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(54) **Title**: LED SPIRIT SYSTEM AND MANUFACTURING METHOD

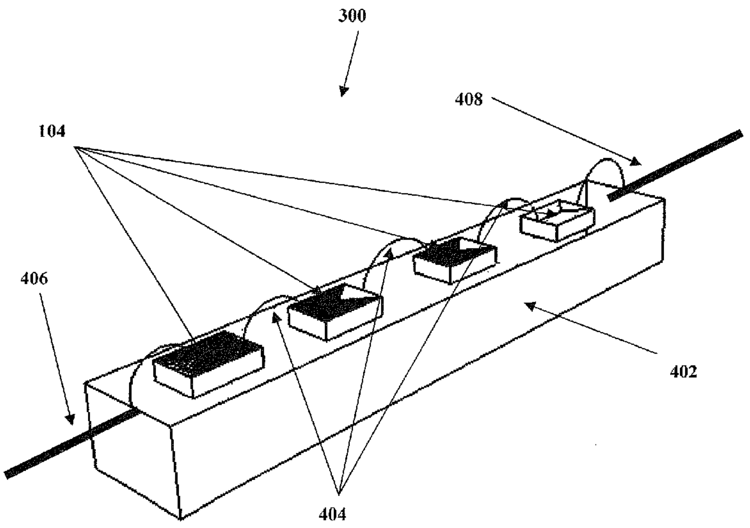

Figure 4

(57) **Abstract**: The present invention relates to a new method, system and apparatus for light emitting diode (LED) packages. An object of the present invention is to provide an LED package having reduced components, a superior heat dissipation property and a compact structure, does not largely restrict use of conventional equipment for its manufacture, and is compatible with implementation within present illumination devices packaging.

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

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- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

LED Spirit System and Manufacturing Method

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to co-pending U.S. Provisional patent application Ser. No. 61/725,191 titled "***LED Spirit System***", filed on Nov. 12th, 2012 the disclosure of which is herein incorporated by reference in its entirety, U.S. Provisional patent application Ser. No. 61/725,196 titled "***LED Spirit Connector System***", filed on Nov. 12th, 2012, U.S. Provisional patent application Ser. No. 61/737,422 titled "***LED Stick, Strings, Straw and/or Chain Manufacturing Method***", filed on Dec. 14th, 2012, U.S. Provisional patent application Ser. No. 61/737,437 titled "***LED Fluid Cooling Assembly*** ", filed on Dec. 14th, 2012, and U.S. Provisional patent application Ser. No. 61/737,459 titled "***LED Stick, Strings, Straw and/or Chain Phosphor Coating System and Method***" filed on Dec. 14th, 2012.

PATENTS CITED:

[0002] The following documents and references are incorporated by reference in their entirety, Ogawa et al (U.S. Pat. No. 7,714,346), Kang et al (U.S. Pat. No. 7,642,563), Mok et al (U.S. Pat. No. 7,262,438), Zykin (U.S. Pat. Appl. No. 13/313,129), Li (U.S. Pat. Appl. No. 2011/0261563) and Vilella (EP 1032912).

FIELD OF THE INVENTION

[0003] The present invention relates to a method for manufacturing Light Emitting Diodes (LEDs) sticks, candles, strings or straws from a surface, and in particular to a method for the high-yield, efficient and inexpensive manufacture of LED sticks.

DESCRIPTION OF THE RELATED ART

[0004] LEDs promise to revolutionize illumination, through their ultra efficient conversion of energy into visible light. Within a decade, we have gone from illumination provided by a 60W incandescent light bulb being replaced by a 13W Compact Fluorescent Light bulb (CFL) to a 3W LED light bulb. In effect, reducing by over 90% the consumption required for similar illumination. The above is not only important because it saves energy, but also because now we can illuminate the world without the need to electrify the world.

[0005] An LED is an element in which electrons and holes are combined in a P-N semiconductor junction structure by application of current thereby emitting certain types of light. LEDs are typically formed to have a package structure, in which an LED chip is mounted on a mechanical carrier, frequently referred to as an "LED package." Such an LED package is generally mounted on a printed circuit board (PCB) and receives current applied from electrodes formed on the PCB to thereby emit light.

[0006] In general illumination applications, engineers have discovered the importance of generating light in a 360 deg. envelope, not unlike the way in which an incandescent filament illuminates. To accomplish such goals, a new type of package termed an LED sticks or LED straw has been created. In it, individual LEDs are serially placed along a thin sleeve or slice of material, typically made of a sapphire or ceramic material. The stick is powered from each end, creating a stick of light.

[0007] In an LED package, heat generated from the LED chip has a direct influence on the light emitting performance and life span of the LED package. When heat generated from the LED chip is not effectively removed, dislocation and mismatch occur in a crystal structure of the LED chip. In effect, brightness is related to power applied, so a large amount of heat is generated in an LED chip due to the high currents, heat that must be typically transferred to a heat sink, typically, a separate device for effectively dissipating the generated heat is required.

[0008] Presently, LED units are manufacture by placing individual packaged LEDs in the stick. Unfortunately, the stresses of placing these with a 'chip-shooter', wire bonding the individual LEDs to each other cause significant stresses to the package, resulting in low yields. In addition to the above, LED string packages from which white light is desired, must receive a coating of yellowing phosphor in order to emit "white" light. Such a coating is hard to apply to an elongated structure such as an LED string.

[0009] What is needed is a way in which to attach LED packages to LED strips, strings or slices that preserves high yields and allows for good yellow phosphor attachment.

SUMMARY OF THE INVENTION

[0010] This section is for the purpose of summarizing some aspects of the present invention and to briefly introduce some preferred embodiments. Simplifications or omissions may be made to avoid obscuring the purpose of the section. Such simplifications or omissions are not intended to limit the scope of the present invention.

[0011] In one aspect, the invention is about an LED light package system comprising a single one or more LED die chips placed on one or more adjoining LED frames, each said LED die chip connected electrically to the LED die chip before and after forming an electrical LED chain, and said one or more LED frames encapsulated within a single solid enclosure, said enclosure having access to its interior via electrical connections to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end, said electrical connections being suitable for connection to a power source. In another aspect, the said one or more LED frames are formed of metal. In yet another aspect, said LED light package is connected to one or more other LED light packages serially or in parallel to form an assembly of light sources. In another aspect, said assembly of light sources is enclosed within a lamp or bulb. In yet another aspect one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material. In another aspect, one or more said enclosure is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material. In yet another aspect, said assembly of light sources is enclosed within a tube.

[0012] In one aspect, said one or more metal LED frames extend outside the encapsulation volume forming one or more fins. In another aspect, said assembly of light sources is enclosed within a lamp or bulb, and one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material. In another aspect, said assembly of light sources is enclosed within a lamp or bulb and one or more said LED light package enclosures is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material. In yet another aspect, said assembly of light sources is enclosed within a tube. In another aspect, said fins are shaped to provide mechanical support within said tube, and one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material. In another aspect, one or more said LED light package enclosures is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material. In one aspect, one or more of the above encapsulation are enclosed within a fluid-filled container.

[0013] In one aspect, said one or more LED frames are formed of a sapphire or sapphire-like material. In another aspect, said LED light package is connected to one or more other LED light packages serially or in parallel to form an assembly of light sources. In yet another aspect said assembly of light sources is enclosed within a lamp or bulb and one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material. In another aspect, said assembly of light sources is enclosed within a lamp or bulb and one or more said enclosure is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material. In another aspect, one or more of said encapsulations are enclosed within a fluid-filled container.

[0014] In one aspect, the invention is about a method for manufacturing an LED light source system, said method comprising, placing one or more LED die chips on one or more adjoining LED frames, connecting each said LED die chip electrically to the LED die chip before and after said LED die chip, encapsulating said one or more LED frames within a single solid enclosure, allowing an electrical connection to the interior of said enclosure to connect to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end.

[0015] In one aspect, the invention is about a method for manufacturing an LED light source system, said method comprising placing one or more LED die chips along rows on an area wafer, connecting each said LED die chip electrically to the LED die chip before and after said LED die chip within a particular row, separating each individual row of LED die chips into an individual sliver, encapsulating one or more said slivers within a single solid enclosure, allowing an electrical connection to the interior of said enclosure to connect to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end.

[0016] Other features and advantages of the present invention will become apparent upon examining the following detailed description of an embodiment thereof, taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIGS. 1A - 1C show illustrations of prior art related to traditional LED mfg. techniques.

[0018] FIG. 2 illustrates a chip-shooter machine, according to prior art.

[0019] FIGS. 3A - 3F, 4 - 12 show illustrations of the improved LED mechanical/electrical packaging options and mfg. methods, according to exemplary embodiments of the invention.

[0020] FIGS. 13 - 35 show various illustrations of improved mechanical/electrical/heat dissipation options, according to exemplary embodiments of the invention.

[0021] The above-described and other features will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] To provide an overall understanding of the invention, certain illustrative embodiments and examples will now be described. However, it will be understood by one of ordinary skill in the art that the same or equivalent functions and sequences may be accomplished by different embodiments that are also intended to be encompassed within the spirit and scope of the disclosure. The compositions, apparatuses, systems and/or methods described herein may be adapted and modified as is appropriate for the application being addressed and that those described herein may be employed in other suitable applications, and that such other additions and modifications will not depart from the scope hereof.

[0023] Simplifications or omissions may be made to avoid obscuring the purpose of the section. Such simplifications or omissions are not intended to limit the scope of the present invention. All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinence of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art.

[0024] As used in the specification and claims, the singular forms “a”, “an” and “the” include plural references unless the context clearly dictates otherwise. For example, the term “a transaction” may include a plurality of transaction unless the context clearly dictates otherwise. As used in the specification and claims, singular names or types referenced include variations within the family of said name unless the context clearly dictates otherwise.

[0025] Certain terminology is used in the following description for convenience only and is not limiting. The words “lower,” “upper,” “bottom,” “top,” “front,” “back,” “left,” “right” and “sides” designate directions in the drawings to which reference is made, but are not limiting with respect to the orientation in which the modules or any assembly of them may be used.

[0026] It is acknowledged that the term ‘comprise’ may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term ‘comprise’ shall have an inclusive meaning—i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term ‘comprised’ or ‘comprising’ is used in relation to one or more steps in a method or process.

[0027] Referring to **FIGS. 1A - 1C**, we illustrate the basic lensed light emitting diode (LED) **102** structure and its fabrication by placing the LED Die chip **104** on a lead frame **106** connected to a cathode (-ve) **1102** and wire bonding it to another lead frame **108** connected to an anode (+ve) **110**, encapsulating the complete assembly in clear or colored epoxy **114**, resulting in light output **116**.

[0028] All of the above is usually done by a placement and wire/bonder onto a metal frame **120**, with the finished product then residing in a plastic LED package. The packaged semiconductors such as LED assemblies are traditionally placed on an plastic frame, FR4 laminate or similar material board with a chip placement machine **200**, usually called a 'chip shooter' **(FIG. 2)**.

[0029] The above may be improved **FIGS 3A - 3E** by creating an LED candle, strings, straw, chain and/or LED stick **300** by redesigning the metal frame **120** so that the "flat" area of the frame **302** to place the individual LED die chip **104** is extended and becomes longer. In addition, the design may span two or more frames **302** on a thin shaped substrate, so that two or more LED die chips **104** can be placed and sequentially wire bonded (even spanning the gap space **304** between frames **302**).

[0030] In one embodiment, one or more LED die chips **104** may be placed in or on each LED frame bar **302**, by placing four or more LED dies or chips **104** on top of the bars or frames **302**. After expansion, the bars now can accommodate many more of the LED dies, chips or crystals. In one embodiment, the actual LED dies **104** may be of different colors, to naturally correct the Color Temperature Reflectance (or CIR) of the light coming off the complete assembly.

[0031] Note the above means that the LED chips within the top of the concatenated bars may be hundreds, and could be a combination of colors. In addition to LED chips, other semiconductors may be placed atop the bar, including other diodes, transistors, electro-static protection elements (resistors, etc.), resistors, capacitors and many other electronic components. This placement may be automated or manual, and connected together via traditional methods such as wire bonding, soldering, etc.

[0032] Once the appropriate electronic components are placed, the complete assembly may be encapsulated within a material. This process may be accomplished using injection molding in any preferred orientation. The injection molded material may be clear **306**, or any other suitable colored desired **308**, including using Phosphor filled plastic injection **310**. The complete entity looks eerily like a candle or LED stick of concatenated individually glowing LED sections, being powered from one end to the other and/or after a number of units.

[0033] Power dissipation is accomplished by the encapsulation material as well as by the extensions of the LED frames outside the encapsulation, which then act as a radiator for the heat. Besides cylindrical shapes, other shapes may be used, including square, rectangular, triangular, etc. Adding one or more of the units within an enclosure creates an Omni directional LED assembly that behaves optically eerily like an incandescent bulb filament.

[0034] The user may elect the shape of the plastic or other material covering the LEDs, such as a long bar covering all LED chips and parts of Cathode(s) and Anode(s). If needed, almost finished Lead Frame may be Phosphor coated, with silicone or other based Phosphor. It could be coated by using immersion, electrostatic coating and any other suitable methods. After finishing encapsulation and coating the lead frame goes to a cutting machine. That machine cuts off not needed anymore technological holders like holders, supports, bases, extra length of anode and cathodes, etc.

[0035] In one embodiment, sapphire-type substrates are preferred over metal, in particular because they allow some of the light to filter around their body, providing the stick with light behavior closer to that of an incandescent filament. Referring to **FIG. 4**, we see the internal structure **400** of such a light stick **300**. An elongated sliver **402** of material has two or more LEDs packages die chips **104** bonded to the surface of one side of said slivers **402**.

[0036] The LED packages dies **104** are then connected to each other electrically. In one embodiment, this may be done via wire bonding **404** each die to the next, as well as to the entry **406** and exit **408** anode and cathode wires. In an alternate embodiment, the exit/entry wires (**406, 408**) may be made as a solid metal cover and later sliced within a solid sheet, solid block and/or lead frame into separate pieces. These entry/exit wires are usually extended outside any encapsulation or cover package features.

[0037] The above LED stick package **300** is then enclosed or encapsulated in clear silicone or similar material, dipped in yellow phosphor and tested. Other colors may be selected for the encapsulation. Note that while in one embodiment the individual LED dies **104** may be comprised of "white light" LEDs, a particular LED stick **300** may be comprised of any desired combination of RED, GREEN, BLUE (and any other customized colors) individual LEDs.

[0038] Unfortunately, because the above process is performed on a sliver **402** of material by a machine traditionally used to deal with an area device or area wafer, many potential failure points are introduced. Holding a sliver is hard and problematic, pushing on it by either the wire bonder, the chip shooter or any other number of parts creates structural stress and/or failure points. In addition, the wire bonder may need to heat the ends, and that heat will be transferred to the sliver in a non-uniform way. In short, a lot of parts are found to be defective or non-working, resulting in a low yield of useful parts.

