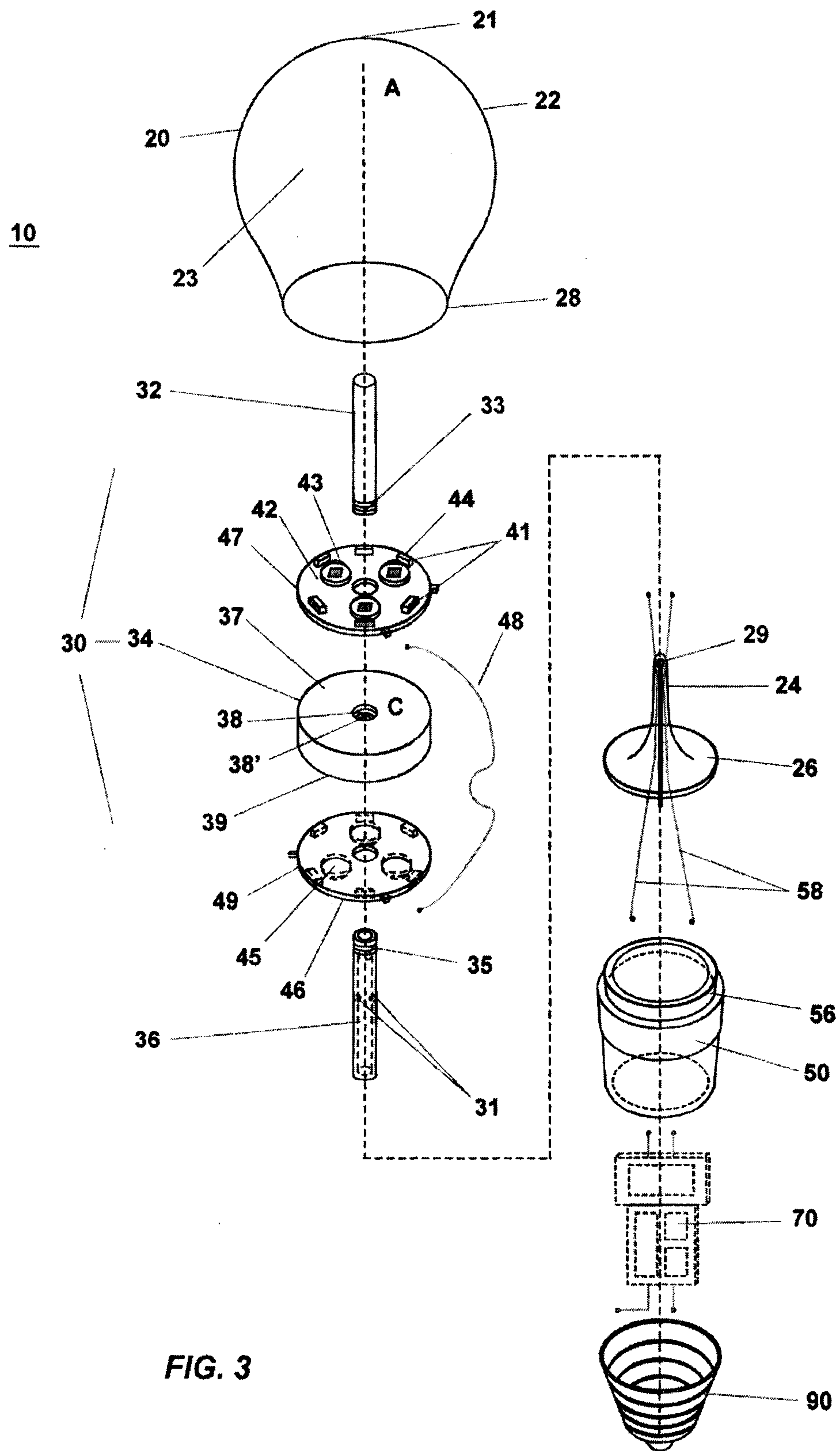
27. The LED light bulb according to Claim 21, wherein the upper and lower inner spaces of the upper and lower envelopes are evacuated to contain at least a partial vacuum and filled with a high thermal conductive medium selected from any one of the following gases: helium, argon, nitrogen, carbon dioxide, hydrogen, metal halides and mixtures thereof.

28. The LED light bulb according to Claim 21, wherein the upper and lower inner spaces of the upper and lower envelopes are filled with a shear thickening fluid.

29. The LED light bulb according to Claim 21, wherein the upper and lower envelopes are integrally formed with the first and second conductive structures respectively of a material selecting from any one of the following: transparent ceramics, glass and silicon based material.

30. The LED light bulb according to Claim 21, further comprising a dielectric ring surrounding an outer circumferential surface of the support block.





