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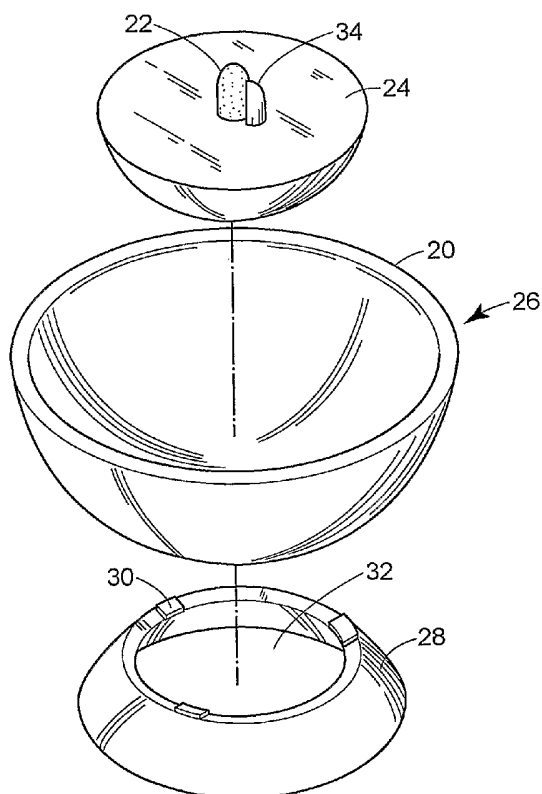
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[Continued on next page]

(54) Title: CANDLE ASSEMBLY



(57) Abstract: A candle assembly includes a melting plate, a wick holder, and a fuel element that fits over the wick holder. The wick holder engages the melting plate preventing the accidental removal thereof from the melting plate. The fuel element is configured to facilitate successful initial ignition and sustained burn of the wick by having a duct dimensioned to ensure that melted fuel material engages the wick when dripping down the duct. The fuel element may also contain an outer shell of fuel material surrounding an inner core of fuel material having different properties than the fuel material of the outer shell. The wick holder includes a wick extending from a sleeve. The sleeve having a constricted portion that reduces an effective capillary fluid flow capacity of the wick and may thereby regulate how quickly fuel is consumed when the candle assembly is burning. A capillary well disposed between the wick holder and the melting plate may be adapted to promote a successful relight after an initial burn of the candle assembly. The candle assembly, may be adapted to promote laminar air flow thereacross during a burn in a substantially calm atmospheric environment.



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CANDLE ASSEMBLY

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates generally to candle assemblies and more specifically to candle assemblies having a fuel element, a melting plate, and a wick holder.

Description of the Related Art

[0002] Clips which locate and secure wicks for candles and for devices which dispense vapors into the ambient air are well known in the art, and useful in many applications. In candles, such clips provide a means to position the wick for the most efficient provision of fuel, such as candle wax, to the flame, while in vapor dispensing devices, such wick clips secure a wick by which a vaporizable liquid is delivered from a reservoir to an exposed surface.

[0003] More recently, melting plate candles and simmer plate dispensers have been used to provide rapid melting of a solid fuel element and/or rapid dispensing of a vaporizable material to the atmosphere. In one melting plate candle, a dispenser for active materials has a melting plate dispenser of volatile or active materials comprising a wax fuel element, a consumable wick disposed in the wax fuel element, and a heat conductive base having conductive elements. Heat from a flame at the wick is transferred to the heat conductive base, which in turn helps melt the wax fuel element at locations other than directly adjacent to the flame. Another melting plate candle has a concave melting plate. A wick in a fuel element is located at a low point in the melting plate such that melted fuel material on the melting plate is directed by gravity toward the wick.

[0004] In these melting plate candles, it is possible that the wick holder assembly, comprising the wick and wax puck, i.e. the fuel, may fall out of the container if the container or candle holder is tipped excessively, or turned on its side, and it may be difficult to precisely

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position the wick holder along the bottom of the candle container. In addition, in each of the aforementioned melting plate candles, the melted wax is allowed to flow up the wick by uncontrolled capillary action, which may cause the candle to burn brighter than necessary or consume the wax faster than desired.

[0005] Candle fuel charges adapted for use with candle assemblies having a plurality of distinct constituents are often used to provide decorative and functional benefits. For example, some candles have a solid outer shell of a first wax surrounding a solid inner core of a second wax having a lower melting temperature than the first wax. The second wax includes a soft mixture of fragrance oil and a carrier, such as petrolatum or a low melting point wax. When a wick disposed in the inner core is burned, the first wax of the inner core is melted and burned, and the second wax of the outer shell contains the molten first wax therein. In one such candle, the solid outer shell may be refilled with replacement paraffin beads placed around a replacement wick after the original inner core wax is consumed.

[0006] Other multi-constituent candle fuel charges have gas bubbles, glass spheres, glitter, and/or other types of decorative materials entrained in a gel fuel material contained in a non-flammable container. Often the decorative materials are entrained into the gel fuel material while the gel fuel material is still molten immediately after being poured into a mold. The bubbles, glass spheres, and/or glitter are dispersed throughout and encapsulated by a substantially solid matrix of the gel fuel material after the gel fuel material cools below the melt temperature thereof. Different colorants and fragrances may be added to each layer of gel fuel material to create a multi-fragrance candle.