[0039] In contrast, the applicant's new inventive design and fabrication method (**FIGS 5 - 10**) begins by mounting the LEDs chips **104** on the complete sapphire or sapphire-like material board or other suitable area wafer **502** before it is sliced into individual slivers **300**. The advantages of using this method are many. The chip shooter is already tooled for holding FR4 laminate boards, and any heat generated by the wire bonder is spread not only into the sliver **300** area, but also to the adjacent neighbor structures. This step is critical, since programming of the wire bonder would allow for the machine to work on other areas (say first bonding LEDs **104** (individually LEDs **600** to **602**, followed by **604**

to **606**)). Such a spreading of the heat would provide less heat stress to the wafer **502** area forming part of the first stick.

[0040] Note that while we mention sapphire, in an alternate embodiment Germanium, Silicon, FR4, plastic and or any other material may be used for the wafer **502**. Similarly, instead of wire bonds, the connections between the LEDs **104** may be sputtered, ion deposited or any other suitable way to lay a conductive layer and LED mounting pads on the board **502** surface.

[0041] In one embodiment, next we lay and connect the LEDs **104** within the board **502** using the area that will in the end form the sliver, performing any force stress, thermal stress and/or other action while the slivers are still forming a solid board. In some embodiments, we excoriate, score, laser etch or mechanically grind the fracture, breakage or separation lines **700** (in a fashion similar to that used when preparing glass for breakage or separation into portions) before laying and attaching the LEDs **104**. This has the advantage of providing the ability to clean any leftovers from that operation before gluing or depositing the LEDs. This may be needed in some embodiments to clear/smooth the surface of the edges.

[0042] In an alternate embodiment, said scoring between slivers **300** is performed later. Note the lines **700** may be surface driven or significantly go into the board/wafer **502**, as long as the unit behaves as a larger area, and not as a sliver (i.e. a thin stick vs. a board), the benefits above will be present. As a next step, the slivers **402** are formed by separating the board **502** into components, creating fully functional LED strip subassemblies **300** that have the input/output wires and are only lacking the subsequent steps of encapsulation)**.**

[0043] This process may be accomplished using injection molding in any preferred orientation. The injection molded material may be clear, or any other suitable colored desired, including using Phosphor filled plastic injection. In alternate embodiments the phosphor is added later, producing a partial LED Stick **300** that only lacks the appropriate color output**.** In one embodiment, said partial LED stick **300** is a sliced sliver or thin strip having a series of crystals glued or affixed to them.

[0044] In an alternate embodiment (**FIG.** 9) the light output from the LED strip subassembly **300** may be doubled and/or increased by placing LEDs **104** on the top **900** surface as well as on the opposite (or bottom) **902** side of the board before cutting. The LEDs on the bottom may be optimally placed in a checkerboard or staggered patter **904** (so that their bottoms do not block any side lobe or residual light travelling across the sliver **402**, or they may be placed opposite of each other. Note the LEDs **904** on the bottom are placed so the light emits away from the sliver **402**.

[0045] The complete entity looks eerily like a column, candle or LED stick **300** of concatenated individually glowing LED sections, being powered from one end to the other. Power dissipation is accomplished by the encapsulation material and or the LED frame inside the encapsulation, which acts as a radiator of heat. While in the embodiment shown the LED stick is cylindrical, other shapes may be accomplished depending on the encapsulation used, including triangular, etc.

[0046] In one embodiment, the encapsulating LED stick **300** plastic is defined as electrically conductive plastic. In an alternate embodiment, it is possible to use a polycarbonate. Polycarbonates (PC), known by the trademarked names Lean, Maroon, Marcela and others, are a particular group of thermoplastic polymers. They are easily worked, molded, and thermoformed. Because of these properties, polycarbonates find many applications. Polycarbonates do not have a unique resin identification code.

[0047] In an alternate embodiment, it is possible to use a polycarbonate. Polycarbonates (PC), known by the trademarked names Lean, Maroon, Marcela and others, are a particular group of thermoplastic polymers. They are easily worked, molded, and thermoformed. Because of these properties, polycarbonates find many applications. Polycarbonates do not have a unique resin identification code.

[0048] Most "white" LEDs use a 450nm – 470nm blue GaN (gallium nitride) LED covered by a yellowish phosphor coating usually made of cerium doped yttrium aluminum garnet (YAG:Ce) crystals which have been powdered and bound in a type of viscous adhesive. The LED chip emits blue light, part of which is converted to yellow by the YAG:Ce. The single crystal form of YAG:Ce is actually considered a scintillator rather than a phosphor. Since yellow light stimulates the red and green receptors of the eye, the resulting mix of blue and yellow light gives the appearance of white.

[0049] Such a dye may be painted onto the stick surface, or the stick may be dipped onto the dye. The injection molded material may be clear, or any other suitable colored desired, including using Phosphor filled plastic injection. In alternate embodiments the phosphor is added later, producing a partial LED Stick **300** that only lacks the appropriate color output**.**

[0050] In either case, if the stick **300** is simply used as embodied above, the heat generated becomes hard to remove, resulting in packages that typically do not exceed the 0.8 Watts per stick, lest permanent damage may occur to the LED components **104**, electrical bonds (**404**), or sliver **402**.

[0051] Applying the cerium or similar phosphor coating to either the LED stick **300** or any container enclosing the LED stick is complicated by the time required to either paint and dry, or the tendency of any dipping to generate gravity fed drooping of the coating. One possible improvement would be to generate cylinder or tube-shaped sheets of the phosphor coating using shrink wrap heat-activated material **1102**, similar to that used for wire wrapping.

[0052] Referring to **FIGS. 11 - 12**, material like this could be coated or impregnated with the appropriate yellow phosphor, placed over the LED stick **300** and heated so that it shrinks and produces a complete and uniform yellow phosphor coated LED light stick **1200** around the original colored LED stick **300**, resulting in light emission characteristics that are uniform.

[0053] By creating a cylinder or tube-shaped sheet of the cerium or similar phosphor coating, laid on an optical quality and/or transparent shrink wrap heat-activated material. Such a heat activated shrink wrap could be similar to that used for wrapping parcels, and would behave similar to the tubes used for wire wrapping. A material like this could be coated with the appropriate yellow phosphor, placed over the uncoated LED stick and heated so that it shrinks and produces a complete yellow phosphor coated LED stick with light emission characteristics that are uniform in the desired wavelength.

[0054] To increase this power output (**FIG. 13 - 14** and **35**), in some applications, users have opted to package the LED sticks **300** inside a bulb **3502** or tube **1300**, reminiscent of how incandescent filaments are inside a vacuum bulb, then filling the inside volume with a fluid having better heat transmission properties than air (such as an dielectric liquid). In such cases, the resulting bulb is significantly heavier, and may leak when placed 'connector down' (as is the case in most lamps). In addition, the liquid inside a bulb has an optical path that is farther around the equator of the bulb than around the top, resulting in a distorted optical path for the light.

[0055] In a similar embodiment, a container could house a clear LED stick **300** or chain of LEDs sticks **300** (say long enough to fit a fluorescent tube) could be packaged inside an overlaying container **1300**, creating a sealed chamber **1400** that encloses said LED stick **300** or assembly, then filled with a fluid. In one embodiment, said container **1300** creates the sealed chamber **1400** having a significantly cylindrical cross section, so that the distance travelled by the light from the LEDs to the walls is significantly uniform, but other shapes may be employed, such as two sided envelopes, triangles, hexagons, octagons, ellipses, etc. In one embodiment, the diameter of the tube is kept small, say below 10 mm. In alternate embodiments, larger diameters may be possible.

[0056] Similarly, the fluid within said container chamber **1400** may be comprised of nothing (a vacuum), a number of gases (including inert) and any number of liquids, including dielectric fluids. In this fashion, the heat transfer unit may allow the LED stick **300** that was limited to 0.8 W to transmit consume as much as 3.2 W. The pipe or container **1300** may be made of any number of materials (plastic, glass, etc.), including the same as those used in the encapsulation of the LED stick subassembly **300** described above.

[0057] The fluid within the container chamber **1400** naturally collect more heat from the LED crystal, since it does so from all sides of the LEDs, and the natural gradient thermal distribution transfers the heat to cooler areas of the chamber. In a regular structure of LEDs, heat is collected or removed only from one side, the one where the LED crystal is attached to the heat sink, with heat removal being blocked by silicone or similar substances on the other sides. In the applicant's, fluid collects heat from all sides of LED and transfers it to the larger area of presented by the outer side of pipe. Said pipe may be made from any optically clear substances, like, but not limited to heat conductive ceramic, crystals, glass, etc.

[0058] Referring to **FIGS. 15 - 19**, these illustrate an alternate embodiment of the invention, where various implementation and design methods are used to create an LED stick or candle **300** (whether clear **300**, colored or encapsulated **1200**) comprised of one LED die chip **104** per frame **302**, each LED chip **104** being connected to its neighbors by a wire bond **404**, and the lower extensions of the frames into fins **1602** acting as extended metal fins leaving the length of the LED stick **300**.

[0059] Note the above means that the LED chips within the top of the bar may number from one to hundreds, as could be the combination of colors. In addition to LED chips, other semiconductors may be placed atop the bar, including other diodes, transistors, electro-static protection elements (resistors, etc.), resistors, capacitors and many other electronic components. This placement may be automated or manual, and connected together via traditional methods such as wire bonding, soldering, etc.

[0060] In one embodiment, insulation material **1702** is placed between the frames **302** and allow for an eutectic LED die **104** placement. This same insulation **1702** may be coated using silicon with a phosphor, allowing for the emitting of light 'around' the space between the frame **302** bases, as seen in the circular cross section **1802**.

[0061] The user may elect the cross sectional shape **1804** of the plastic or other material covering the LED stick **300**, such as a long bar covering all LED chips and parts of

Cathode(s) and Anode(s). If needed, almost finished Lead Frame may be Phosphor coated, with silicone or other based Phosphor. It could be coated by using immersion, electrostatic coating and any other suitable methods. After finishing encapsulation and coating the lead frame goes to a cutting machine. That machine cuts off not needed anymore technological holders like holders, supports, bases, extra length of anode and cathodes, etc.

[0062] Referring to **FIG. 19**, we see how the complete LED stick **300** looks eerily like a candle (albeit with wicks at both ends). Power dissipation is accomplished in two ways, the encapsulation **1804** material warms and emits heat, and the lower extensions of the frame fins **1602** bring portions of the heat inside the enclosure **1804** to the outside, by acting as radiator fins for the heat.

[0063] In one embodiment, the encapsulating LED stick **300** plastic is defined as electrically conductive plastic. In an alternate embodiment, it is possible to use a polycarbonate. Polycarbonates (PC), known by the trademarked names Lexan, Makrolon, Makroclear and others, are a particular group of thermoplastic polymers. They are easily worked, molded, and thermoformed. Because of these properties, polycarbonates find many applications. Polycarbonates do not have a unique resin identification code.

[0064] Concatenating (**FIGS. 20 - 23**) two or more **2000** of the LED stick units **300** while letting them connected to each other by an extended connector **2002** between candles **300**, allows for a method in forming an assembly **2102** in which the candles form a candelabra in which the fins **1602** may be together or separate, yet cooperate geometrically between them to eliminate any shadows, while at the same time being compact enough to fit within a bulb, lamp or tube. Note that the connection to a power source may be accomplished serially **1202** or in parallel **FIG. 22**.

[0065] Referring to **FIGS. 24 - 26**, we show an alternate embodiment in which the fins **1602** are extended and bent, so that in addition to serving as a radiator, they mechanically support a train of candles **300** within a T-5, T-8 or any other suitable tubular housing **2402**. In the case of both a bulb or the T-5/T-8 tube, there could be introduced into the container a gas mix. The electronics to drive the various LEDs may be housed within the bulb, or attached to the base of said bulb.

[0066] **FIGS. 6 - 20** illustrate alternate embodiments of the above, including the various methods that may be used to create a candle having extended solid and continuous base cooling fins **602** created by leaving the length of the metal base upon which the LED **200** is mounted/formed fully extended.

[0067] Note the above means that the LED chips within the top of the bar may be hundreds, as could be the combination of colors. In addition to LED chips, other semiconductors may be placed atop the bar, including other diodes, transistors, electro-static protection elements (resistors, etc.), resistors, capacitors and many other electronic components. This placement may be automated or manual, and connected together via traditional methods such as wire bonding, soldering, etc.

[0068] Referring to **FIGS. 27 - 31** we see an embodiment where the LED dies **104** are placed in a non-eutetic fashion, so that the complete base can be a solid piece of metal or other suitable heat transferring media, allowing the encapsulation to produce an LED stick **300** with superior heat transferring external fin **2702** outside the encapsulating media.

[0069] Referring to **FIGS. 32 - 34**, the coating of yellowing phosphor described above may be applied near the periphery of the encapsulation **3202**, above the actual LED die area **3302** or directly above the LED die on a traditional package **3402**.

Example 1:

[0070] An LED light emitting bar, pole, filament, or candle could have a size of bar that is plastic covered in length of 30 mm, diameter of 2.5 to 3.5 mm, having a size of bar with connectors of 38 – 40 mm. In such an example, the quantity of light chips **200** within a single candle could be 26 pcs, in the 465 – 475 nm, having a serial connection.

[0071] It could be mfd. using flip chip technology, having a working voltage of 70 – 90 Volts, with current up to 30 mA, with a pulse of up to 100 mA. The LED chip size(s) 10 x 18, 10 x 20, 10 x 23, 10 x 26 mm, depending on the pad size being used. Some additional LEDs could be 10 x 18 or 20 x 20 mm with ESP. Thickness of LED die sapphire substrate in the 200 – 430 micron (0.2 - 0.43 mm). Thicker may be better (say – 0.43 mm) as a standard for sapphire wafer. Each chip seats on it's own pad – "leg", having no reflector on the pad.

[0072] Top attach, using an eutectic placement, wire bonding: Au or Al with Au plated – chipper. Wire bonding: could be done by 1 wire to LED die, or by 2 wires on same LED die "Leg" size of L 5.0 x W 0.7 x T 0.7 or L 5.0 x W 0.5 x T 0.5 mm. LED die "Leg" goes throughout of plastic for 3.0 - 4.0 mm.

[0073] Type of plastic (Epoxy) cover: LED compatible, phosphor compatible, no need for weather protection, bar will be insulated inside and protected Plastic (Epoxy): mixed with phosphor, molded over metal "legs" with LED dies Plastic (Epoxy). Especially shaped for better light output and distribution, cylindrical stars. Microscopic view: bar inside, single wire bonding, eutectic die attach, die thickness~10 mil

[0074] In one embodiment, the system could be used as replacement for incandescent light bulbs filaments, since due to its shape it could also be used as replacement for "gas discharge line" in T8, T5 fluorescent tubes. There is no need for PCB (Printed Circuit Board), and the separated, independent heat sink for every LED die (chip) in a bar would provide one of the best heat dissipation ability for LED dies, due to the ratio of sizes between LED die and size of the heat sink.

[0075] Very low thermal resistance between LED die and heat sink, to ambient, due to eutectic bonding process. Very wide angle of light distribution, due to a shape of pad for die attach, of plastic (epoxy) lens. No needs for secondary optics, lens are molded at the same time of production. Possibility to make heat sink electrically insulated, by using different die attachment methods.

CONCLUSION

[0076] In concluding the detailed description, it should be noted that it would be obvious to those skilled in the art that many variations and modifications can be made to the preferred embodiment without substantially departing from the principles of the present invention. Also, such variations and modifications are intended to be included herein within the scope of the present invention as set forth in the appended claims. Further, in the claims hereafter, the structures, materials, acts and equivalents of all means or step-plus function elements are intended to include any structure, materials or acts for performing their cited functions.