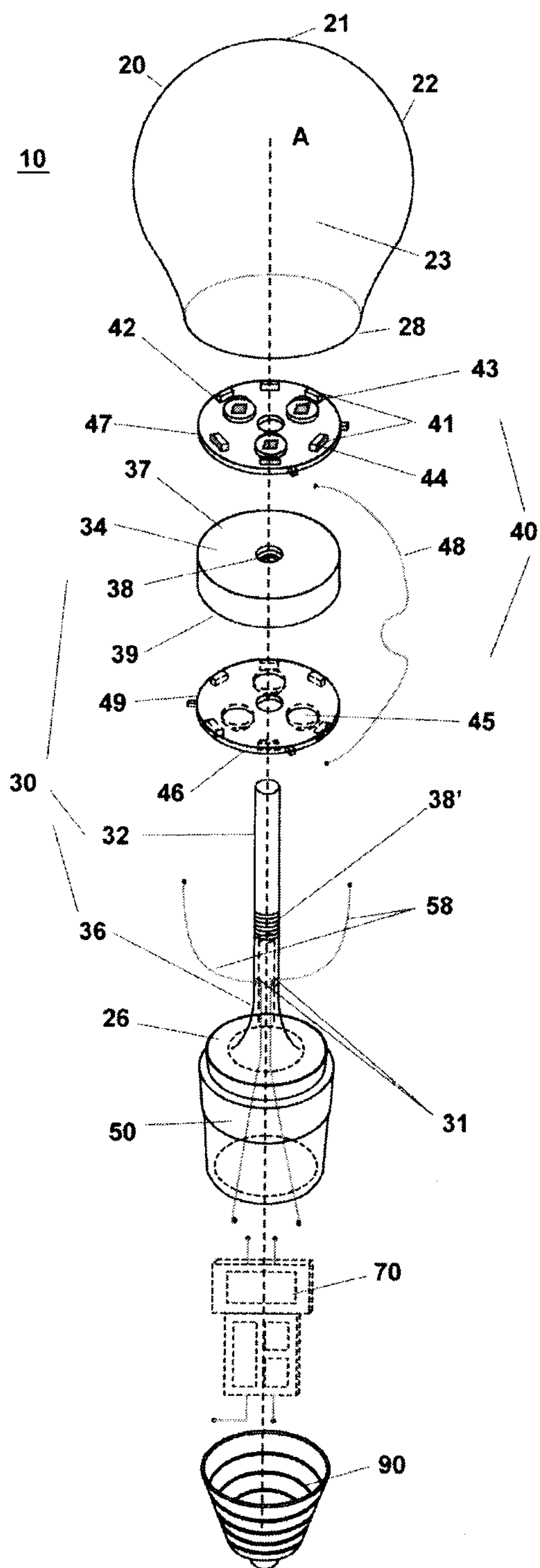


FIG. 4

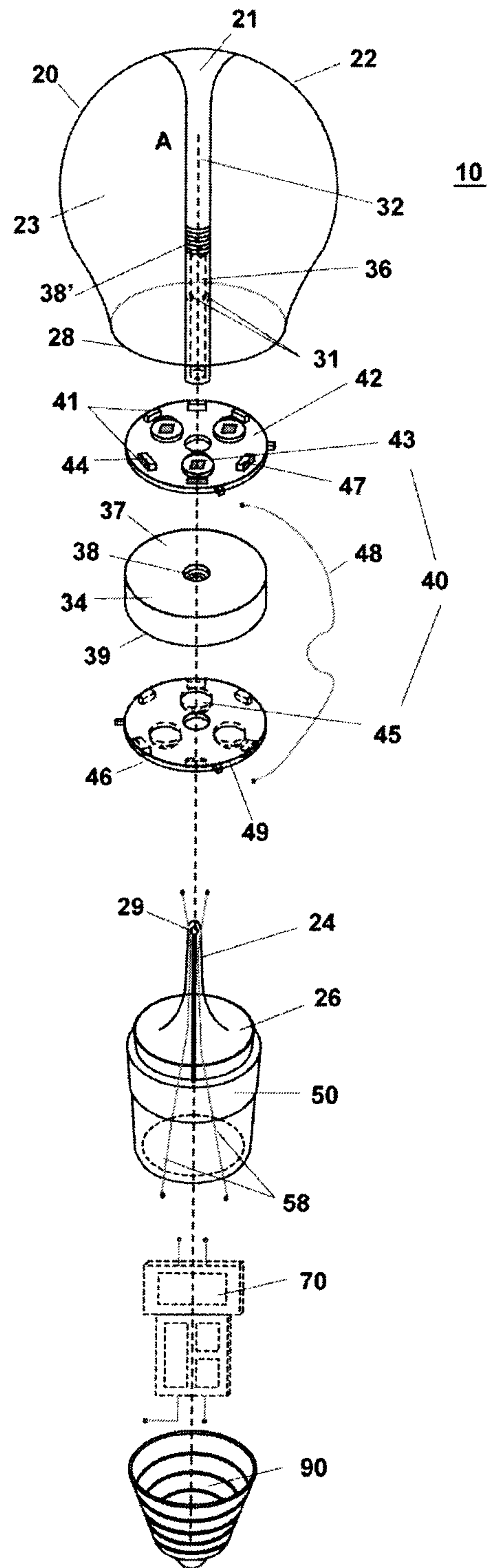


FIG. 5