[0007] Yet other multi-constituent candle fuel charges have a glass vial containing fragrance oil partly embedded in a wax body parallel to and spaced from a wick. An open end of the glass vial extends upwardly from a top surface of the wax body through which the wick extends. Heat from a flame located at the wick warms the fragrance oil and disperses fragrance to the surrounding atmosphere without burning the fragrance oil.

[0008] In another multi-constituent candle, wax prill, i.e., wax pellets ranging in size between 500 microns and 2000 microns, embedded with scented volatile actives is compressed in a compression mold into a multi-layered candle. At least one layer has a different

color than an adjacent layer thereto. A smooth or textured outer surface finish may be created by applying a heat source to the compression mold while the candle is being compressed or by applying an overdip coating.

SUMMARY OF THE INVENTION

[0009] In one aspect of the invention, a candle assembly includes a meltable fuel element, a melting plate comprising a heat conductive surface upon which the meltable fuel element rests. The candle has a wick retainer positioned on the melting plate comprising at least one of a pedestal that cooperatively and lockingly engages a base portion of the wick holder or a magnetic means that engages and magnetically retains the wick holder so as to prevent accidental removal from the melting plate. The wick holder has a wick and the wick holder is adapted to conduct heat from a flame optionally disposed on the wick to the melting plate and engage the meltable fuel element.

[0010] In another aspect of the invention, a meltable fuel element adapted for use with a candle assembly having a wick retainer to engage or retain a wick holder includes a body of substantially solid fuel material defining a duct adapted to receive a wick therethrough in an assembled condition. The duct has a first width adapted to ensure that liquid passing through the duct engages the wick in the assembled condition.

[0011] In a further aspect of the invention, a method of supplying liquefied fuel to a wick in a candle assembly includes melting a portion of a meltable fuel element into the liquefied fuel by direct convection from a flame on the wick and by conduction of heat from the flame to a melting plate supporting the meltable fuel element, collecting the liquefied fuel into a pool on the melting plate, delivering the liquefied fuel from the pool to the wick, and introducing a fuel additive that slows capillary flow of liquid fuel through the wick into the pool after the pool has been formed.

[0012] Other aspects and advantages of the present invention will become apparent upon consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 illustrates a melting plate candle of the prior art, in simplified isometric view;

[0014] FIG. 2 illustrates the melting plate candle of FIG. 1, in simplified cross-section;

[0015] FIG. 3A is a simplified isometric view of a melting plate candle holder, including a melting plate and a capillary pedestal;

[0016] FIG. 3B is a partially exploded isometric view of a melting plate candle assembly showing a fuel element and a candle holder according to one embodiment of the invention;

[0017] FIG. 4A is a cross-sectional view of one embodiment of a melting plate candle assembly, showing a candle holder, a melting plate, a wick clip assembly, and a fuel element in an assembled position according to one aspect of the present invention;

[0018] FIG. 4B is a partial cross-sectional view of the melting plate candle assembly of FIG. 3B;

[0019] FIG. 5A is an exploded isometric view of a melting plate candle assembly according to another embodiment of the present invention having a capillary pedestal, with a wick holder with fins and incorporated wick, and a fuel element;

[0020] FIG. 5B is an exploded isometric view of a melting plate candle assembly according to yet another embodiment of the present invention having a capillary pedestal, with a wick holder with fins and incorporated wick, and a fuel element;

[0021] FIG. 6 is an isometric view of the assembled melting plate, wick holder, and fuel element of FIGS. 5A and 5B;

[0022] FIG. 7 is an exploded isometric view of a candle assembly according to another aspect of the present invention;

[0023] FIG. 8 is an enlarged isometric view of a wick holder shown in FIG. 7;