[0077] It should be emphasized that the above-described embodiments of the present invention, particularly any "preferred embodiments" are merely possible examples of the implementations, merely set forth for a clear understanding of the principles of the invention. Any variations and modifications may be made to the above-described embodiments of the invention without departing substantially from the spirit of the principles of the invention. All such modifications and variations are intended to be included herein within the scope of the disclosure and present invention and protected by the following claims.

[0078] The present invention has been described in sufficient detail with a certain degree of particularity. The utilities thereof are appreciated by those skilled in the art. It is understood to those skilled in the art that the present disclosure of embodiments has been made by way of examples only and that numerous changes in the arrangement and combination of parts may be resorted without departing from the spirit and scope of the invention as claimed. Accordingly, the scope of the present invention is defined by the appended claims rather than the forgoing description of embodiments.

Claims:

Claim 1 An LED light package system comprising;

a single one or more LED die chips placed on one or more adjoining LED frames, each said LED die chip connected electrically to the LED die chip before and after forming an electrical LED chain, and

said one or more LED frames encapsulated within a single solid enclosure, said enclosure having access to its interior via electrical connections to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end, said electrical connections being suitable for connection to a power source.

Claim 2 the LED package of claim **1**, wherein;

said one or more LED frames are formed of metal.

Claim 3 the LED package of claim **2**, wherein;

said LED light package is connected to one or more other LED light packages serially or in parallel to form an assembly of light sources.

Claim 4 the LED package of claim **3**, wherein;

said assembly of light sources is enclosed within a lamp or bulb.

Claim 5 the LED package of claim **4**, wherein;

one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material.

Claim 6 the LED package of claim **4**, wherein;

one or more said enclosure is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material.

Claim 6 the LED package of claim **3**, wherein;

said assembly of light sources is enclosed within a tube.

Claim 7 the LED package of claim **6**, wherein;

said one or more metal LED frames extend outside the encapsulation volume forming one or more fins.

Claim 8 the LED package of claim **7**, wherein;

said assembly of light sources is enclosed within a lamp or bulb; and

one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material.

Claim 9 the LED package of claim **7**, wherein;

said assembly of light sources is enclosed within a lamp or bulb; and

one or more said LED light package enclosures is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material.

Claim 10 the LED package of claim **3**, wherein;

said assembly of light sources is enclosed within a tube.

Claim 11 the LED package of claim **10** wherein;

said fins are shaped to provide mechanical support within said tube; and one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material.

Claim 12 the LED package of claim **10**, wherein;

said fins are shaped to provide mechanical support within said tube; and

one or more said LED light package enclosures is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material.

Claim 13 the LED package of claim **12** wherein;

one or more of said encapsulations are enclosed within a fluid-filled container.

Claim 14 the LED package of claim **1** wherein;

said one or more LED frames are formed of a sapphire or sapphire-like material.

Claim 15 the LED package of claim **14**, wherein;

said LED light package is connected to one or more other LED light packages serially or in parallel to form an assembly of light sources.

Claim 16 the LED package of claim **15**, wherein;

said assembly of light sources is enclosed within a lamp or bulb; and

one or more said enclosure is surrounded by a coating of appropriate yellow phosphor material.

Claim 17 the LED package of claim **15**, wherein;

said assembly of light sources is enclosed within a lamp or bulb; and

one or more said enclosure is surrounded by a heat-activated sleeve coated with the appropriate yellow phosphor material.

Claim 18 the LED package of claim **17** wherein;

one or more of said encapsulations are enclosed within a fluid-filled container.

Claim 19 A method for manufacturing an LED light source system, said method comprising;

placing one or more LED die chips on one or more adjoining LED frames;

connecting each said LED die chip electrically to the LED die chip before and after said LED die chip;

encapsulating said one or more LED frames within a single solid enclosure, allowing an electrical connection to the interior of said enclosure to connect to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end.

Claim 20 A method for manufacturing an LED light source system, said method comprising;

placing one or more LED die chips along rows on an area wafer,

connecting each said LED die chip electrically to the LED die chip before and after said LED die chip within a particular row;

separating each individual row of LED die chips into an individual sliver;

encapsulating one or more said slivers within a single solid enclosure, allowing an electrical connection to the interior of said enclosure to connect to the initial LED package located at said chain near end, and to the final LED package located at said chain distal end.

DRAWINGS:

Prior Art

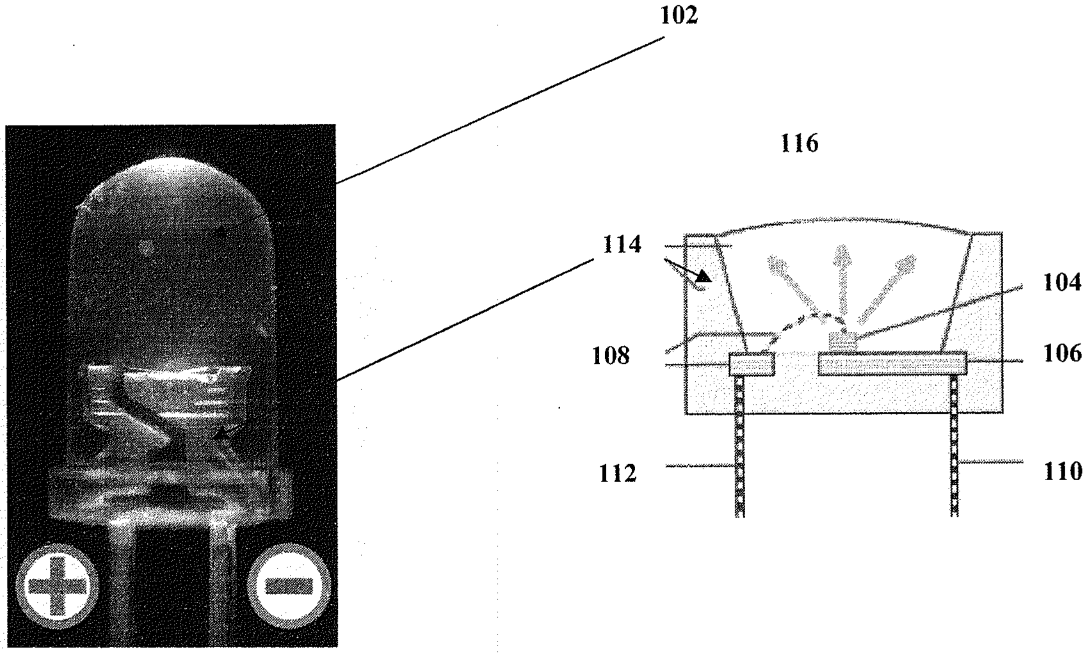


Figure 1A

Figure 1B

Prior Art

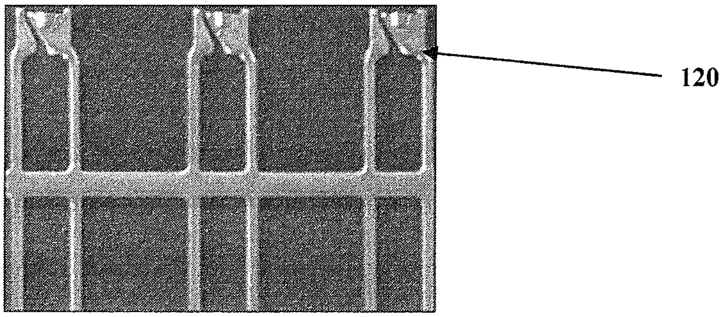
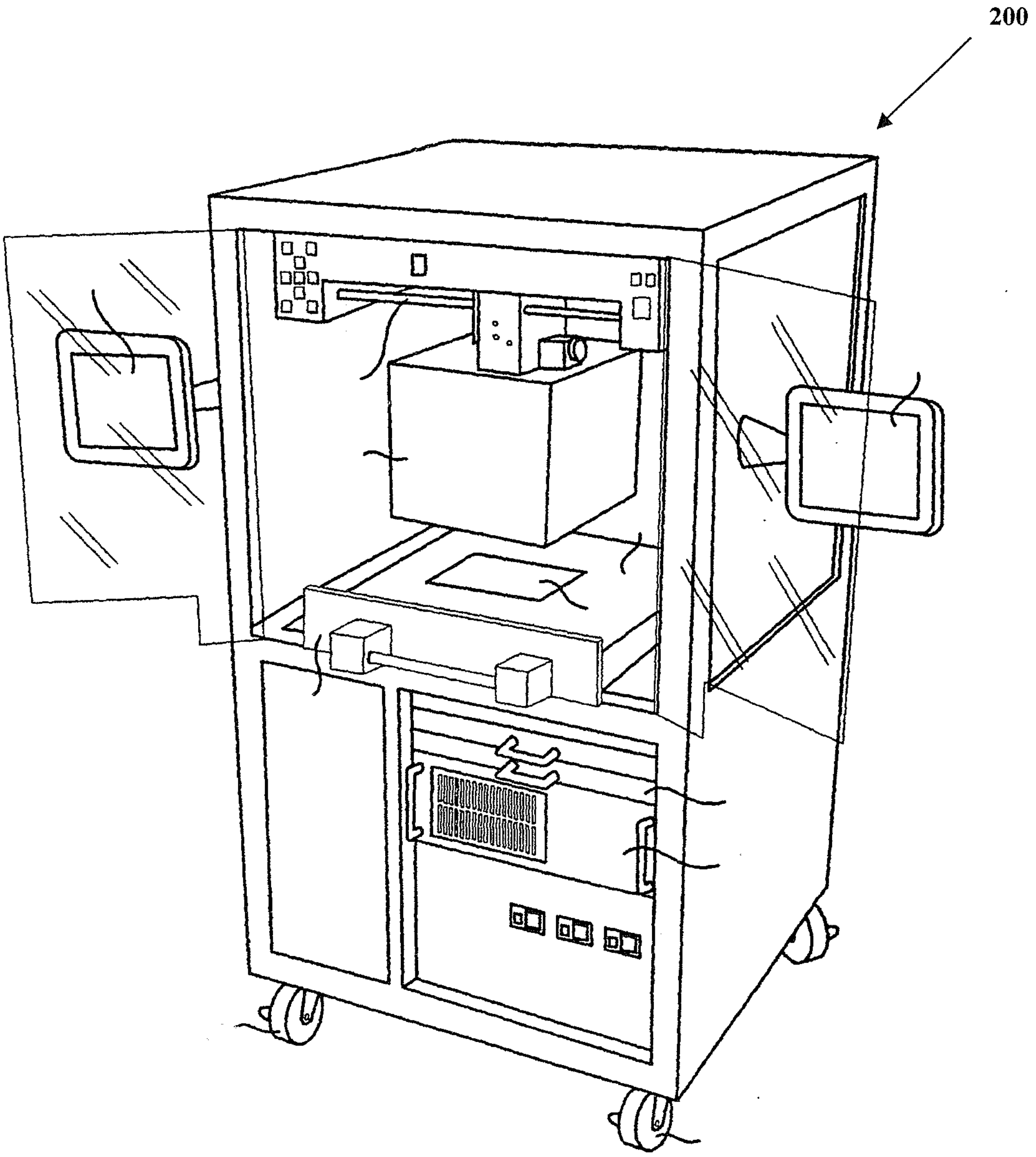