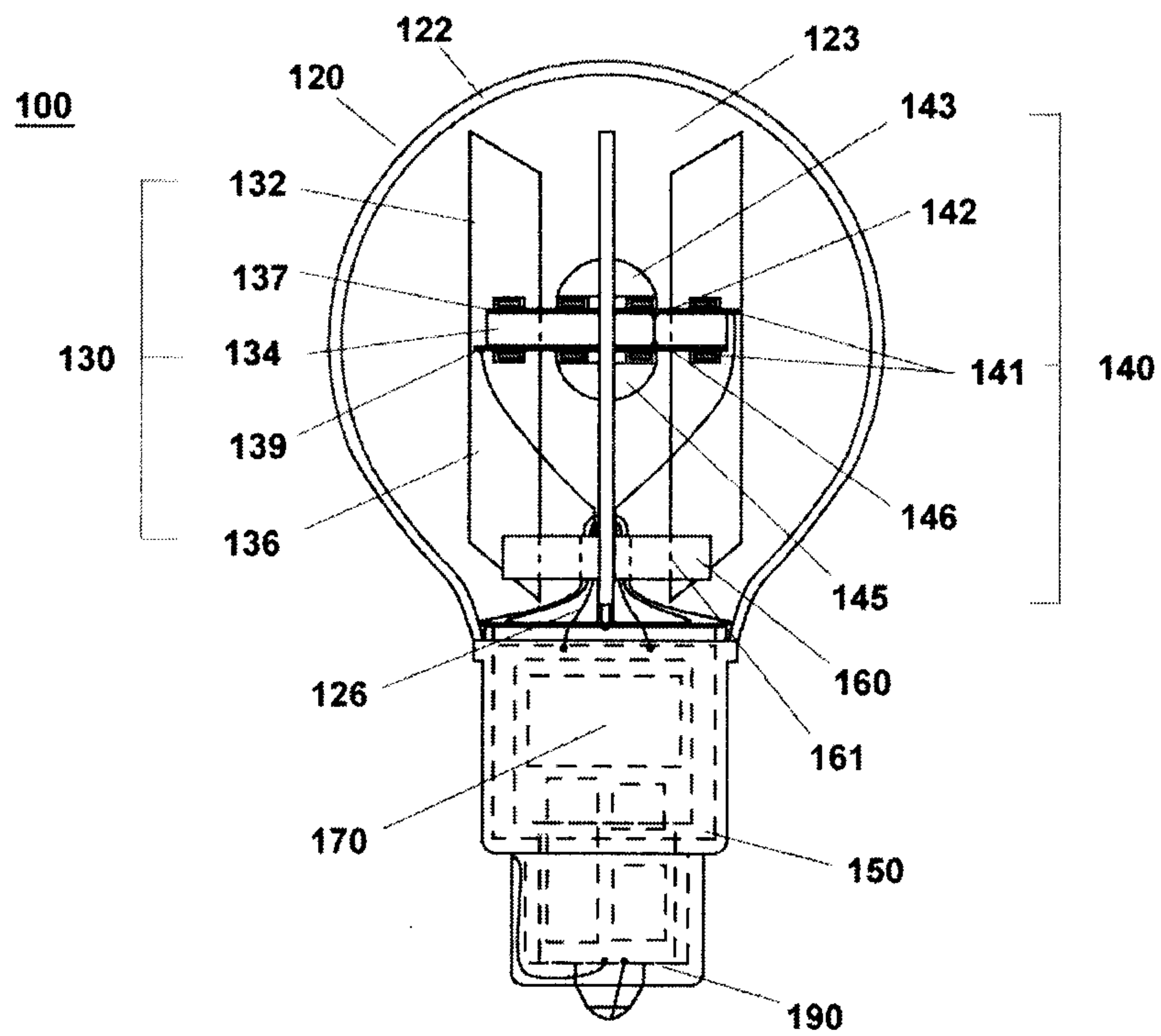


FIG. 6

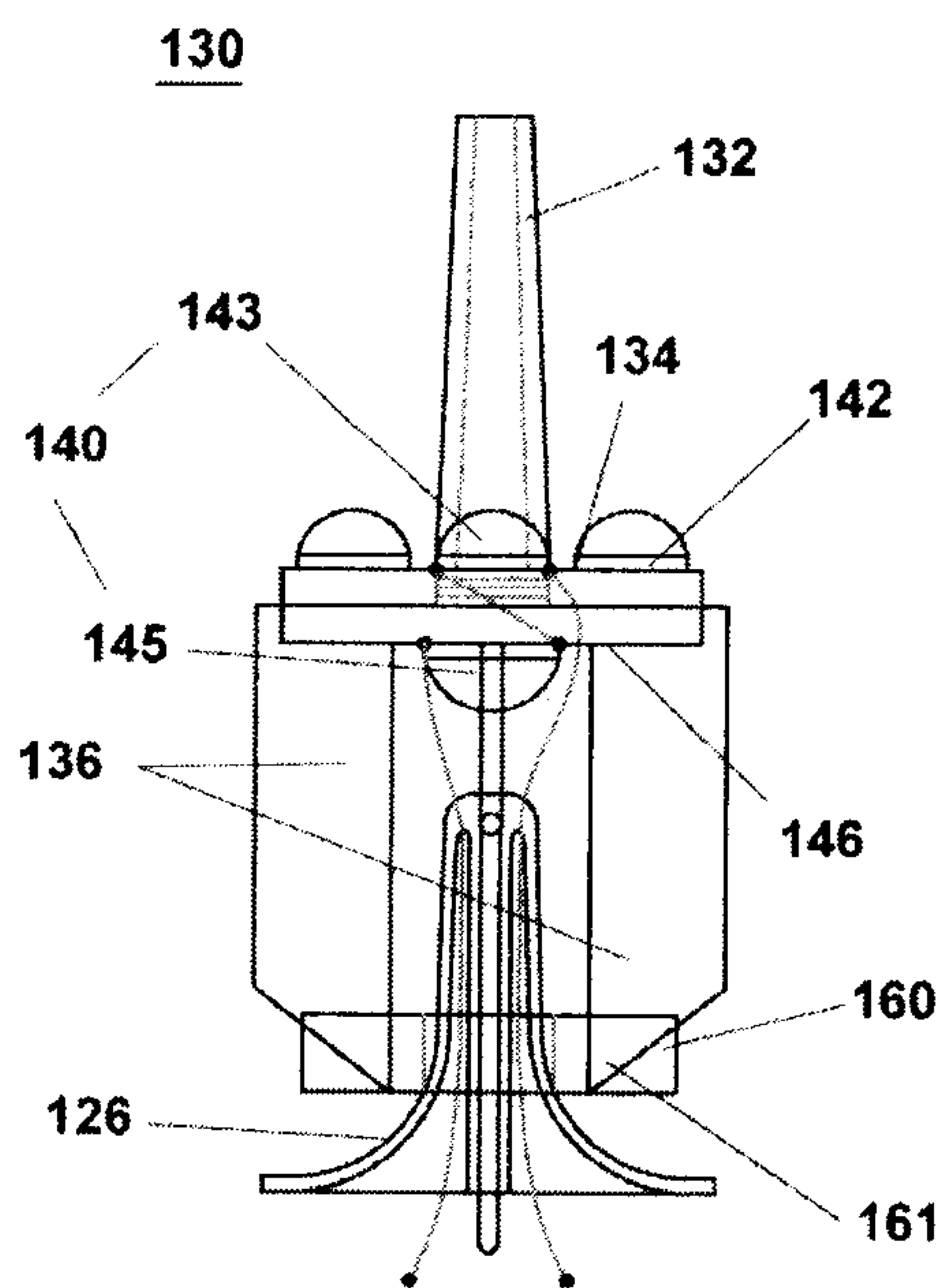


FIG. 7A

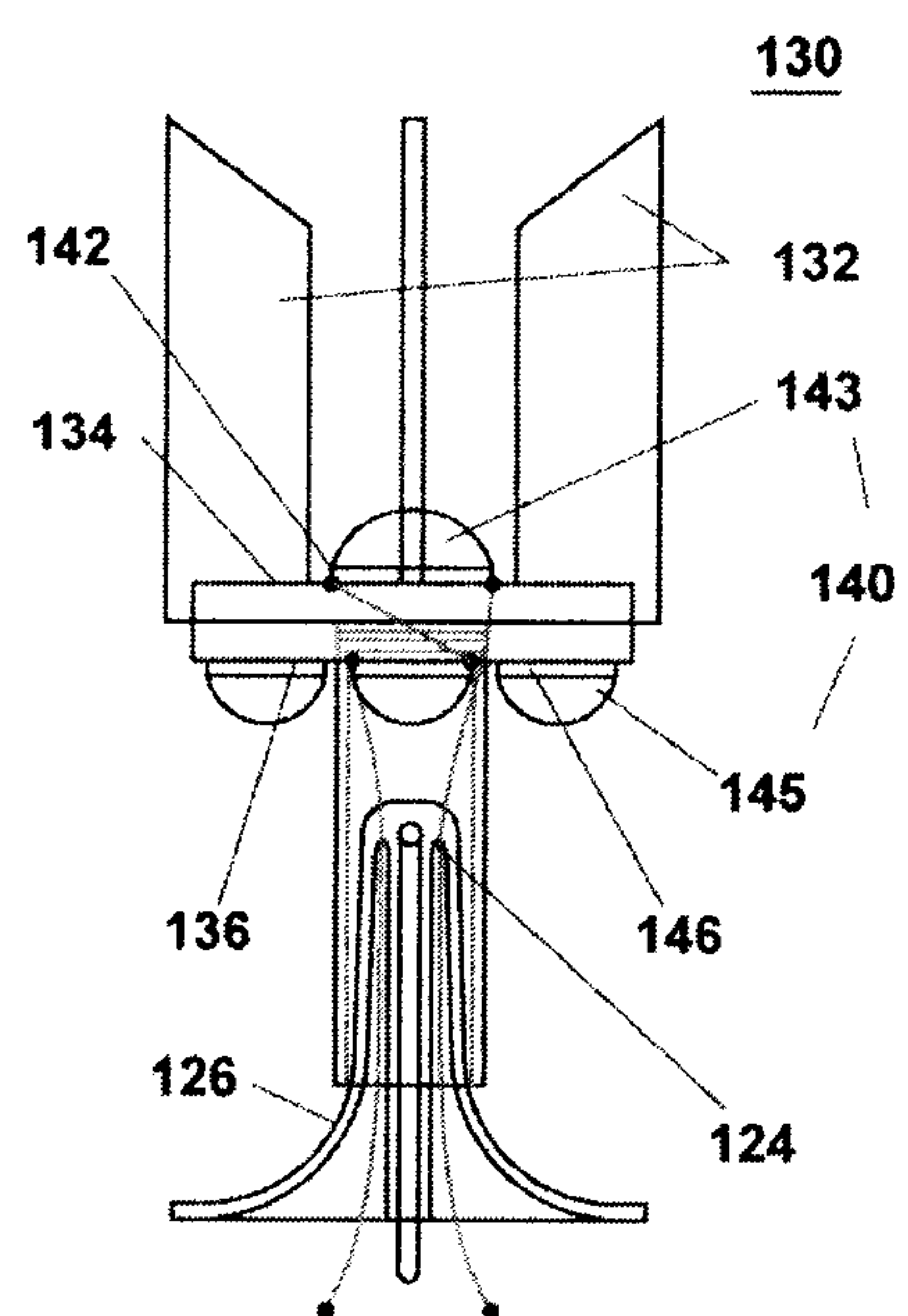