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- [0024]** FIG. 9 is a cross-sectional view of a fuel element along the line 9-9 of FIG. 7;
- [0025]** FIG. 10 is a cross-sectional view generally transverse to line 9-9 of FIG. 7 with the candle assembly in assembled form;
- [0026]** FIG. 11 is an enlarged partial cross-sectional view along the line 11-11 of FIG. 10;
- [0027]** FIG. 12 is an enlarged isometric view of a wick holder and a portion of a melting plate according to yet another aspect of the invention;
- [0028]** FIG. 13 is an isometric view of still another wick holder according to the present invention;
- [0029]** FIG. 14 is an enlarged cross-sectional view of the wick holder shown in FIG. 12 in a similar view as shown in FIG. 11;
- [0030]** FIG. 15 is an isometric view of a candle holder according to another aspect of the present invention.
- [0031]** FIG. 16A is a partial cross-sectional view of a melting plate assembly as seen along the lines 16-16 of FIG. 6, but with a fuel charge according to another embodiment of the present invention;
- [0032]** FIG. 16B is a partial cross-sectional view similar to that of FIG. 16A of a fuel charge according to yet another embodiment of the present invention;
- [0033]** FIG. 17 is a cross-sectional view of the fuel charge as seen along the lines 17-17 of FIG. 16B;
- [0034]** FIG. 18 is an isometric view of a fuel element according to a further embodiment of the present invention for use with the melting plate candle assembly of FIG. 5; and
- [0035]** FIG. 19 is a cross-sectional view of the fuel element of FIG. 18 as seen along the lines 19-19.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Ordinary candles comprise a vertical, self-supporting body or column of wax, with a substantially horizontal top and a central longitudinal wick which extends through and above the wax. The exposed portion of the wick above the solid wax is lighted by a flame, and the heat generated by the flame melts a small volume of the wax at the top of the candle, adjacent the wick, establishing a puddle or reservoir of molten wax to serve as fuel for the flame on the wick, and to release any volatile actives present therein. The capillary attraction of the molten wax and the wick, which is generally a structure of closely related fibers, causes the molten wax to travel through the wick to the flame, by which it is consumed. As the wax is consumed in this manner, the body of wax diminishes and the top surface thereof progressively lowers. The upper portion of the wick, extending above the lowering wax, is generally consumed by the flame. The flame in such a candle remains in the same position relative to the horizontal center of the candle, but decreases in height relative to the surface upon which the candle rests, from the start to the end of the burn, at which time all or at least most of the wax has been consumed.

[0037] Also well known are such candles as votive candles and tea lights. For purpose of discussion, tea lights shall be considered to be relatively small candles in which a body of paraffin is located in a closely fitted container, such as an aluminum tray configured to fit closely about the body of paraffin, having a wick centrally disposed, while votive candles shall be considered to be candles of similar size provided without a container. At the lower end of the wick is typically found a wick clip having a flat horizontal bottom surface, which functions to retain the wick in its perpendicular position, even as the paraffin is melted and liquefied by the heat of the flame. In most such votive candles and tea lights, the wick is a cotton material saturated with paraffin, and burns with the paraffin, thus being consumable. In such candles, or lights or warmers employing the same, the visible flame moves lower, or closer to the bottom surface of the container as the fuel and wick are consumed, down to the level of the bottom of the wick. Further, after consumption of all of the wax above this point in the unit, the container (of the tea light), the unburned wax, and the wick clip remain to be disposed of by the consumer. As a safety consideration in such candles, the wick is normally

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crimped or terminated at a point about 0.25 inches above the bottom of the wax, so as to cause the flame to extinguish above the bottom of the container, and to thus prevent the heat of the flame from reaching the surface upon which the candle is positioned, preventing damage to such surface, and reducing the likelihood of igniting possible contaminants such as burnt matchsticks remaining at the bottom of the candle, or carbonaceous remains of the consumable wick. Such an arrangement also has the detriment of leaving a small volume of unburned wax in the bottom of the container when the flame extinguishes.

[0038] As utilized herein, the term melting plate candle shall encompass the combination of a solid fuel element and a heat conductive container or holder for the fuel. The terms fuel container and fuel holder shall be meant to encompass a support plate or melting plate comprising means to contain and melt the fuel element, and a wick holder engaging a wick and said support plate, said wick holder comprising heat conductive elements, such as fins, referred to hereinafter as either wick fins or heat fins. Said wick holder shall also encompass a base having a skirt or legs configured to engage a complementarily shaped pedestal portion of the support plate, and to transfer heat from a flame upon said wick to said melting plate. Thus, the support plate functions to hold the fuel element, to retain the wick holder, and to conduct heat to the solid fuel element to thereby melt the fuel element to provide a liquid fuel to feed to the flame via the wick. Moreover, the base portion of the wick holder engages, by the use of legs or skirt or a magnetic means, a pedestal on the surface of said support or melting plate in such a manner as to resist detachment from the melting plate, while also providing a means for transporting liquid fuel from the support plate to the wick by capillary action. Thus, the pedestal to which the wick holder is attached may be referred to as a capillary pedestal, whereas in previous melting plate candles, in which no locking or attachment means is present to secure the wick holder to the base of the melting plate, the wick holder is said to engage a capillary lobe. The capillary pedestal of the present invention may thus be considered to be a capillary lobe having an undercut or a magnetic or other means by which a wick holder may be engaged so as to resist accidental displacement. The wick holder may thus be considered to be locked in place to the capillary pedestal, although it is removable by the consumer for replenishment of the wick and/or the fuel element, by exertion of sufficient force to overcome the engaging pressure or the magnetic force. As will be appreci-

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ated, the manufacturer may provide melting plate devices, wicks and wick holder assemblies, and solid fuel elements, either together, or independently (separately), and the consumer may join the separate elements to form a melting plate candle, fuel burner, or dispenser of active materials, with the option to change wicks and fuel elements at will. In a preferred embodiment of the invention, the wick, wick holder, and fuel element may be provided as a unitary replacement element to be utilized with a separately provided melting plate.