Figure 1C



Prior Art

Figure 2

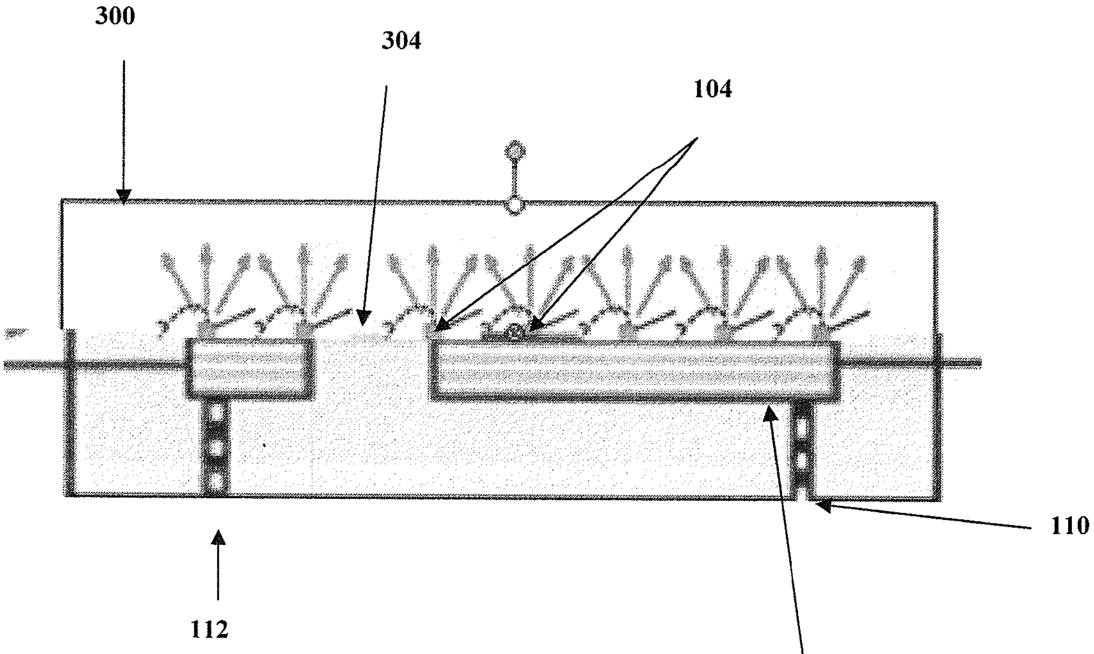


Figure 3A

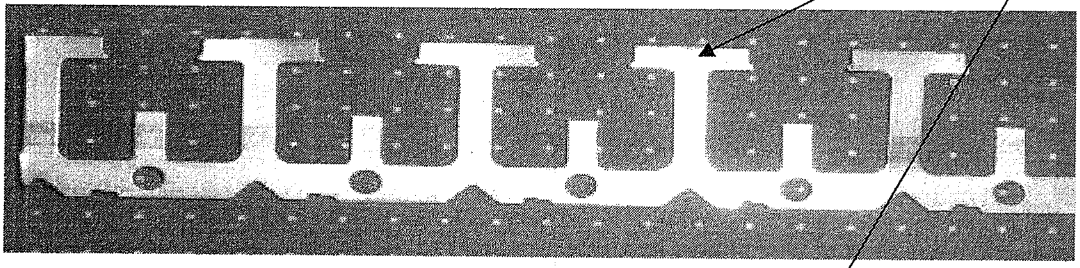


Figure 3B

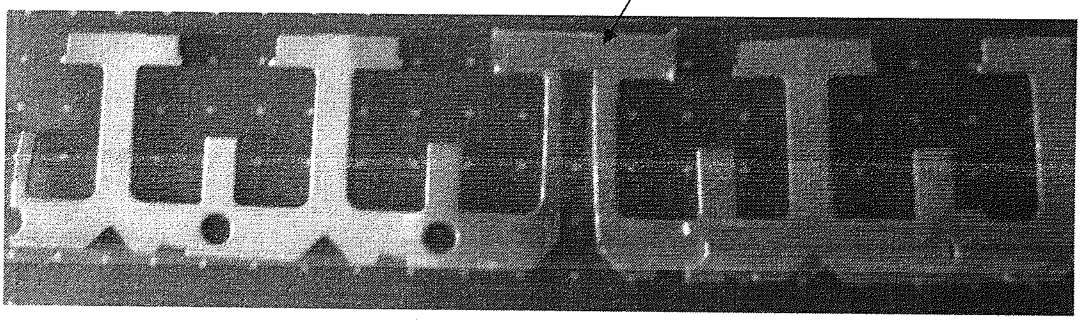


Figure 3C

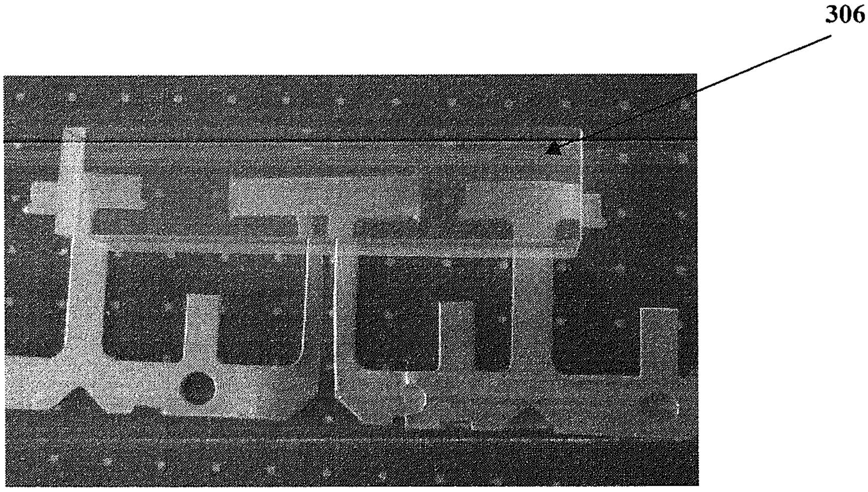


Figure 3D

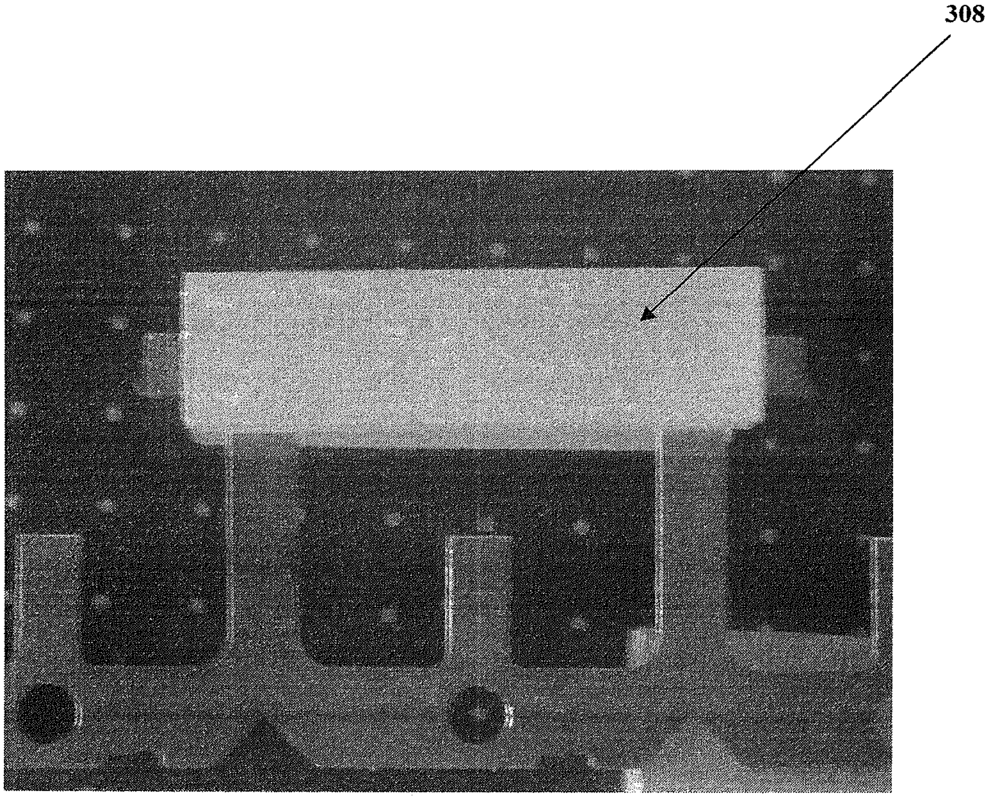


Figure 3E

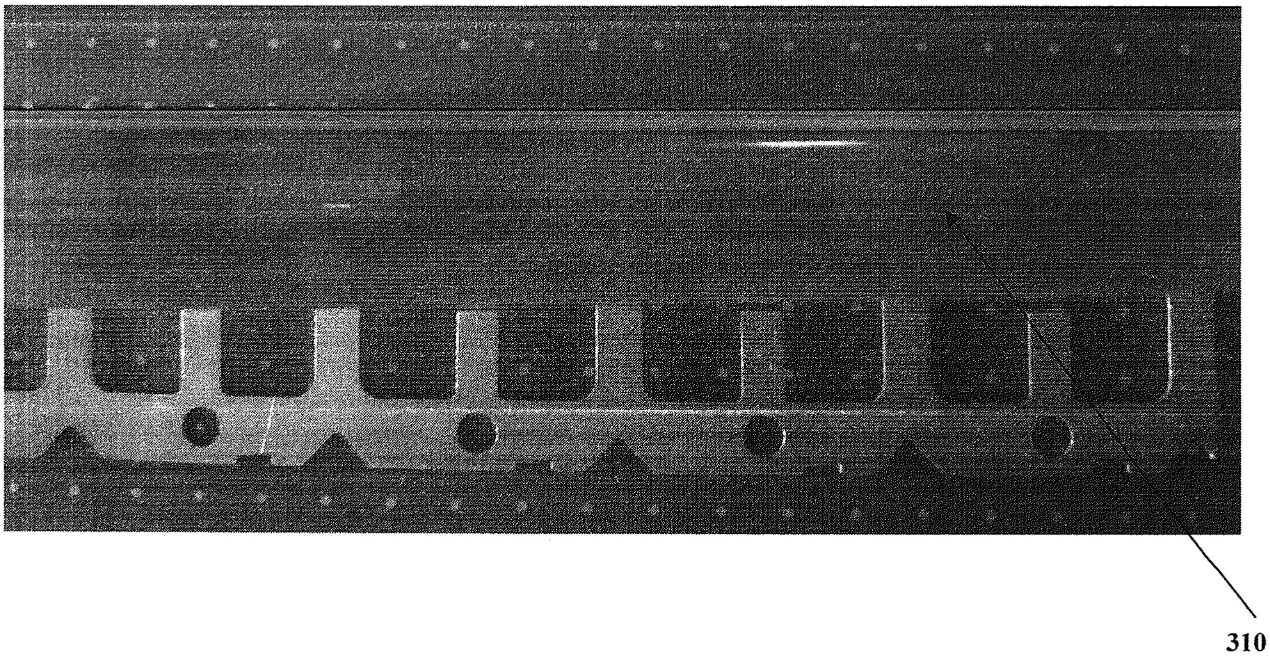


Figure 3F

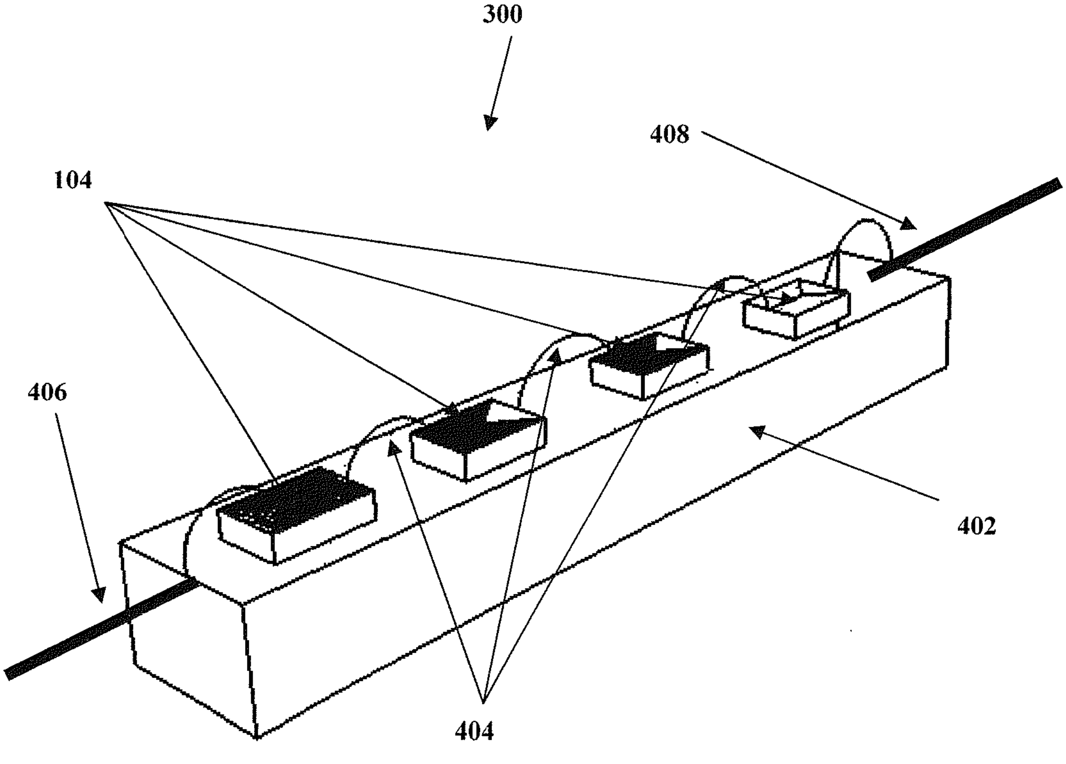


Figure 4

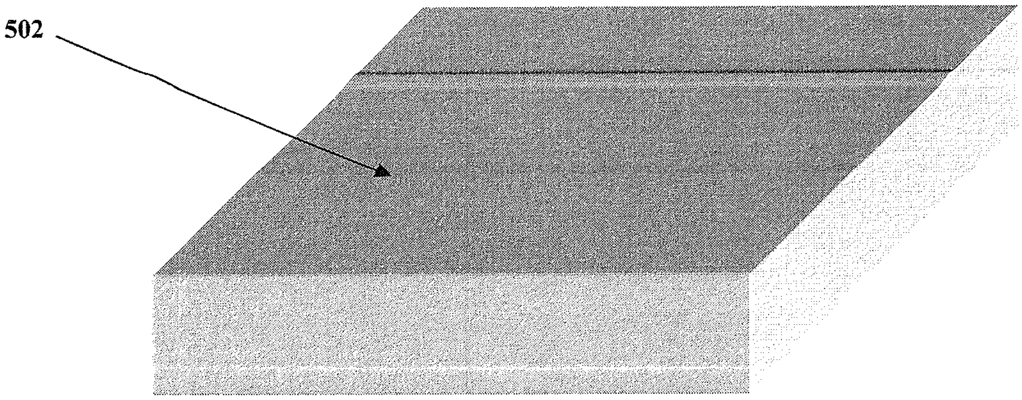


Figure 5

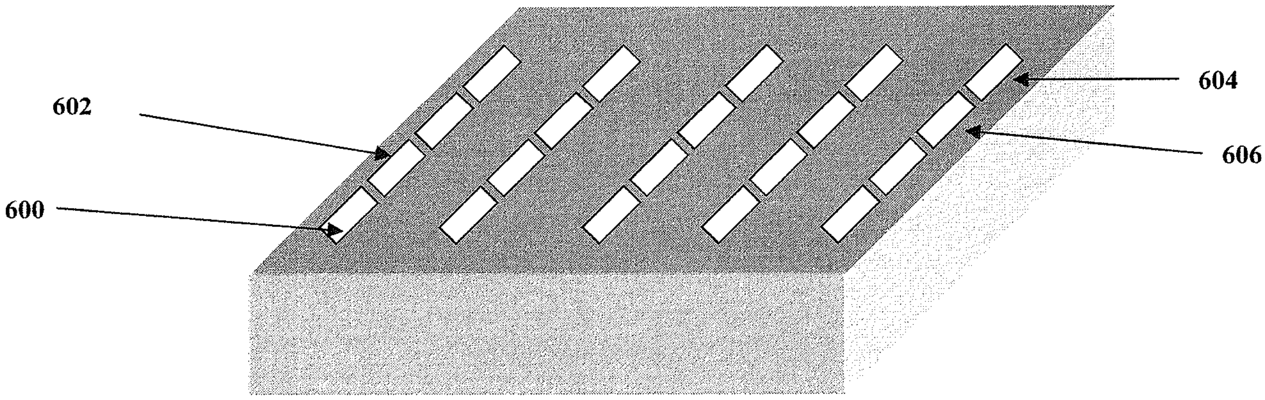


Figure 6

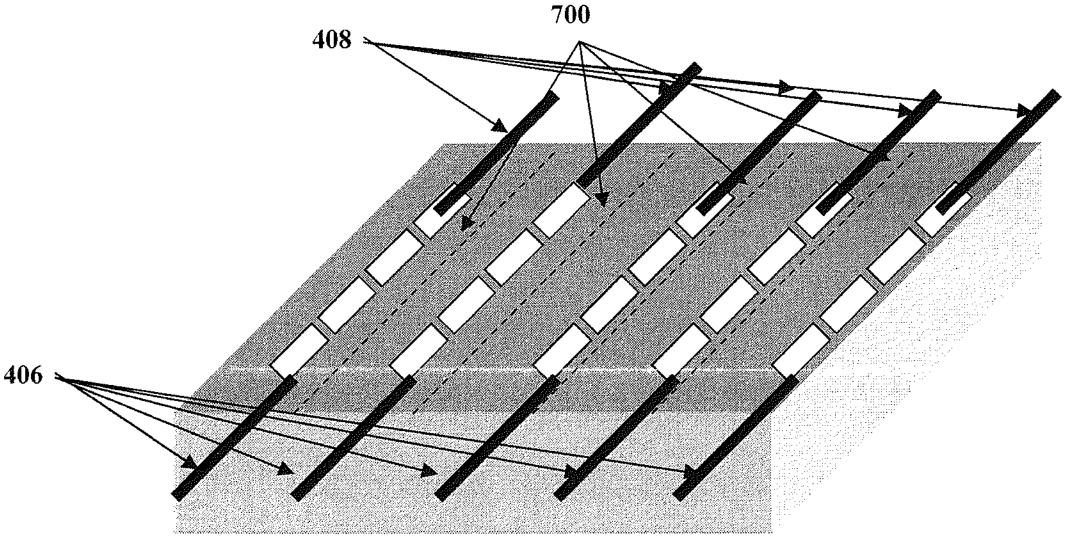