FIG. 7B

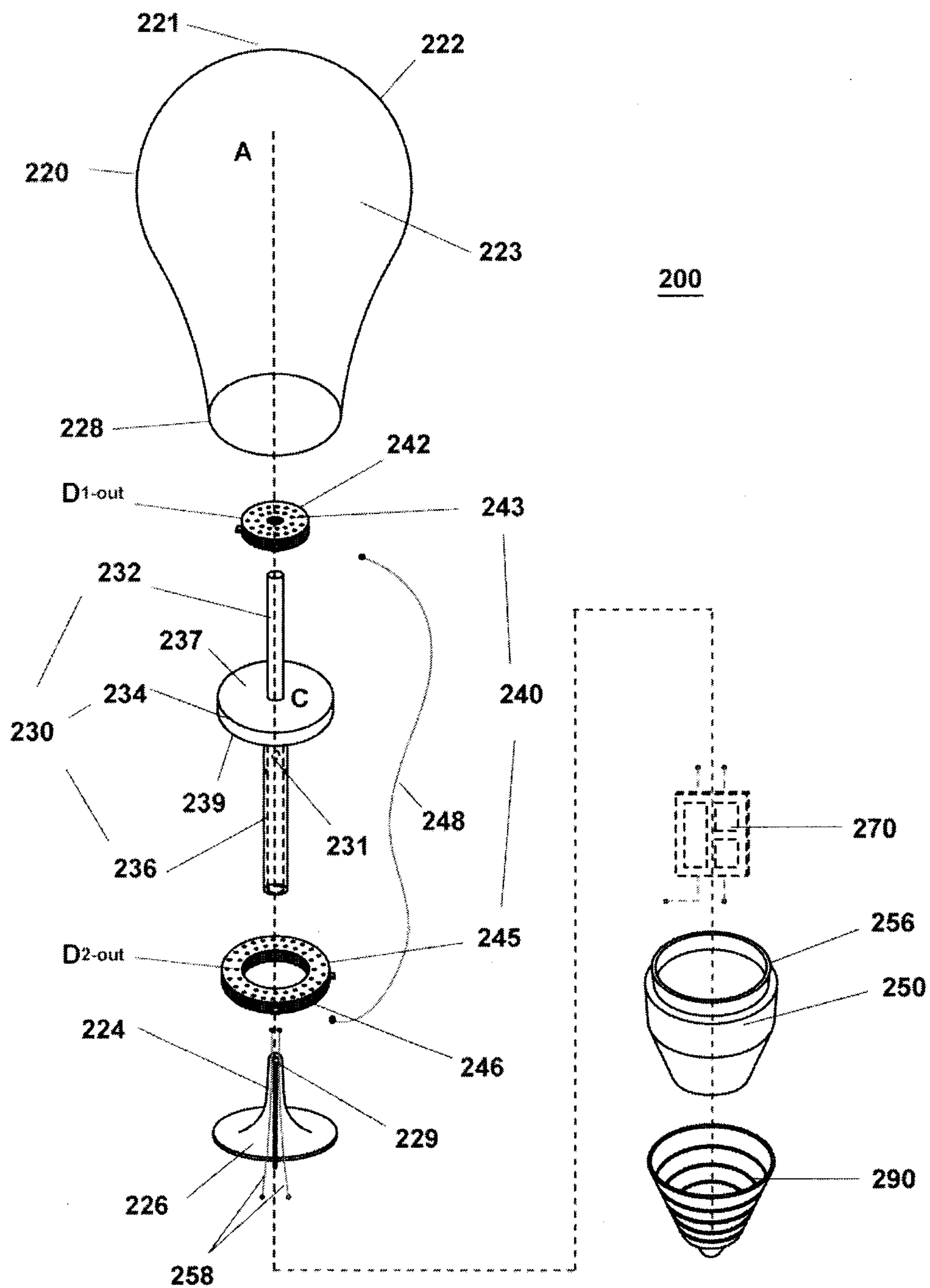
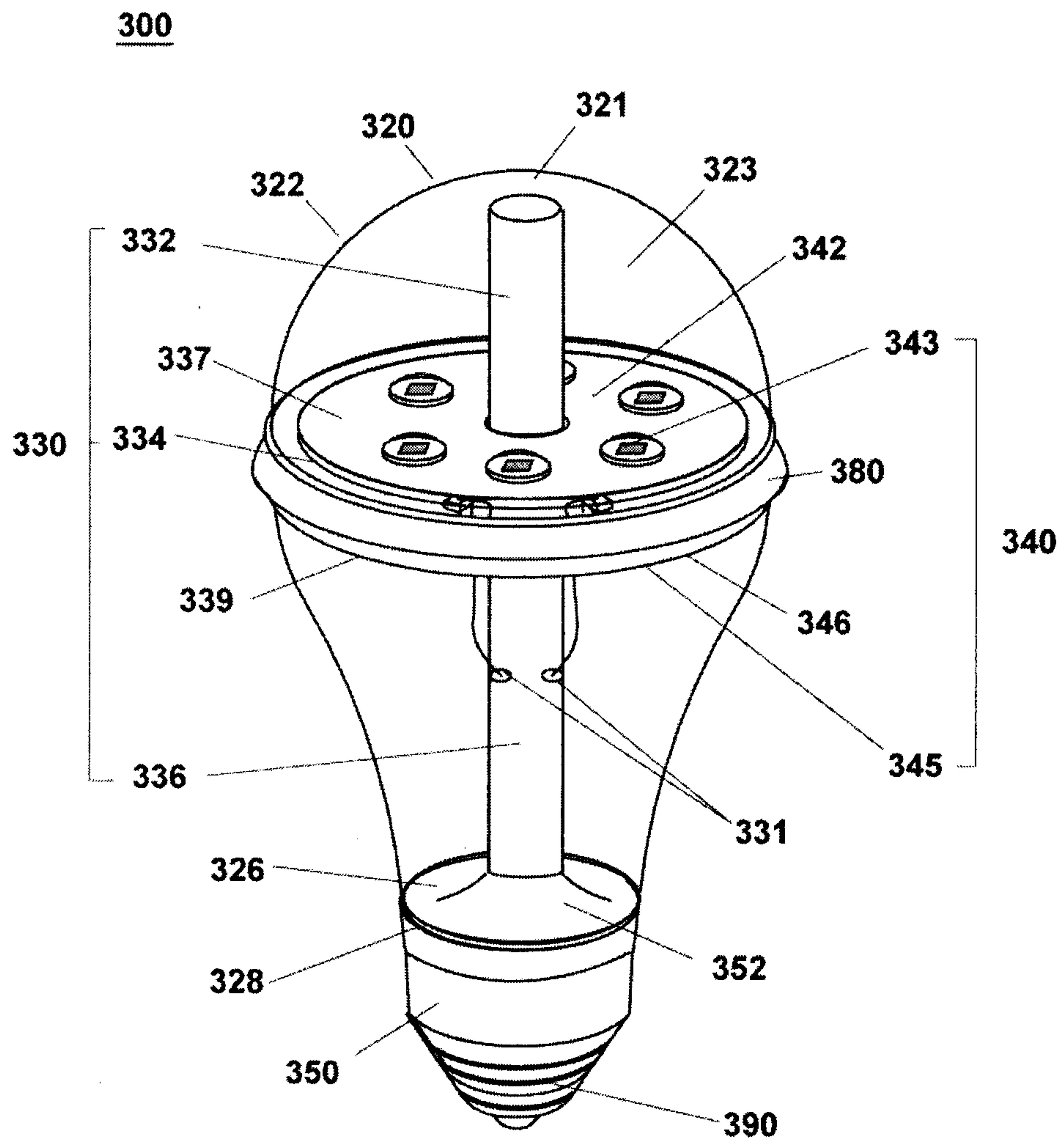