[0039] In one embodiment, a capillary pedestal is on the melting plate, which pedestal provides a locating device for a complementarily shaped wick holder, creates a site for capillary feed of fuel to the wick, and provides a means for heat transfer from the flame to both the melting plate and the solid fuel. The wick holder, in addition to providing a mounting means for the wick, has a base which closely conforms to the capillary pedestal in such a manner as to create a capillary feed by which melted wax flows to the wick as fuel. Moreover, in an embodiment the capillary pedestal of the present invention is configured so as to engage the wick holder in such a manner that the wick holder may not be easily or accidentally removed from the pedestal. This may be accomplished, for example, by means of an undercut in the side of the pedestal, which undercut engages a complimentarily shaped leg or skirt of the wick holder. The leg or skirt may preferably be made of a resilient material, such as a heat conductive metal, and is biased inwardly on the pedestal in the area of the undercut therein, so as to resist removal. The engagement of the wick holder may also be accomplished by means of a magnet located on the under side of the pedestal, which magnet engages a magnetically attracted metallic insert in the complimentarily shaped leg or skirt of the wick holder. The leg or skirt may be made of a non-magnetic but highly heat conductive metal, such as aluminum. It is also to be recognized that the present invention may encompass a combination employing a melting plate without a pedestal, whereby the wick holder is magnetically held to the melting plate at a locating position not related to a capillary pedestal, but at a position determined by the presence of a magnet upon or beneath the surface of the melting plate. Still further, it is to be recognized that the magnetic retention may be accomplished by means of a magnet in both the melting plate and the wick clip, or a magnet in one and a ferrous material in the other. Still further, the wick clip may be fashioned partially or

primarily of a heat conductive ferrous material, which material may be attracted to a magnet positioned upon or beneath the surface of the heating plate.

[0040] In addition to the base and/or skirt of the wick holder being a heat conductive element, the wick holder may preferably also provide an additional heat conductive element such as a fin or fins, which may be in close proximity to, or in contact with the flame, and thereby conduct heat back to the wick holder base, and thus to the capillary pedestal, and thereby to both the melting plate and the fuel. It is to be understood that this arrangement of elements provides for much greater control of the degree of heating of the pool of melted wax, and the pool temperature, by virtue of the ability to control the amount of heat conducted to the pool by either the skirt of the wick holder or by the fins thereof. This may be accomplished by selection of the number of fins, for example, or control of the conductivity thereof, such as by choice of position relative to the flame, or material of construction. This in turn is most important in candles which dispense a volatile material, such as a fragrance, where a rapid temperature rise to the most effective temperature for volatilization of the active material is desired. Such a rapid temperature rise clearly results in a more rapid melt of the fuel element, and a more rapid dispensing of volatile material. In fact, with the present invention, it is possible to tailor a melting plate candle to a specific volatile active to be contained within a fuel element, by permitting control of the amount of heat conducted to the pool of melted fuel, and thus controlling the temperature thereof.

[0041] Alternative aspects of the present invention provide for the fuel element to be provided as a separate element which is complementarily shaped relative to the wick holder, so as to fit around the wick holder in its position on the capillary pedestal of the melting plate. While it is possible for a permanent wick and wick holder assembly to be provided as a part of the melting plate, in a preferred embodiment of the invention, the wick holder, wick, and fuel element are provided to the consumer as a single unit. Alternatively, the wick and wick holder may be provided as a single unit, with individual separate fuel units, perhaps containing differing fragrances, for example, to be combined with a melting plate. In this manner, wick holders of differing shape and configuration may be combined with fuel elements of appropriate configuration which differ in color or scent, for example.

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[0042] In one embodiment, a melting plate candle assembly of the present invention includes a fuel element and a container encompassing the fuel element. The container includes a heat conductive support member, such as a metallic melting plate including a bottom wall and a capillary lobe, which can either be a raised pedestal or a depression in the bottom wall. The fuel element includes a fuel charge having a defined outer surface, which is in thermal communication with the bottom wall, such as by direct contact or through an intermediate heat conductive member, and is supported or contained therein. The melting plate candle assembly may also include additional heat transfer elements, in either or both of the melting plate and the wick holder, to deliver heat by conductive means to the fuel and to the melting plate, in addition to heat transferred to the melting plate by direct radiation from the flame. The melting plate thus functions as a heating plate for the fuel element and any melted or liquefied fuel pooled on the bottom wall. The melting plate may include highly thermally transmissive, or heat conductive, material, such as polished aluminum or any metal, and/or less thermally transmissive materials may be used, such as glass or ceramic, or combinations thereof. The surface of the melting plate may have a coating of a surface tension modifying material applied thereto for purposes of preparing a self-cleaning or easy cleaning melting plate, such as, for example, a thin layer of a polytetrafluoroethylene material.

[0043] The melting plate may be shaped so as to collect the melted or liquefied fuel at a low point thereon, with the capillary lobe disposed at the low point. A wick may be located with a wick holder positioned over the capillary lobe, so that liquefied fuel is fed to the wick, in order to promote maximum consumption of the liquefied fuel. Thus, the melting plate may be shaped as a bowl or a funnel with the low point disposed centrally on the bottom wall. The melting plate may also be essentially flat with raised edges or a surrounding wall to contain the melted fuel. The entire interior surface of the melting plate may be highly heat conductive, or only a small portion or none of the melting plate may be highly heat conductive. Candle assemblies employing such melting plates are generally referred to, collectively, as melting plate candles.