Figure 7

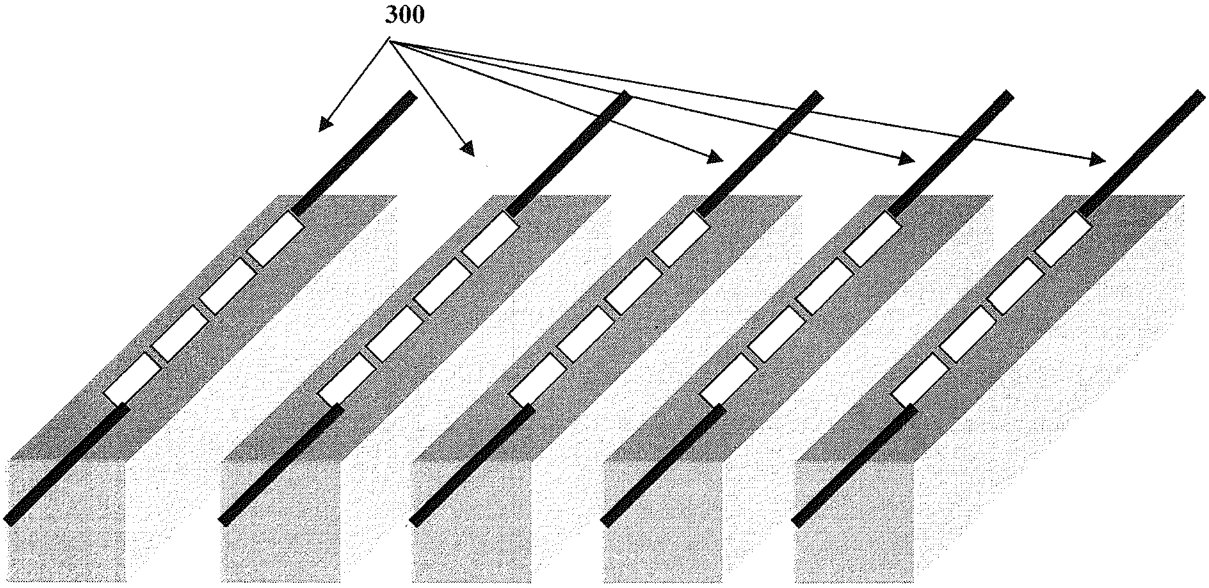


Figure 8

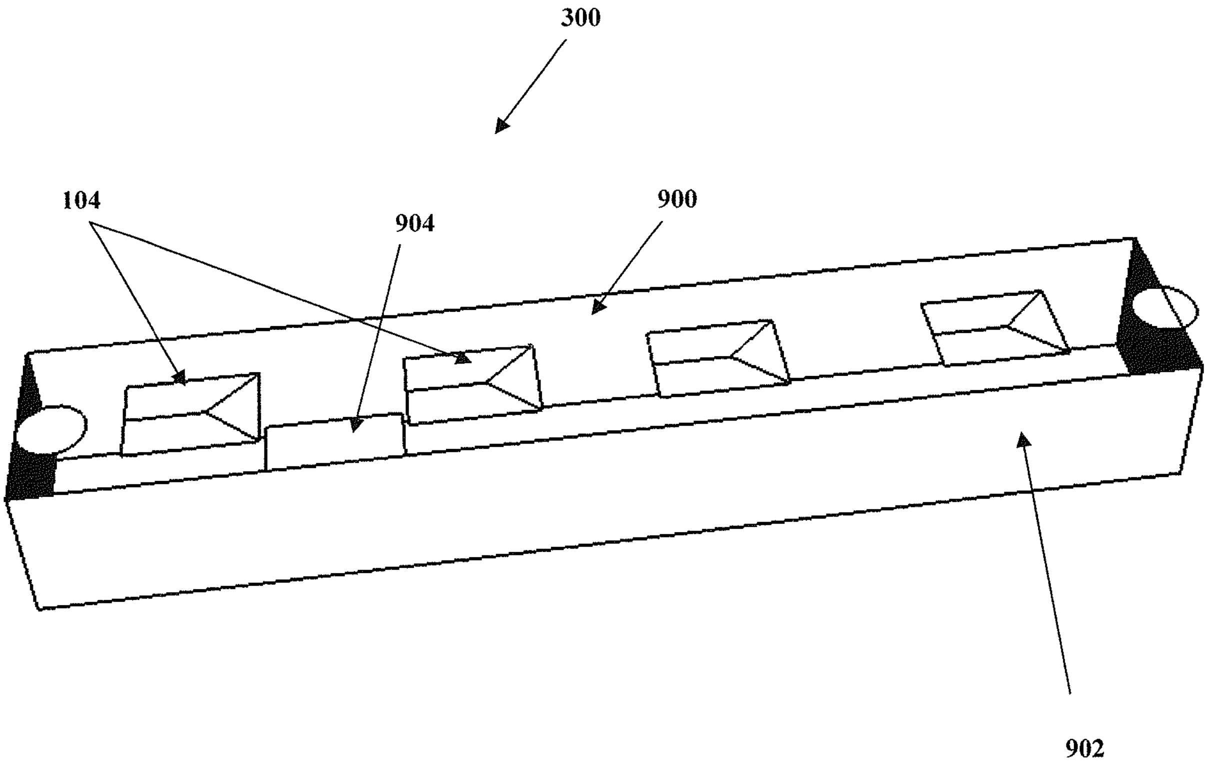


Figure 9

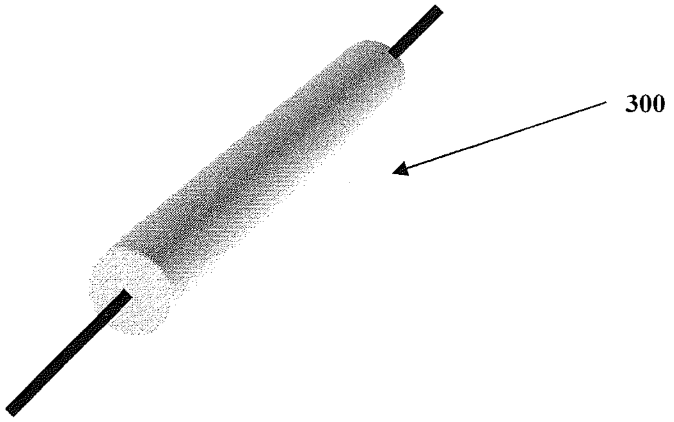


Figure 10

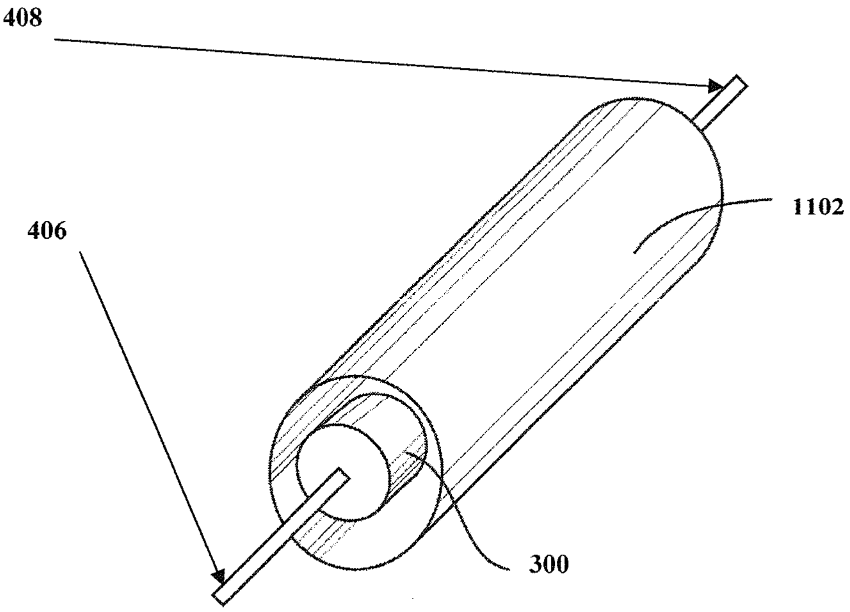


Figure 11

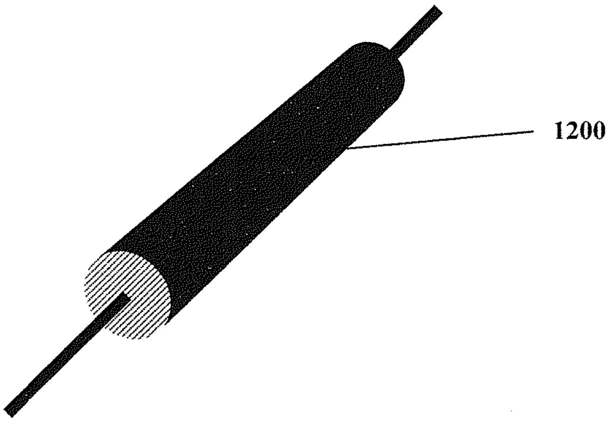


Figure 12

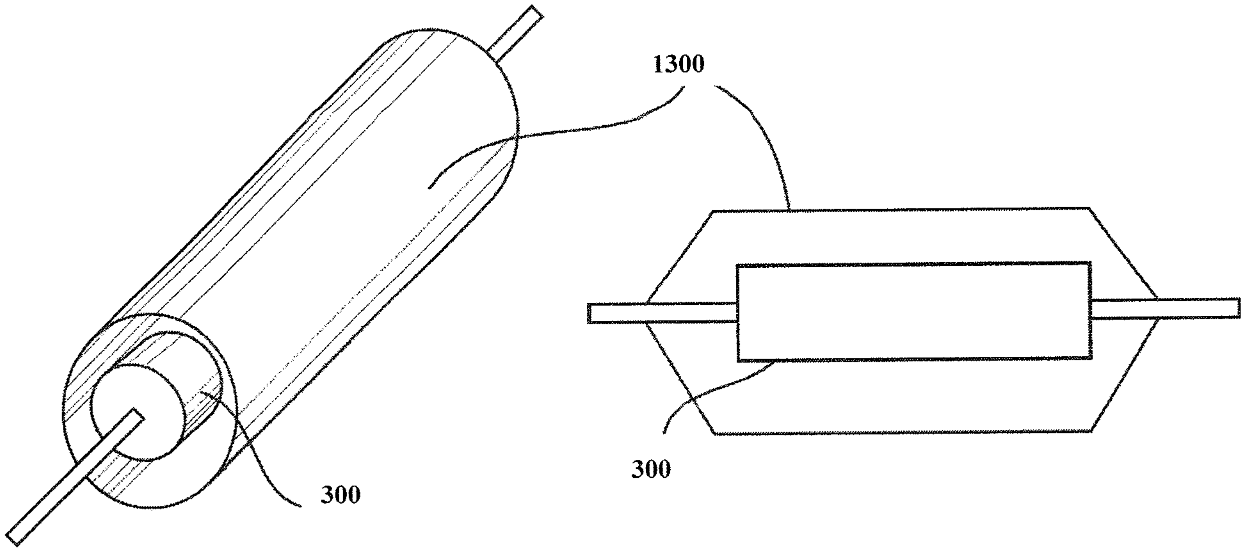


Figure 13

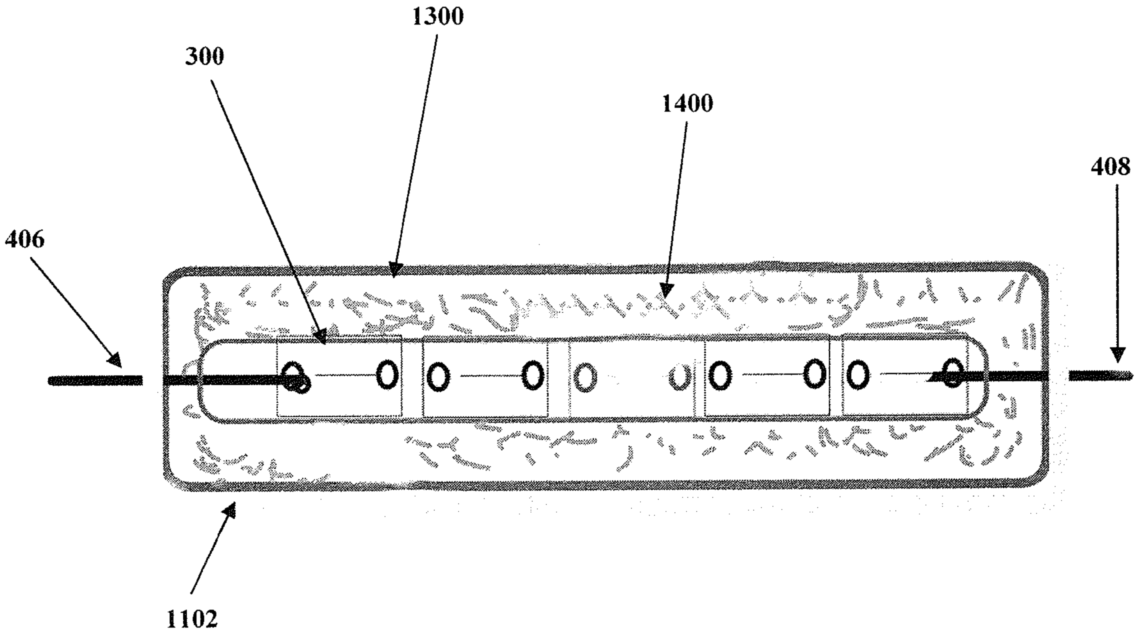


Figure 14

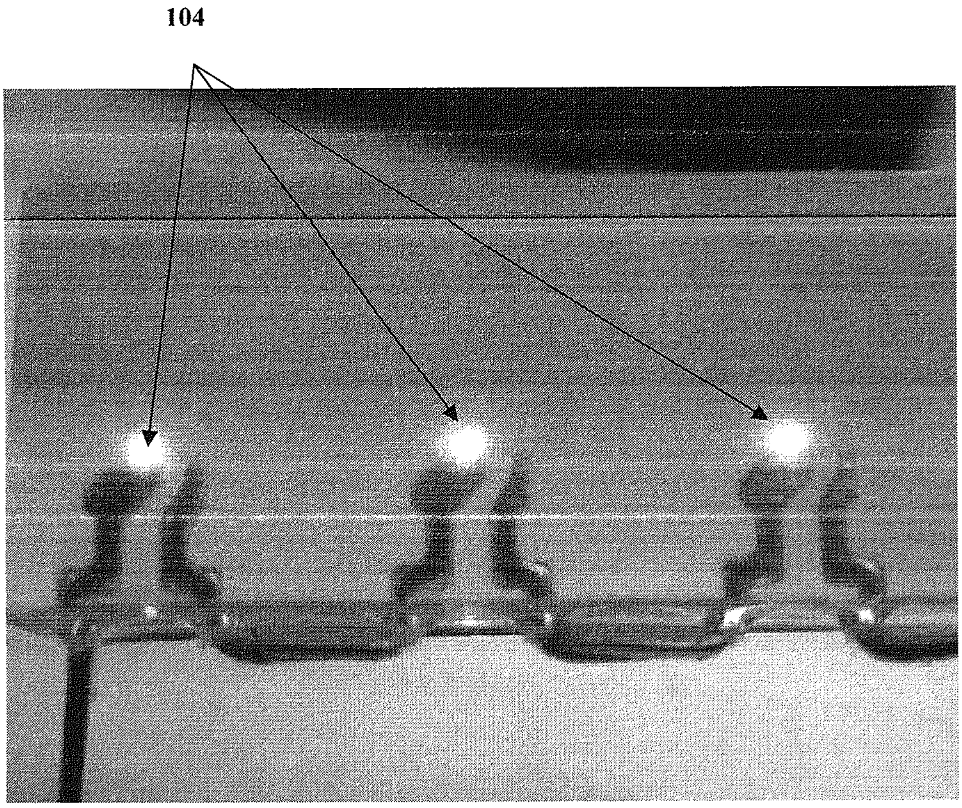


Figure 15

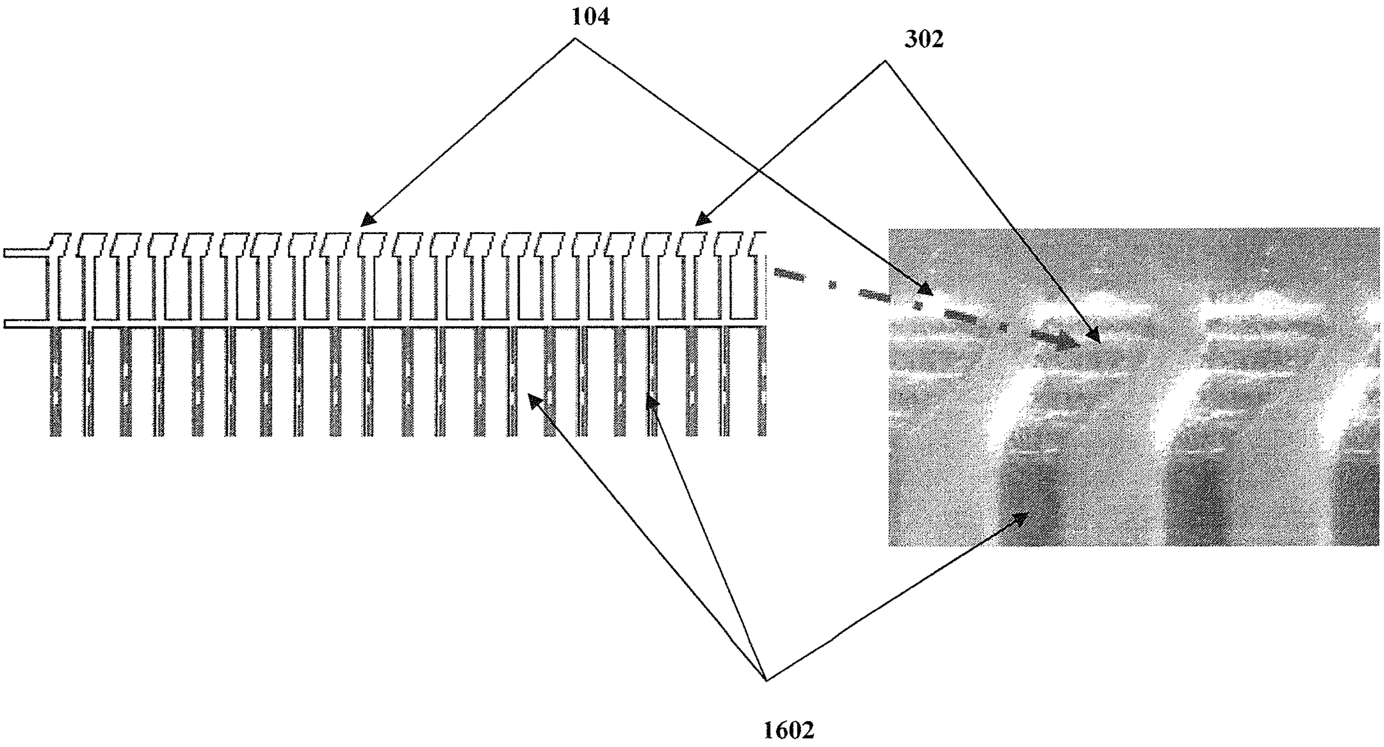


Figure 16

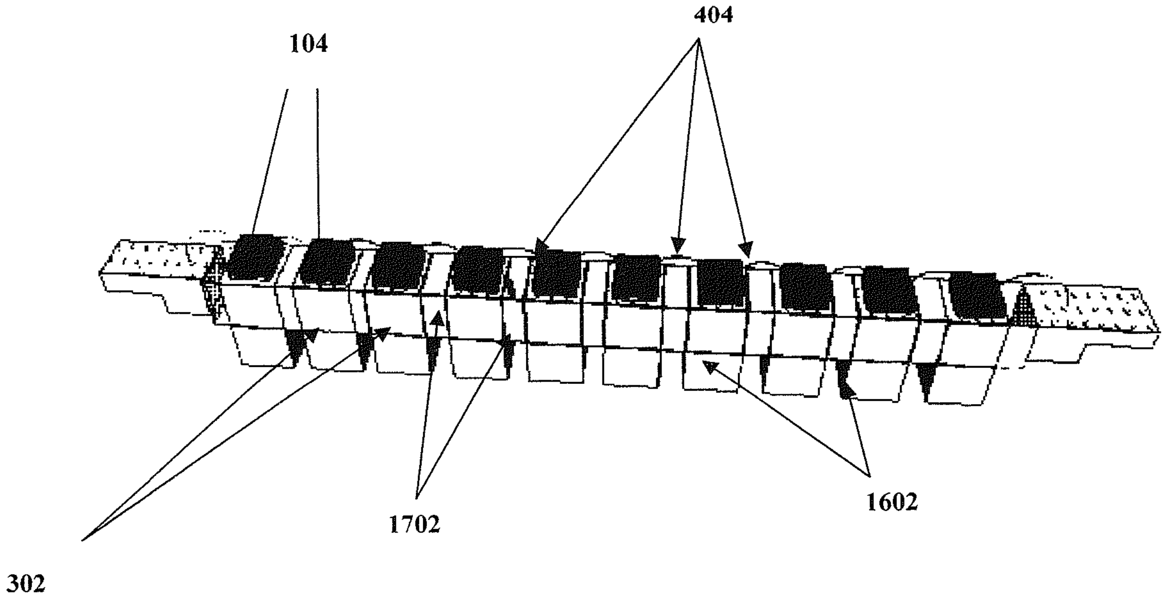


Figure 17