FIG. 9

**FIG. 10**

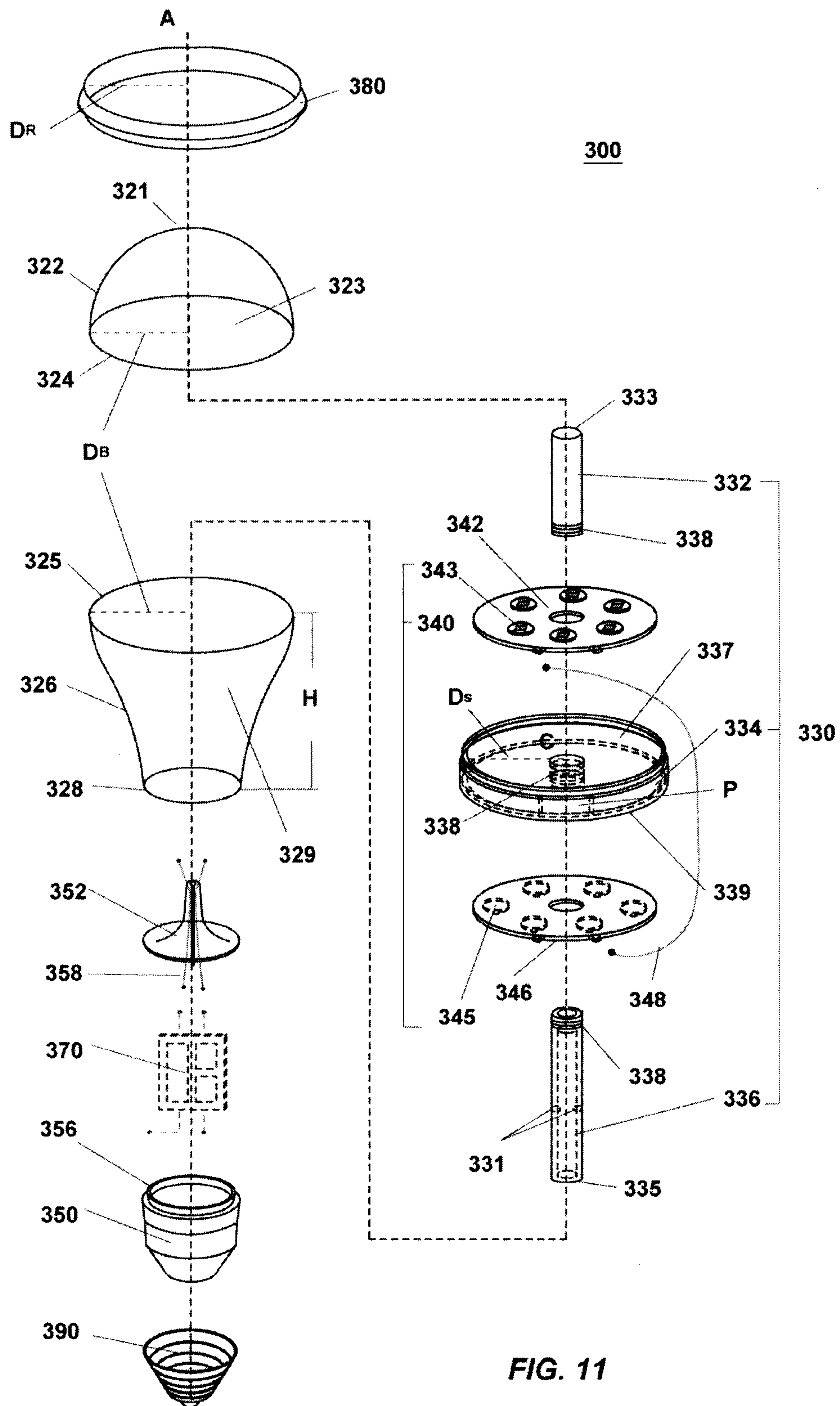


FIG. 11