[0044] The fuel charge utilized in the present invention may be initially in solid and/or gel form, and is in liquid form for moving up the wick by capillary action to the flame, where it is consumed. For convenience, the term solid fuel shall be used hereinafter to refer to a fuel charge in either a gel or conventional solid state, such as conventional candle wax in the form of a shaped body or “puck” of wax having a hard outer surface at room temperature. The wick draws the fuel consumed in the flame at the burning wick from a pool of liquid fuel, which is formed by melting the solid fuel by conductive heat transfer from the melting plate and heat exchange elements in addition to radiant heat from the flame. The pool of liquid fuel is contained on the upper surface of the bottom wall of the melting plate. This pool of liquid fuel may initially contain unmelted fuel in the solid state, as well as melted fuel, and the elevated temperature of the pool achieved by the present invention aids in complete melting of the fuel element.

[0045] The wick is secured in a position with the wick holder. The wick holder engages the melting plate at the capillary lobe, which locates the wick holder (and thus, the wick) in a preselected position relative to the melting plate and transmits heat from the flame on the wick to both the fuel and the melting plate. Thereby, the fuel element is heated both by convection directly from the flame and also by conduction through the wick holder and the melting plate. The wick holder and the capillary lobe may also be disposed to enhance flow of fuel to the wick by means of capillary action through an appropriately sized gap, or capillary space, formed between the lobe and the wick holder. The wick holder may also be configured to engage the fuel element in a lock and key relationship and to position it on the melting plate at a preferred or preselected location.

[0046] The primary heat conductive element constitutes the melting plate, which may itself comprise portions formed, raised, or bent to be in closer proximity to the flame, such as a raised section of the plate, e.g. the upper edge of the raised side of the melting plate. For example, the melting plate may constitute a bowl shaped container having its outer periphery in close proximity to the flame, such as a container in which the side wall of the bowl is formed so that the lip of the upper opening curves back toward the center of the bowl, and thus toward the flame. The melting plate may also have secondary heat conductive elements,

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such as one or more raised portions which act not only to absorb and distribute heat by conduction, but to channel or direct the flow of liquid fuel to the wick. Such raised portions, referred to herein as lobes, may constitute areas of material having higher heat conductivity than surrounding areas of the container. In such examples, the support plate may comprise a less conductive material, such as glass, and the primary heat exchange may be by radiant heat and conducted heat by means of the secondary heat conductive elements of the wick holder. It may thus be seen that the wick holder assembly, comprising a wick, and a fuel element, in conjunction with a base configured so as to complementarily engage a capillary pedestal, may be utilized in any candle container comprising a capillary pedestal, and is thus not specifically limited to melting plate candles.

[0047] The capillary lobe may engage and/or position the wick, wick holder, and/or fuel element in such a manner as to provide an advantageous positioning thereof for maximum consumption of the liquefied fuel, as well as creating a capillary flow of melted fuel from the melting plate to the wick positioned in the wick holder, which is placed in such close relationship to the capillary lobe as to create a narrow gap between the lobe and the wick holder. By virtue of this narrow gap, which illustratively may be, for example, between approximately 0.01 inch and approximately 0.04 inches (0.2 mm – 1 mm), or about 0.02 inches (0.5 mm), liquefied fuel rises to the wick for consumption by a flame thereon. The capillary action may also or alternatively be the result of grooves cut in the lobe or in the wick holder, and the wick holder may be held away from the lobe by the presence of appropriately positioned and sized bumps located on the lobe, the wick holder, and/or the melting plate. Moreover, the capillary forming combination of elements may constitute a concave depression in the melting plate, rather than a raised male lobe, and the wick holder in such case may be an appropriately shaped male member that fits closely within the depression so as to create a capillary gap between the members, by which fuel is fed to the wick. Still further, the capillary lobe, either in a male configuration or in a female configuration, need not constitute a raised circular member, but may be of any shape, such as for example cylindrical, pyramid shaped, square, oval, triangular, or any other desired shape, in combination with a like-shaped and appropriately dimensioned wick holder. The capillary lobe need not transmit liquid fuel to the wick at all parts of the perimeter of the capillary lobe, but rather may only create a

capillary gap for a limited portion of its circumference. Thus, the wick holder need not be in a close enough proximity to the lobe throughout the total area of engagement therewith to provide a sufficient capillary effect to maintain the flame on the wick.

[0048] Secondary heat conductive elements for conducting heat from the flame to the fuel charge may take the form of one or more heat fins or heat conductive surfaces disposed on the wick holder, and having an orientation conducive to heat conduction, including a vertical and/or horizontal orientation. The secondary heat conductive elements are heated by contact with the flame or by heat radiation from the flame and conduct heat to the melting plate and directly to the fuel charge. The secondary heat conductive elements, hereinafter exemplified as heat fins, although not limited to fins per se, and intended to encompass other heat conductive extensions of the wick holder which may serve this function, may be of any heat conductive material, and may be independent from or formed as an extension of the wick holder or joined to the wick holder in such a manner as to conduct heat from the flame to that portion of the wick holder which is engaged by the capillary lobe and/or the melting plate. Illustratively, the wick holder may thus include heat fins, a member to hold the wick, such as a wick receiver, and a base configured to engage the capillary lobe and transfer heat from the heat fins to the melting plate.