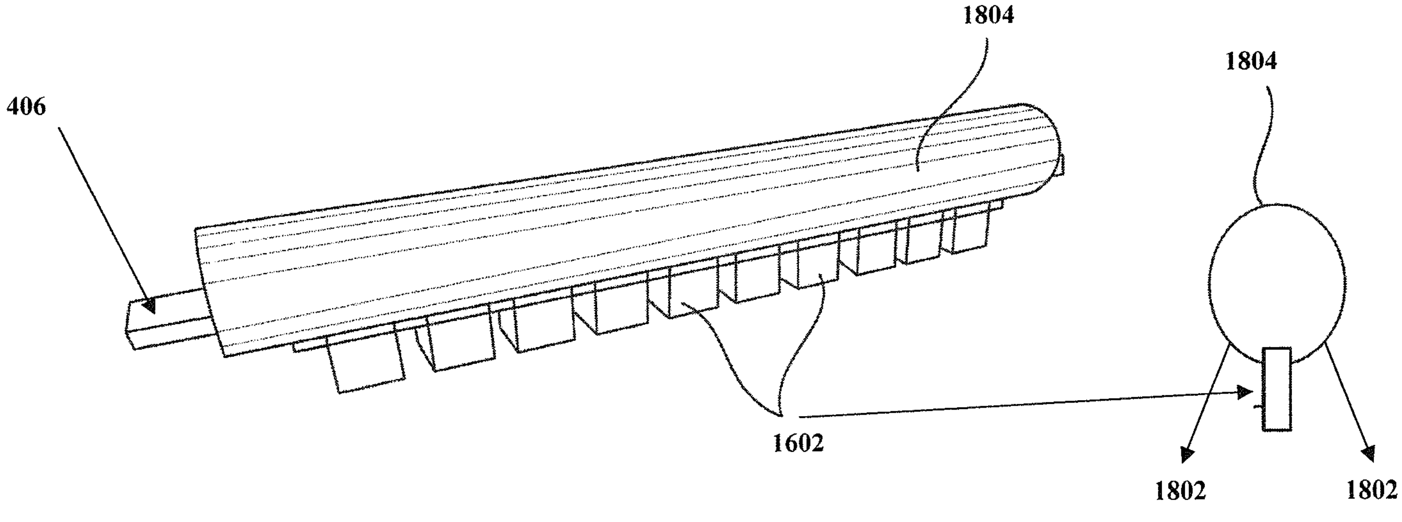


Figure 18

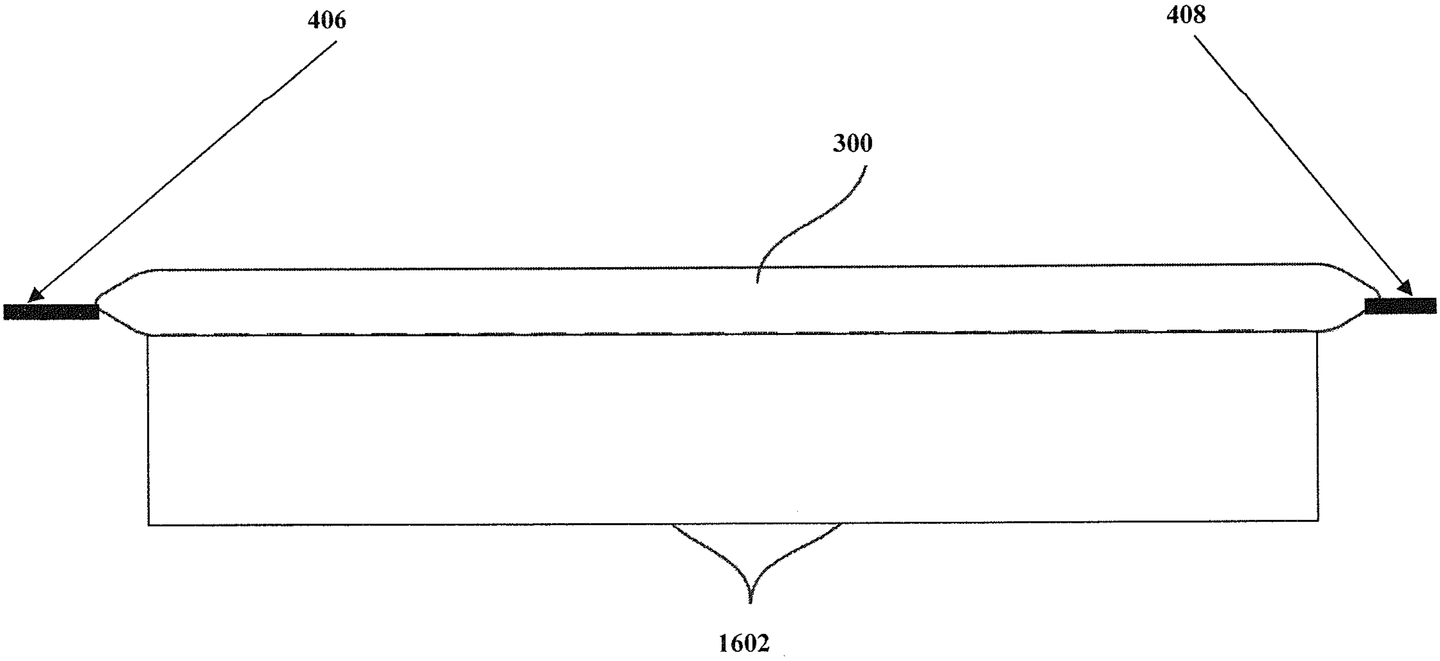


Figure 19

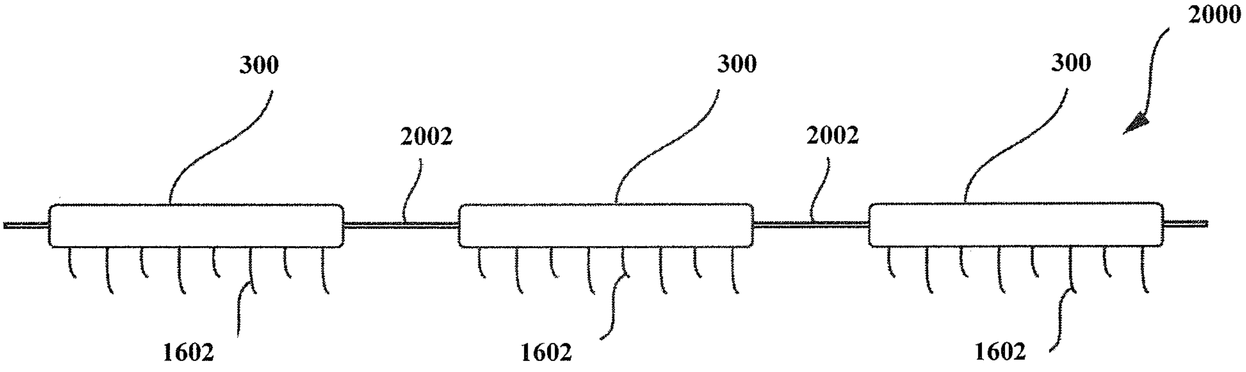


Figure 20

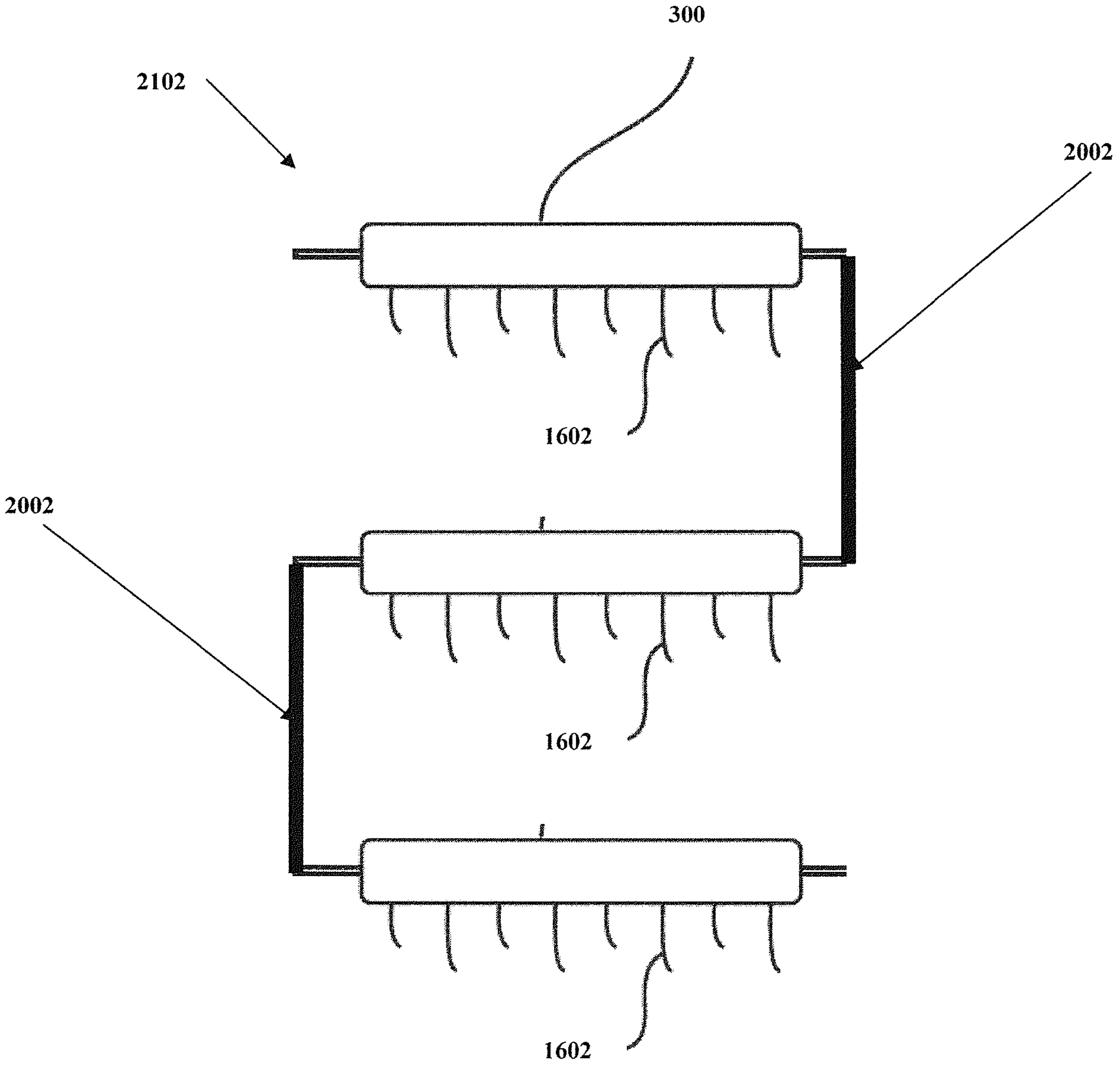


Figure 21

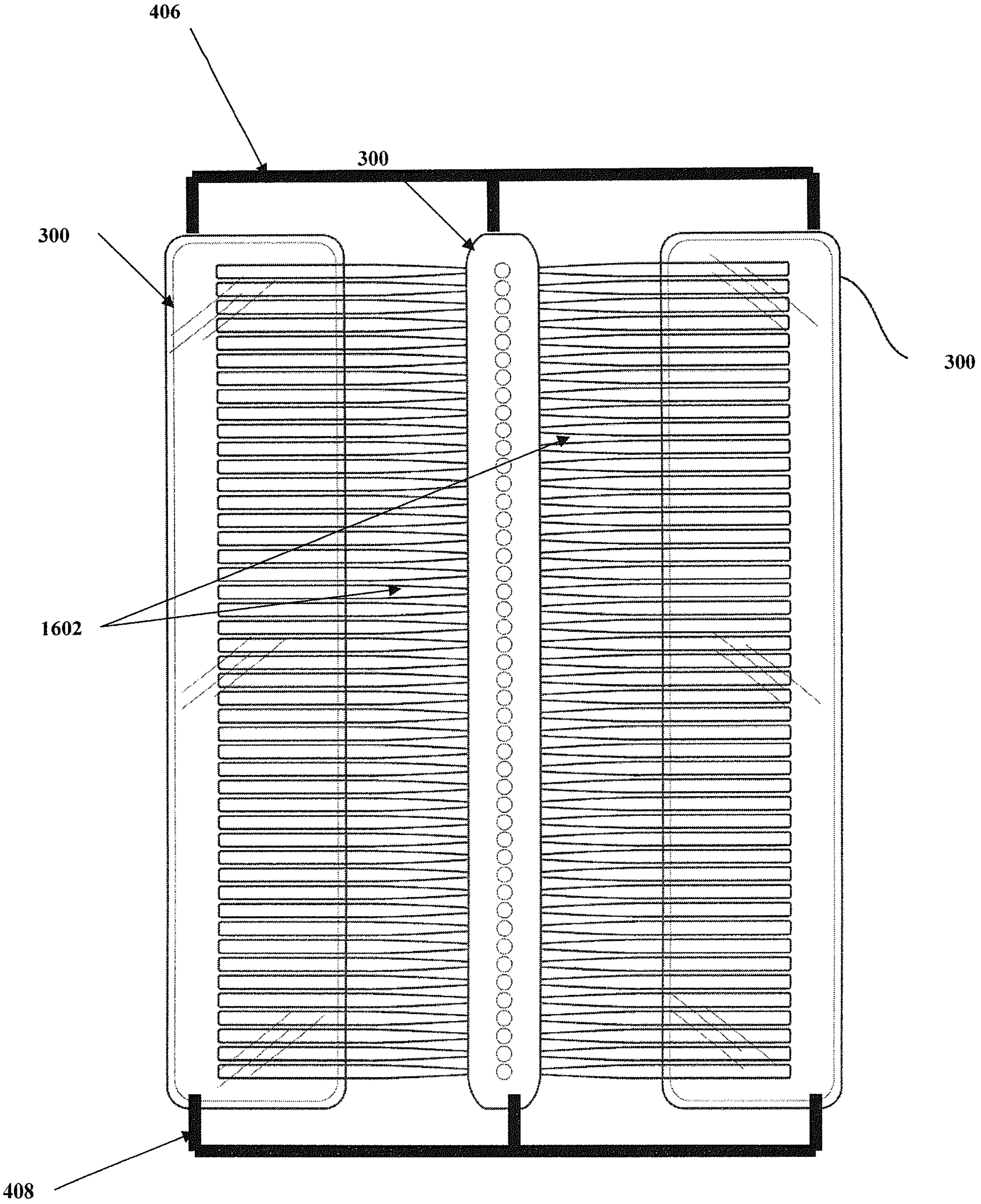


Figure 22

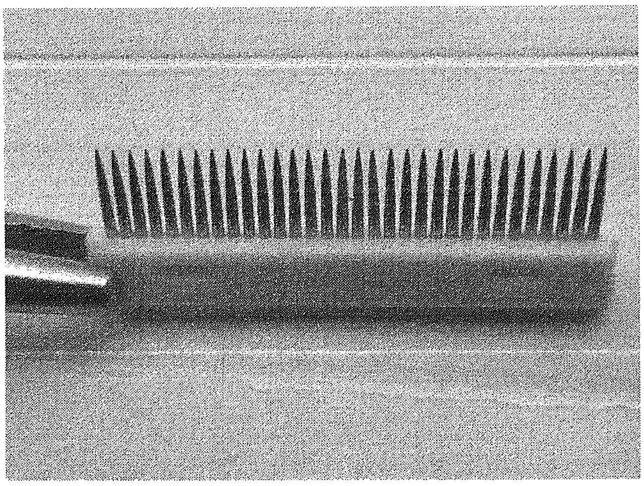


Figure 23

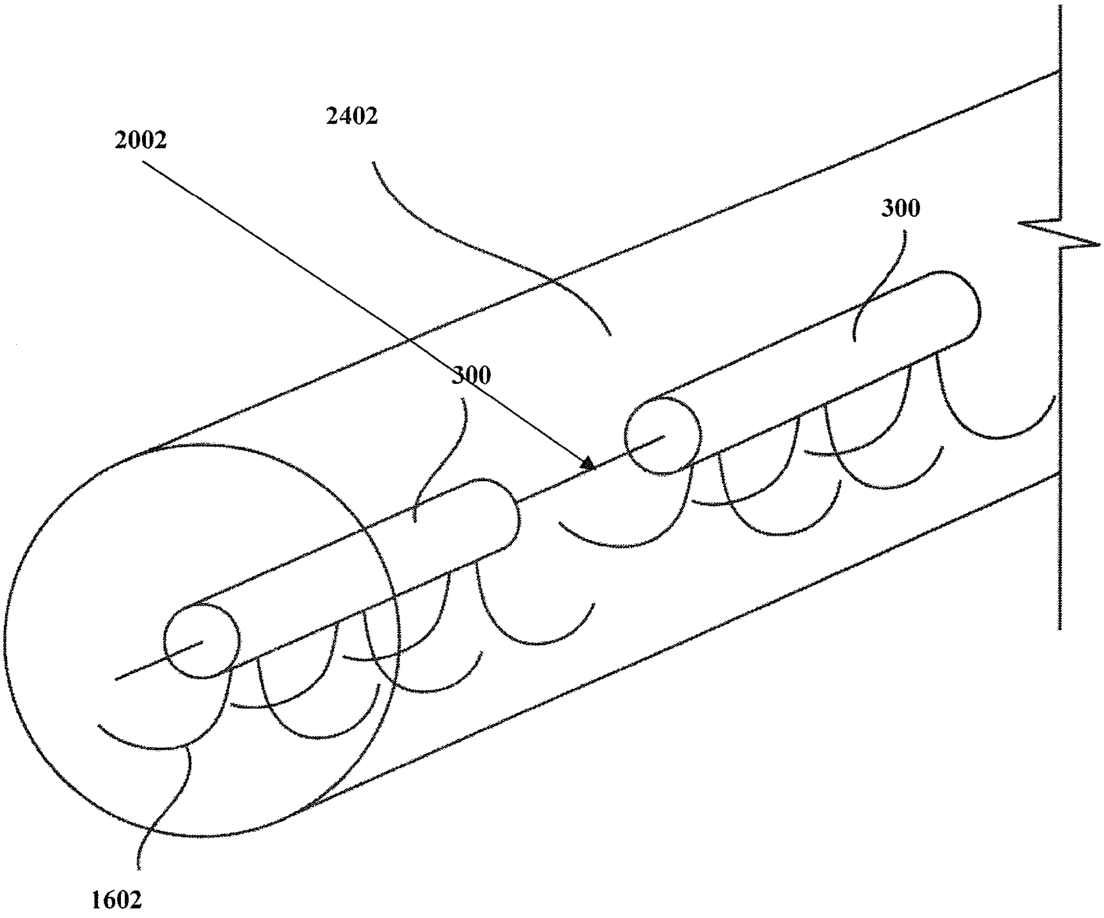


Figure 24

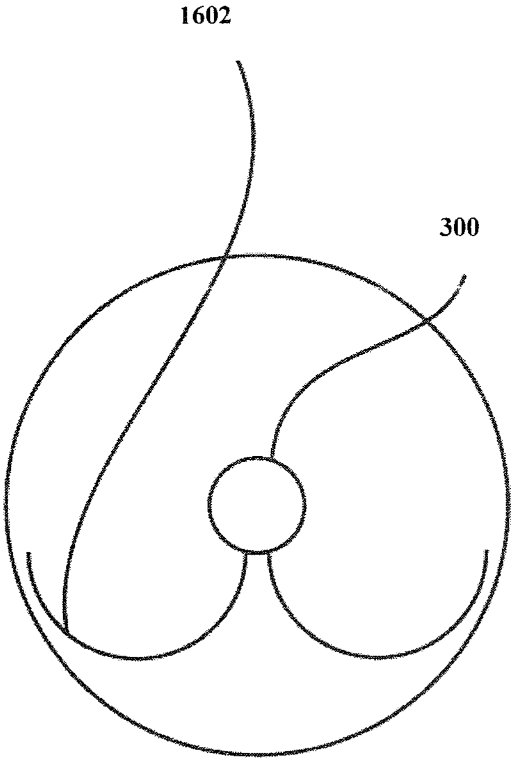


Figure 25

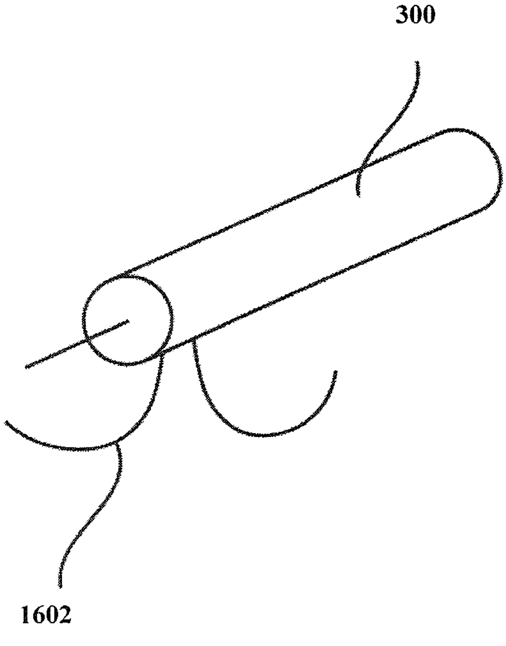


Figure 26

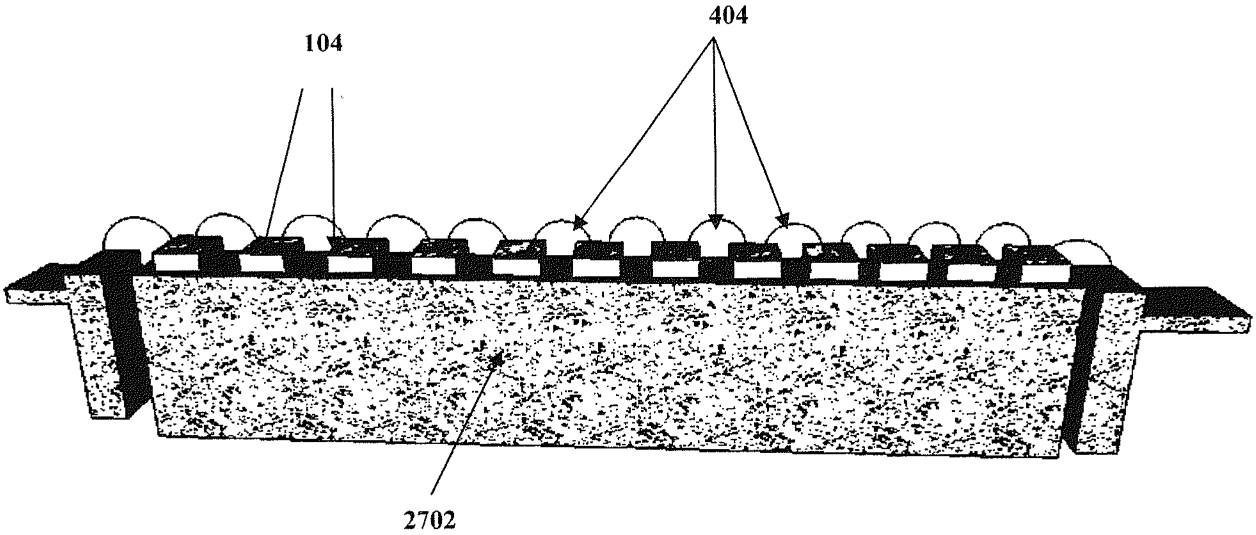


Figure 27