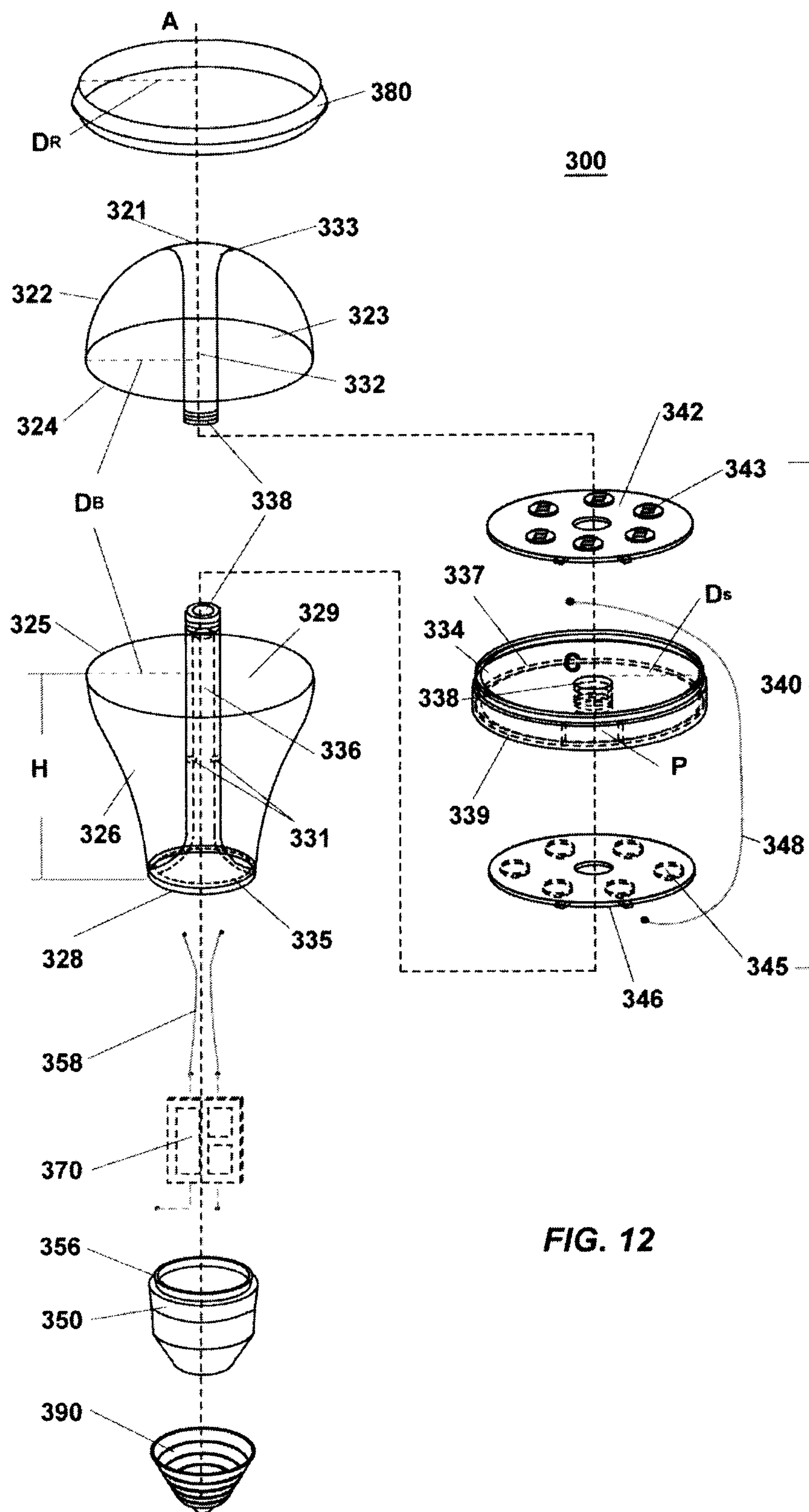


FIG. 12

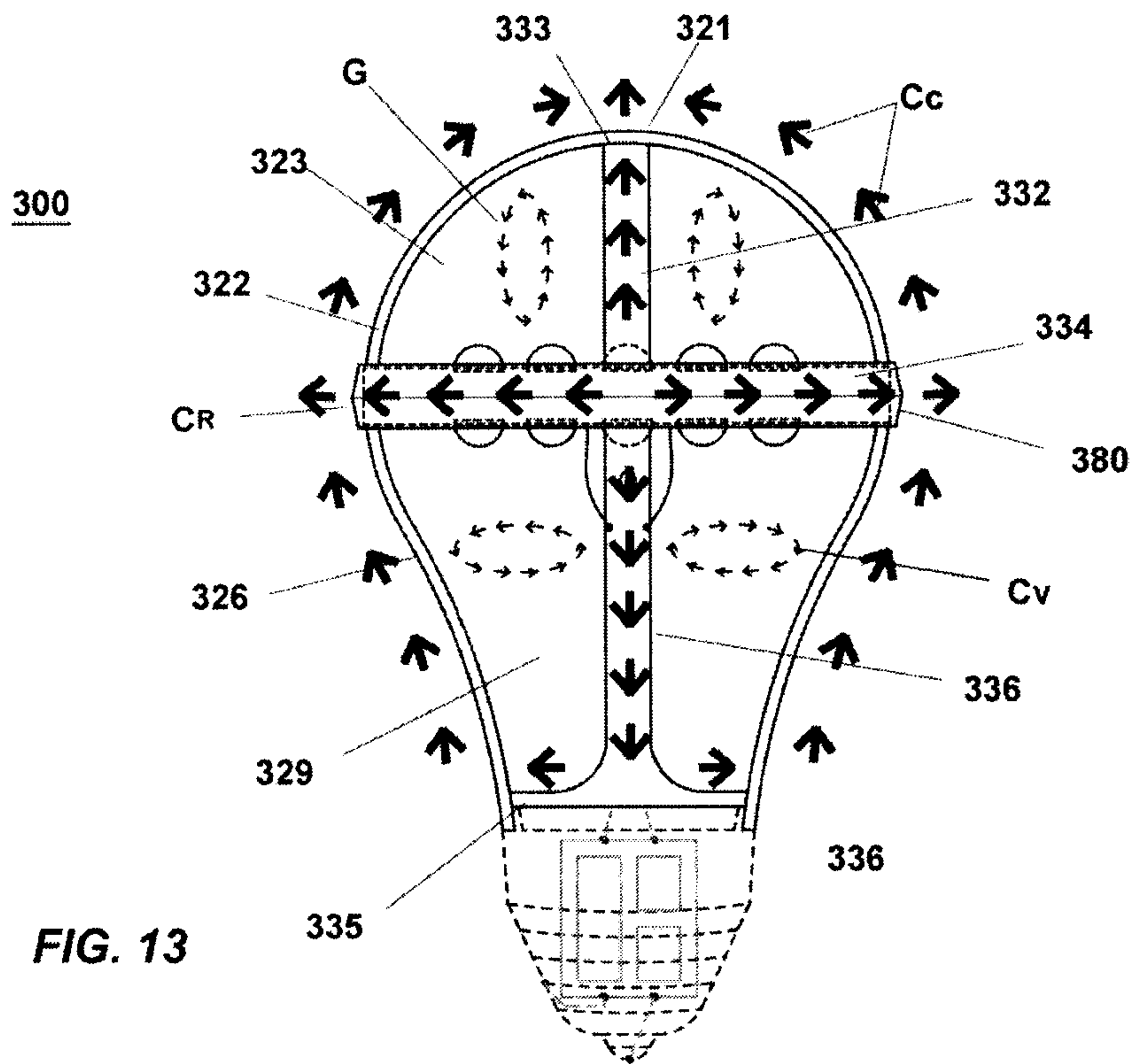


FIG. 13