[0049] The fuel charge may be formed of one or more materials having a defined outer surface at room temperature, such as paraffin, beeswax, montan wax, carnauba wax, microcrystalline wax, polyvinyl acetate, fatty alcohols, fatty acids, fatty esters, and gels incorporating such fuels, and may have any convenient form, such as pucks, donuts, chips, slivers, balls, pellets, shavings, particulates, cubes, discs, three dimensional shapes, and wafers, or in any other suitable shape. The fuel charge may optionally further include volatile active materials, such as fragrances, air fresheners, deodorizers, odor eliminators, odor counter-actants, insecticides, insect repellants, herbals, medicinal substances, disinfectants, sanitizers, mood enhancers, aroma therapy compositions, and the like. The fuel charge may be colored for decorative effect, if so desired, and may be shaped to fit any given configuration of melting plate and/or wick holder. For example, the bottom of a solid fuel element may be curved complementarily to the shape of the melting plate upon which it is to rest, and have

melting temperatures above ambient, but below the flame temperature of a wick burning such fuel.

[0050] The melting plate and/or the fuel container may be formed in such a manner as to permit placement of fuel elements of specific configuration, such as wax pucks having a complementary configuration, for example, in a preselected position in proximity to the heat conductive elements themselves, or to the wick holder, in such a manner as to maximize heat transfer from the melting plate to said fuel elements. Due to the interaction between the fuel element and the capillary lobe, a user may readily dispose a replacement fuel element including the fuel charge, wick holder, and wick, on the melting plate at a location designed to most effectively melt and consume the fuel element.

[0051] The use of the melting plate technology of the present invention may also provide such advantages as elimination of tunneling, significant reduction of retention of wax at the conclusion of the burn, and elimination of walking or off-center wicks, while also giving a larger pool of liquid wax with a relatively small flame in a relatively short time period. In addition, the container may be of almost any shape desired, providing for great aesthetic possibilities. Since the fuel element, either alone or in combination with a wick and wick holder, may be provided as a separate unit, the consumer may be provided a great number of choices as to the color, content, and nature of the fuel, and the configuration of the fuel element may be varied to provide a large choice of shapes, such as seasonably decorative items. For example, shapes such as pumpkins may be provided for Halloween, wreaths for Christmas, and flowers for all seasons. In addition, the fuel element preferably is configured as to cooperatively engage both the melting plate and the wick holder, which wick holder in turn engages the capillary pedestal on the melting plate, in such a manner as to provide the consumer the greatest degree of ease in placement of the fuel element in optimal position in the melting plate candle, with the least possibility of incorrect placement. Further, the melting plate or support plate may have decorative features, such as designs, embossed, etched, printed, or stamped thereon. Moreover, the magnetic retention of the wick holder on the pedestal provides a safety feature should the melting plate candle be tipped or overturned,

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by preventing the wick holder and wick itself, especially if lit, from falling from the melting plate candle to a surface upon which the candle is placed.

[0052] These and still other advantages of the present invention will be apparent from the description which follows, which description is merely of preferred embodiments, and not indicative of the full scope of the invention.

[0053] Turning now to the drawings, FIGS. 1 and 2 illustrate a melting plate candle in its most basic form, such as set forth in Furner et al. U.S. Patent No. 6,802,707, issued October 12, 2004, and incorporated herein in its entirety by reference. As illustrated, a heat conductive container, such as a melting plate 20, is provided, which transfers heat obtained from the heat source, a flame (not shown) located on wick 22 by means of heat conduction, to a solid fuel element 24, which rests upon a top surface of the melting plate. For purposes of illustration, and for clarity, but intending no limitation, the wick 22 is illustrated as being of a relatively large diameter, rather than as a fibrous wick of small diameter. The wick 22 is positioned within and engages the solid fuel element 24, such as with a wick clip (not shown in FIGS. 1 and 2). The melting plate 20 as shown in FIGS. 1 and 2, is heated directly by a flame on the wick 22 by radiation as a result of the melting plate being bowl-shaped so as to have a portion, such as outer shoulder 26, in relative proximity to the flame, the diameter of the melting plate being such as to permit inner surfaces thereof to absorb appreciable amounts of heat from the flame.

[0054] The melting plate of FIGS. 1 and 2 is shaped with the outer shoulder 26 raised in order to contain a resultant pool of melted fuel. The melting plate 20 may be in the form of a tray, bowl, concave plate, or other configuration, which is capable of holding a pool of hot liquid fuel, and is shaped in one embodiment so as to funnel or channel the liquefied (e.g., melted) fuel to the wick. The melting plate 20 may constitute a container in itself, as shown, or may be surrounded by a separate container. In the embodiment shown in FIGS. 1 and 2, the melting plate rests upon a non-conductive base 28 or legs of non-conductive or insulating material, so as to permit placement upon a table, counter, or other surface. The non-conductive base, as illustrated, comprises contact points 30 so as to minimize the amount of contact between the base and the melting plate, and to create an insulating air gap 32 between the melting plate and the surface upon which the assembly rests.