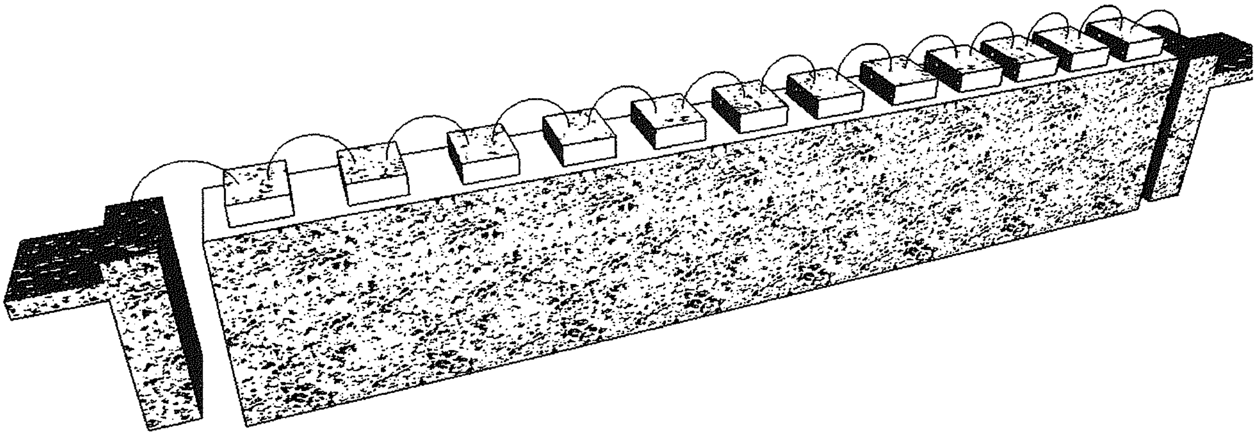


Figure 28

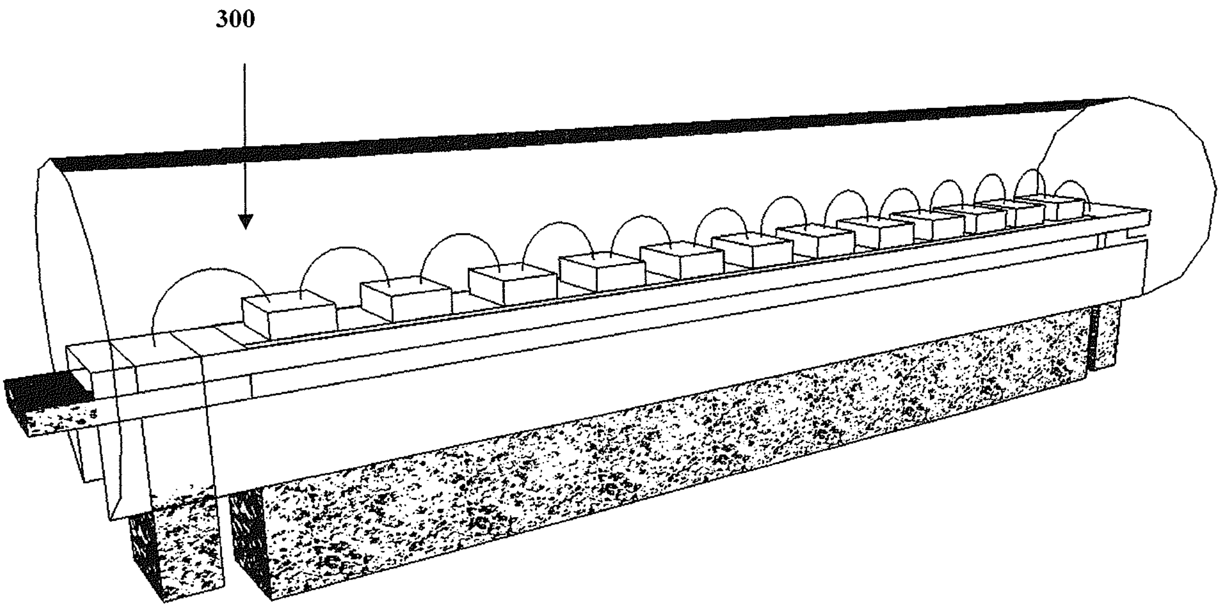


Figure 29

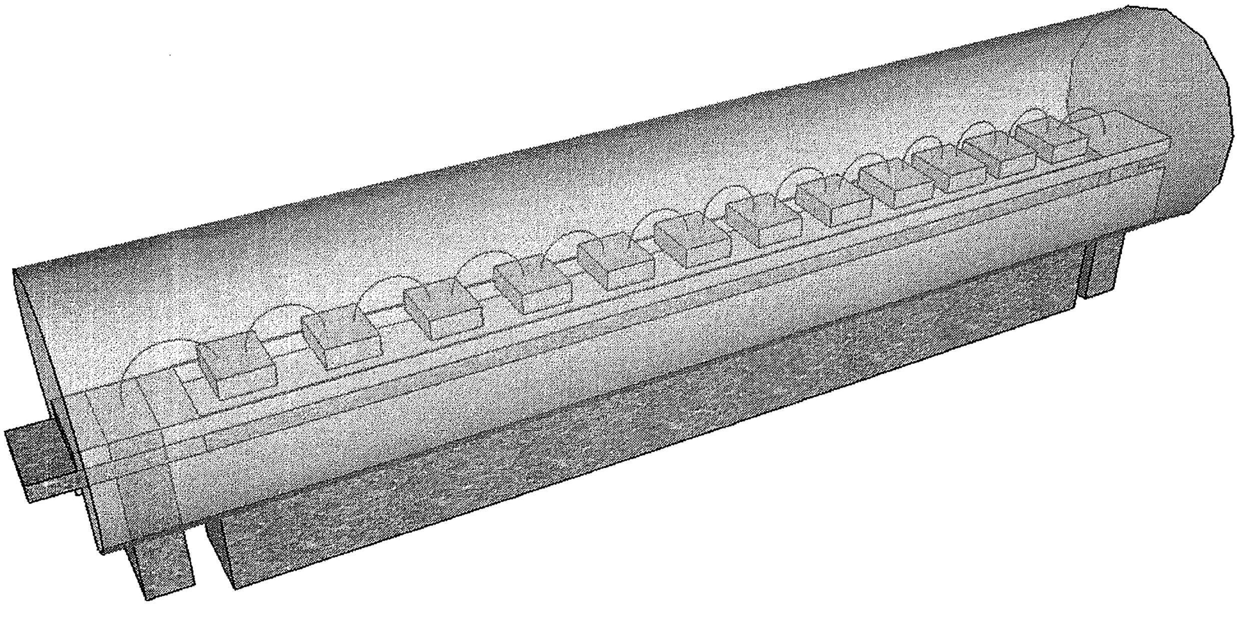


Figure 30

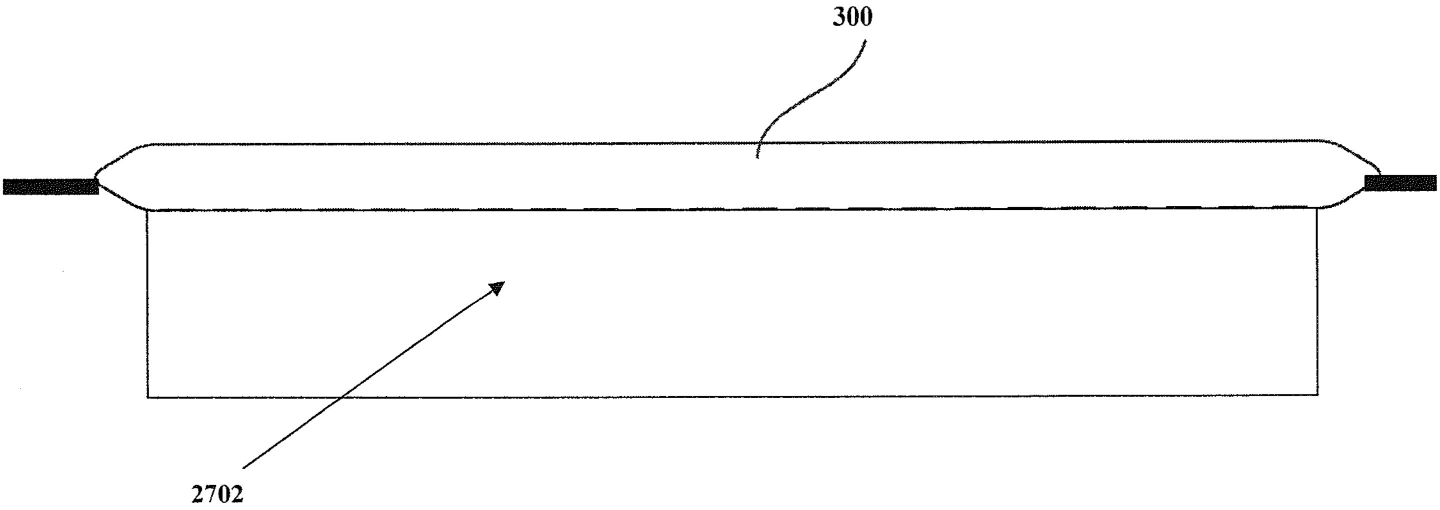


Figure 31

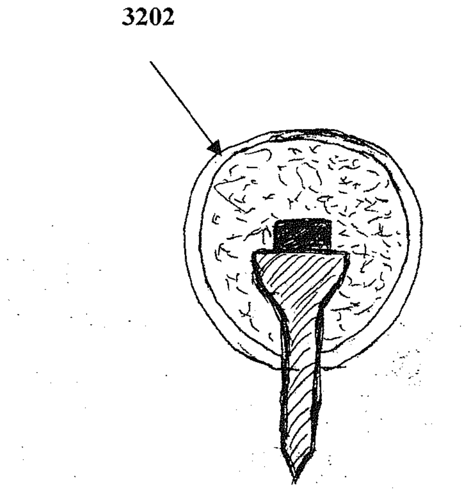


Figure 32

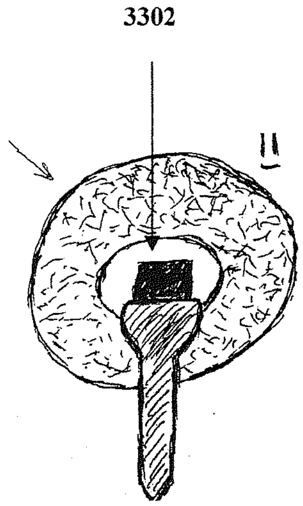


Figure 33

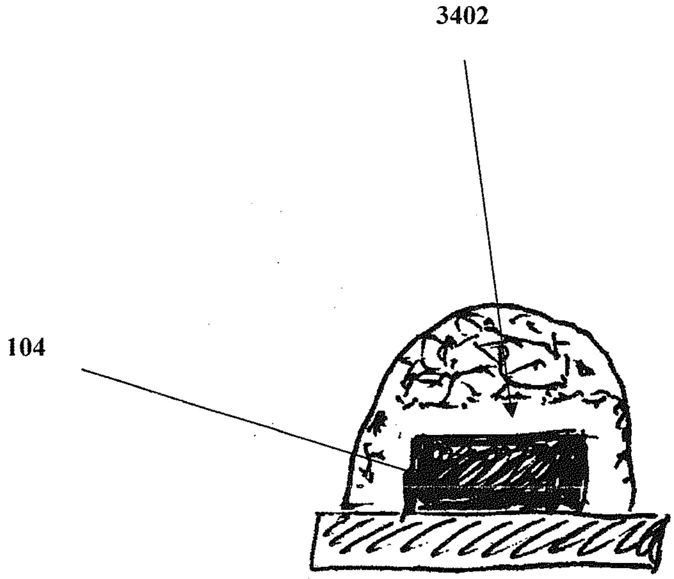


Figure 34

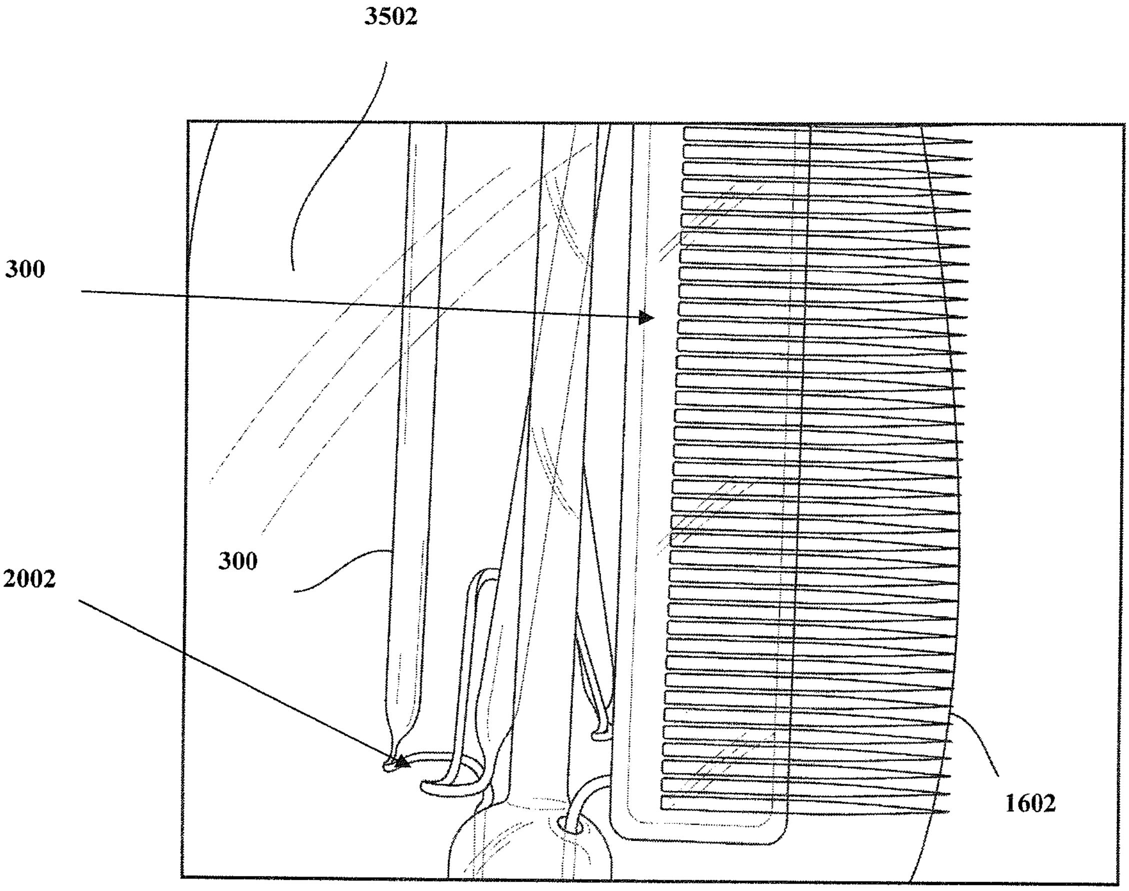


Figure 35

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2013/069455

A. CLASSIFICATION OF SUBJECT MATTER

H01L 25/075 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L 25/075, F21V 23/00, H01L 33/00, 25/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	CA 2810658 A1 (ZHEJIANG LEDISON OPTOELECTRONICS CO., LTD.) 15.03.2012, fig.1-16, claims	1, 20 2-5, 7-9, 11
Y	WO 2011/078506 A2 (SEOUL SEMICONDUCTOR CO., LTD. et al.) 30.06.2011, fig.1-6	2-5, 7-9, 11
A	US 2004/0066142 A1 (GELCORE, LLC) 08.04.2004	1-21
A	US 8093600 B2 (EVERLIGHT ELECTRONICS CO., LTD.) 10.01.2012	1-21

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

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