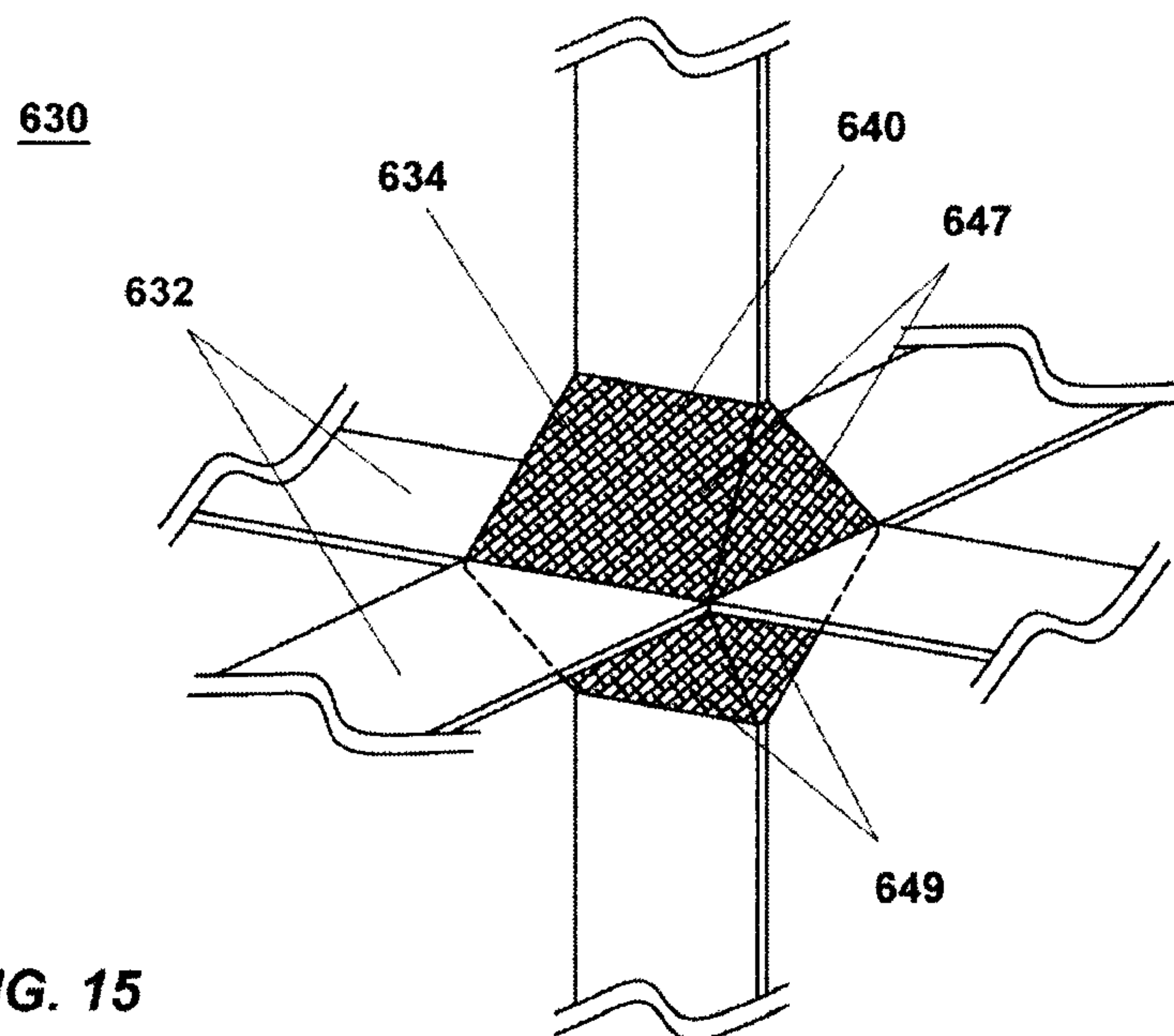
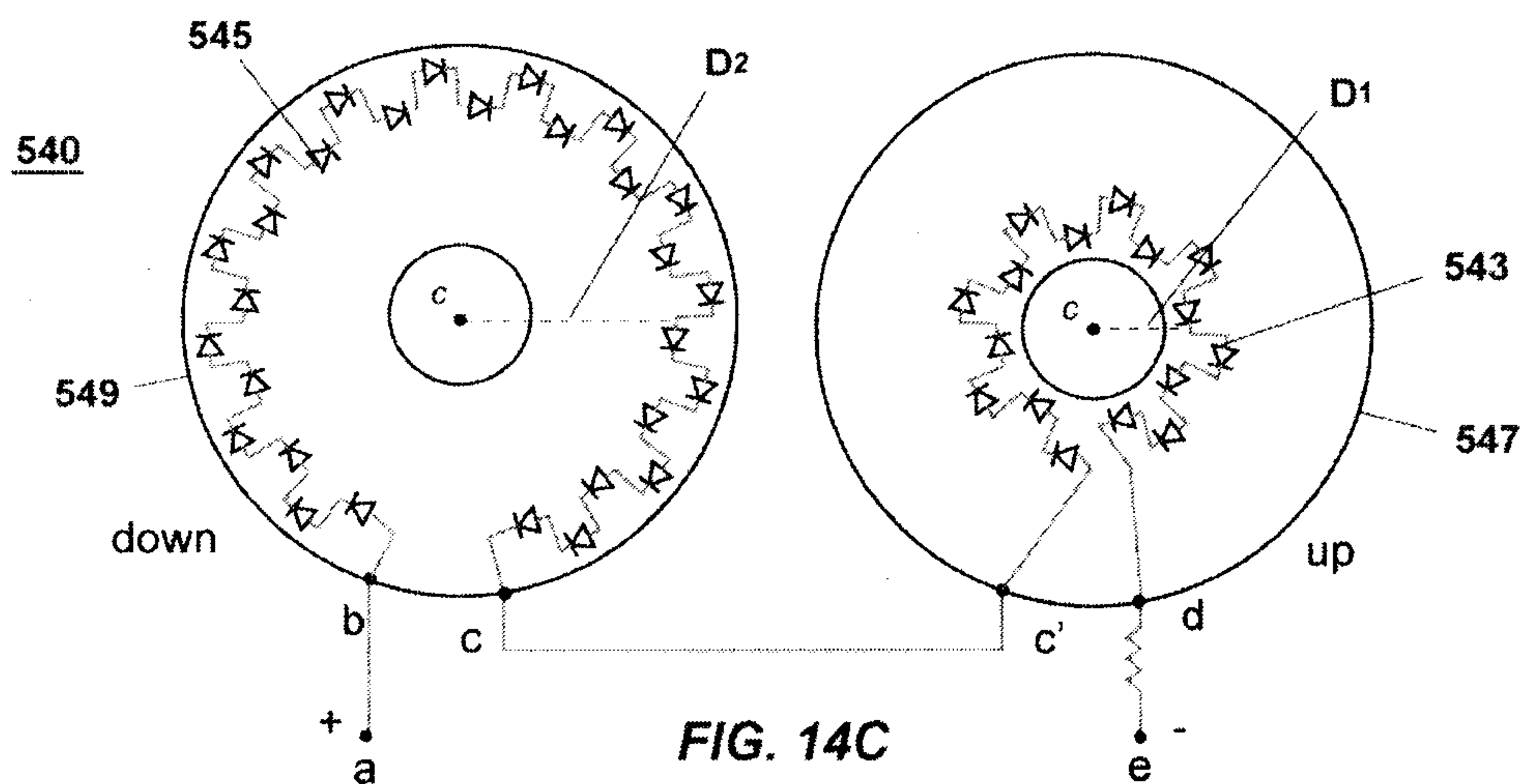