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[0055] The melting plate 20 may be of any heat conductive material, such as brass, aluminum, steel, copper, stainless steel, silver, tin, bronze, zinc, iron, clad materials, heat conductive polymers, ceramics, glass, or any other suitable heat conductive material or combination of such materials. As shown in FIG. 2, the fuel element 24 is preferably located in direct contact with the top surface of the melting plate 20, which plate may, if desired, be constructed so as to have a non-conductive lower surface, so that the melting plate may rest upon a table surface or such. Such a configuration may result from a clad material, a conductive melting plate material coated on the surface of a non-conductive material, a non-conductive material having an insert of a heat conductive material, or other suitable arrangements to permit the melting plate to be cool enough on the bottom surface to permit ease of handling, and/or placement upon surfaces not suitable for contact with heated bodies.

[0056] The wick 22 in one embodiment constitutes a conventional consumable wicking material, such as cotton, cellulose, nylon, or paper, or the like, which by capillary action carries liquid fuel to the flame. In another embodiment, non-consumable wicks may comprise such materials as porous ceramics; porous metals; fiber glass; metal fiber; compressed sand, glass, metal, or ceramic microspheres; foamed or porous glass, either natural or man-made, such as pumice or perlite; gypsum; and/or chalk. The wick 22 may be located in the center of the melting plate 20 or may be off-center as desired, provided that the melting plate is configured so as to channel or funnel melted fuel to said wick. As illustrated, the wick 22 may be positioned in conjunction with a starter bump 34 of wax in the top surface of the fuel element 24 for ease of lighting. The presence of two or more wicks is also within the scope of the present invention. The wick 22 is provided in conjunction with a wick clip or, wick holder assembly, one embodiment of the wick holder assembly being such as to cooperatively engage a complementarily shaped capillary pedestal 36 on the melting plate 20, as shown in FIGS. 3A, 3B, 4A, 4B, 5A and 5B, discussed hereinafter.

[0057] FIG. 3A is a simplified perspective view of a melting plate candleholder 38, showing a capillary lobe, such as a capillary pedestal 36 having a frustoconical shape with a flat top, but absent the wick holder assembly and a candle. The candleholder 38 is of a decorative shape, which may be of any suitable shape for the use intended, with an open top for placement of a fuel element (not shown) and the wick holder assembly upon a melting

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plate 20. The melting plate in turn has a raised area, or pedestal 36, near the center of the melting plate 20, upon which the wick holder assembly may be positioned. As shown, the candleholder 38 has a bowl-like configuration, with raised edges to confine and hold a liquefied fuel. The melting plate 20, as previously indicated, may be of any heat conductive material, for example, a material such as aluminum, and may be bonded adhesively to the surface of the candleholder by conventional means, or may be otherwise held in position.

[0058] FIG. 3B is a partially exploded isometric view of an embodiment of a melting plate candle assembly, showing a support plate, such as a melting plate 20 carried by a support base 28 and a fuel element 24. The fuel element 24 has a depression 40 in a bottom surface 42 thereof that fits over a capillary lobe 36 in a bottom wall 44 of the melting plate 20 such that the bottom surface of the fuel element surrounding the depression is in thermal communication with the bottom wall, such as, for example by being disposed on the bottom wall. In the pictured embodiment, the capillary lobe 36 has a generally conical shape having a substantially smooth outer surface and a rounded peaked apex 46, and the depression 40 has a conical shape generally complementary to the shape of the capillary lobe. The bottom wall 44 and the capillary pedestal 36 are formed of a thermally transmissive, or highly heat conductive, material, such as aluminum. In other embodiments, the capillary lobe 36 has a pointed peaked apex with a roughened or stepped outer surface, and can have any shape generally defining a peaked apex, such as, for example, pyramidal, egg shaped, an elongate ridge, etc. The capillary lobe 36 is disposed at a low point of the bottom wall 44, which has a generally dished or concave shape, so that liquid fuel, such as melted wax and/or oil, will flow toward the capillary lobe.

[0059] FIG. 4A is a cross sectional view of one embodiment of a melting plate candle, showing a candle holder 38, a melting plate 20, a wick clip assembly, or wick holder 48, and a fuel element 24 in an assembled position. The candle holder 38 may be of any material, such as glass, metal, plastic, wood, ceramic, or other material suitable for the intended use. The melting plate 20 constitutes a bowl-like structure held in place in the candleholder 38, such as with adhesive 50. The melting plate may have a decorative design embossed, printed, engraved, etched, or carved into a surface thereof. At or near the center of the melting plate 20, and thus the candleholder, a raised pedestal 36 is positioned to engage a base portion 52

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of the wick holder 48. The wick holder 48 is adapted to hold and position a wick 22 in an appropriate position and location. Beneath the pedestal 36 is positioned a magnet 54 adhesively held to the bottom of the melting plate 20. Alternatively, the magnet 54 may be positioned, either loosely or adhesively or otherwise held, upon the surface of the candle-holder beneath the pedestal. The wick holder 48 is positioned over the pedestal 36 so as to engage the pedestal and to provide a capillary flow of melted wax to a base of the wick 22. To provide retention of the wick holder 48 on the pedestal 36, the wick holder 48 encompasses one or more magnetic metal inserts 56, such as rivets, to engage the magnet force of the magnet 54 located below the pedestal. Such magnetic metal inserts 56 may be of any material that is attracted magnetically to the magnet, and may alternatively constitute metal screws, rivets, clips, etc. The fuel element 24 is positioned so as to cooperatively engage both the melting plate 20 and the wick holder 48.