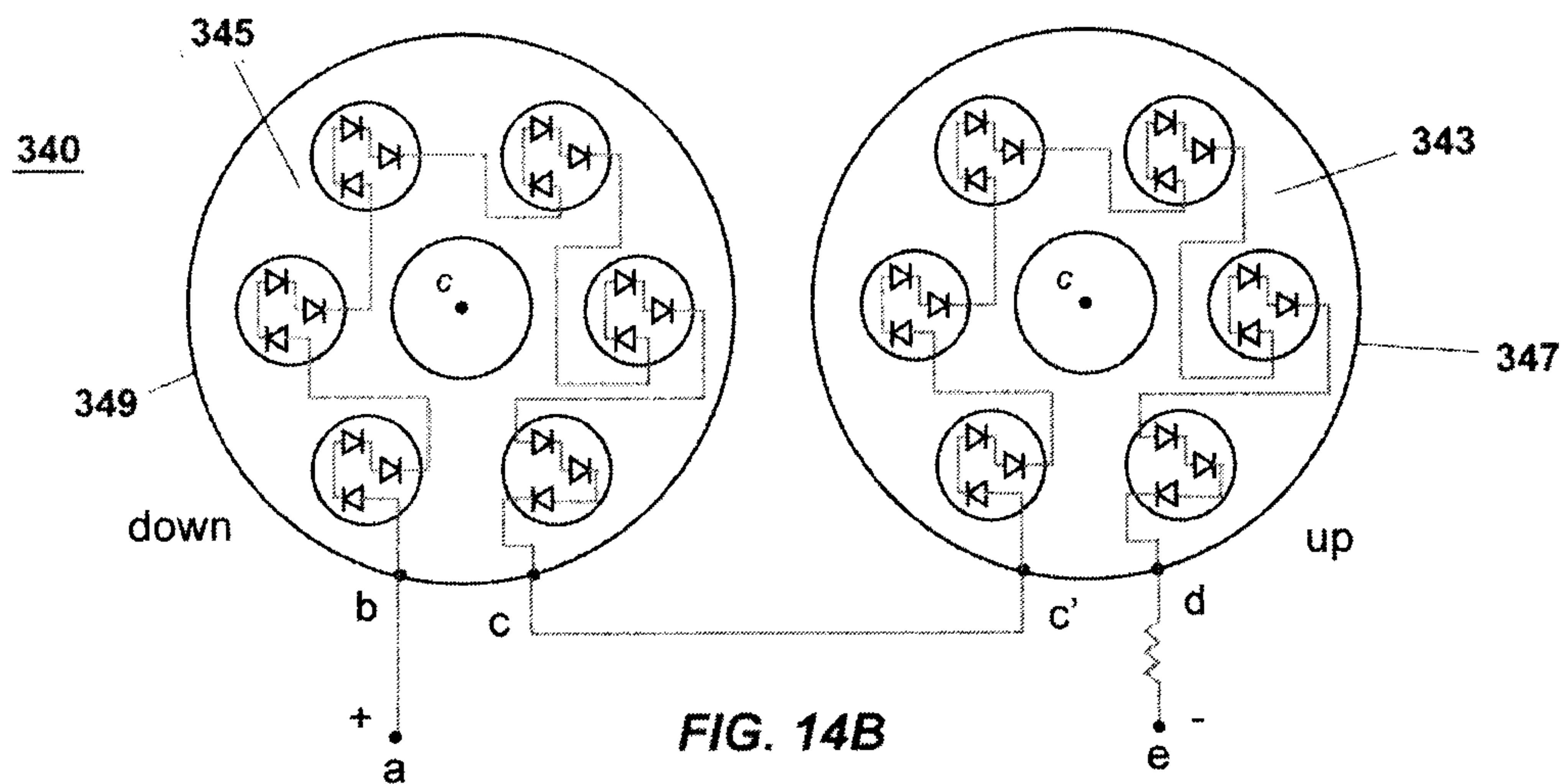
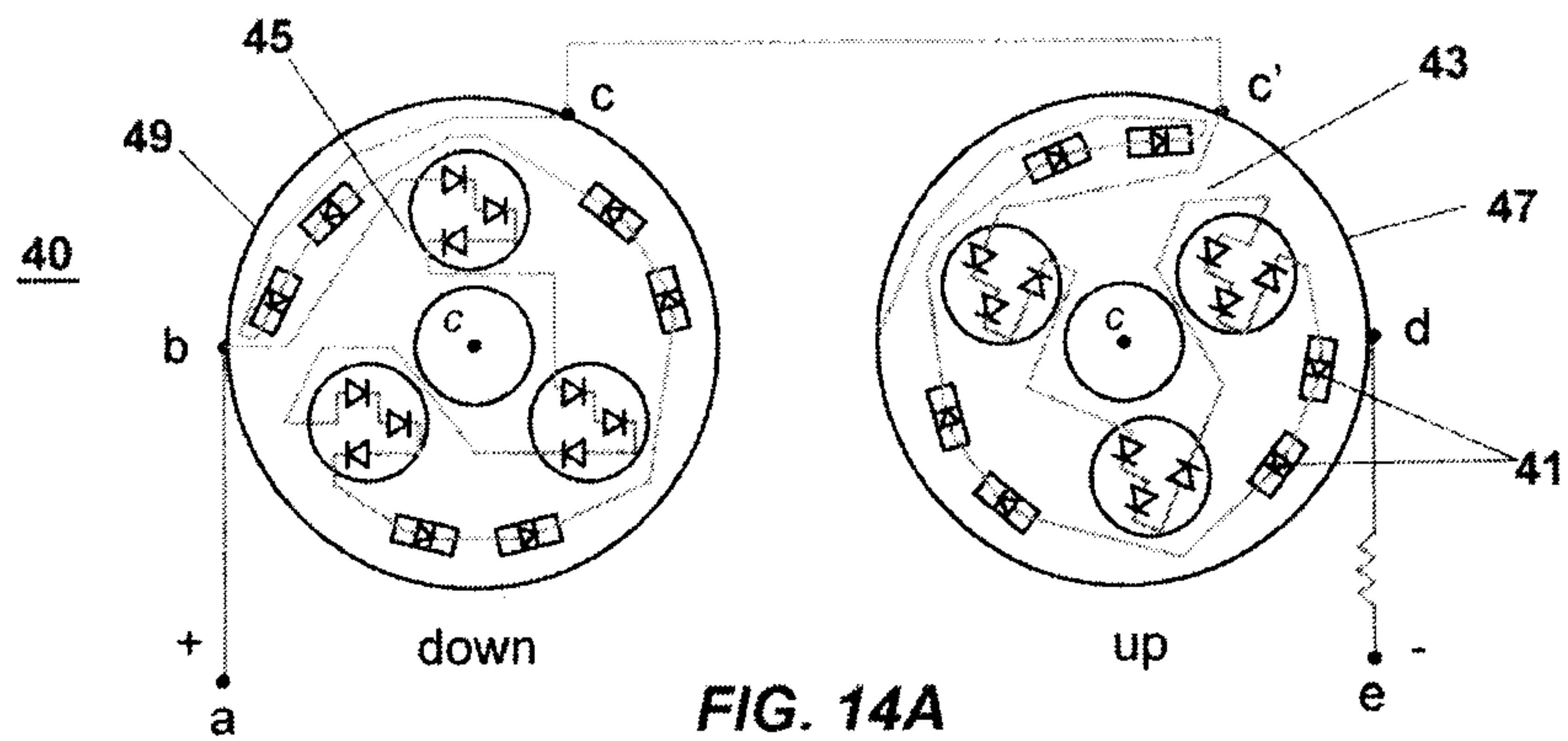


FIG. 15



300