[0060] FIG. 4B shows a cross sectional view of another embodiment where a wick holder carrying a wick is at least partly surrounded or encompassed by a fuel element, such as a wax puck. The wick holder 48, which includes a wick receiver 58 extending from a base portion, such as a skirt 60, and a heat fin 62, is formed substantially of a heat conductive material, such as aluminum, and is disposed through a slot 64 in the fuel charge 24. The skirt 60 is disposed in and at least partly defines the depression 40, and the wick 22 extends above an upper surface of the fuel charge 24. The skirt 60 is generally conically shaped complementary to the shape of the capillary lobe 36 and includes, for example, a Ferro-magnetic material, such as steel rivets 66, which is magnetically attracted to a magnet 54 disposed underneath the capillary lobe. The steel rivets 66 maintain a small gap, or capillary space 68, between the skirt 60 and the capillary lobe 36 through which liquid fuel travels upwardly from the bottom wall 44 to the wick receiver 58. The wick receiver 58 maintains the wick 22 in a preselected position above the peaked apex 46 to draw the liquid fuel from the capillary space 68 when a flame 70 is burning on the wick.

[0061] In FIG. 5A, an exploded perspective view of another embodiment is shown with a bowl-shaped melting plate 20, which includes a capillary pedestal 36 located approximately in the center thereof. A wick holder 48 is shown above the capillary pedestal 36, the wick holder being shaped in such a manner as to fit closely over the capillary pedestal and to

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magnetically engage the pedestal so as to be locked in position. FIG. 5B shows another embodiment where the capillary pedestal 36 has a rounded or generally hemispherical shape defining a peaked apex 46. The wick holder 48 also includes a wick 22 and a heat transfer element, such as a heat fin 62. A solid fuel element 24 has a cut out portion 64 through which the heat fin 62 and wick 22 may pass, so as to place the wick in close proximity to a top surface of the fuel element. The solid fuel element 24 is shown as a wax puck, although other shapes may be used within the scope of the present invention. Since difficulty in lighting the wick 22 may be encountered, a starter formation of fuel, such as the starter bump 34 shown in FIGS. 1 and 2, may be provided in close proximity to the wick 22. As illustrated in FIGS. 1 and 2, the starter bump 34 is most easily molded directly into the shape of the fuel element 24 and provides a ready source of liquid fuel to the wick 22 when a match or other appropriate source of flame is employed to start the wick burning, which source of flame will melt the starter bump 34 to thus create an initial pool of liquid fuel.

[0062] In an operational configuration, as shown in FIG. 6, the fuel element 24 is positioned on the melting plate 20 with the base 52 of the wick holder 48 positioned over the capillary lobe 36 (not shown) and the bottom surface (not shown) of the fuel element 24 contacting the bottom wall 44. A capillary space (not shown) is formed between the capillary lobe 36 and the base 52 to transfer liquid fuel from the bottom wall 44 upwardly to the wick by capillary action when a flame is burning on the wick. Additional advantages and details of a similar capillary pedestal are discussed in Unites States Patent Application No.10/780,028, filed February 17, 2004, which is incorporated herein by reference in its entirety, and which discloses a melting plate candle having a solid fuel element, a melting plate, and a lobe which engages a wick holder for a wick, wherein the wick holder engages the lobe in such a manner as to create a capillary flow of melted fuel to the wick.

[0063] Thus, when using a solid fuel, such as wax, in conjunction with a heat conductive wick holder 48, solid fuel refill units similar to the fuel element 24 may be shaped to fit a shape of the melting plate 20, with a specific relationship to the wick holder, which itself is engaged with the melting plate 20 by, for example, magnetic forces. For example, the melting plate 20 may be a decoratively shaped container, and wax may be provided in the form of fuel element refill units specific for the container shape selected, such as round,

square, oval, rectangular, triangular, or otherwise, so shaped that the wick holder assembly incorporated with the fuel element refill unit will fit and engage a complementarily shaped capillary pedestal 36.

[0064] The use of a melting plate 20 with additional heat conductive elements, such as the heat fins 62, offers a number of distinct advantages. First, it permits a larger pool of liquid fuel, due to improved heat conduction into the fuel, which results in more rapid formation of the pool. This in turn allows better regulation of the size and shape, as well as the temperature, volume, and depth of the liquefied wax pool to allow more efficient use of fuels present. For example, melting plates of the present invention permit ease of refill, with little or no cleaning. In most instances, no cleaning is required, but if desired, the melting plate 20 may be conveniently washed in a manner such as a dish, plate, or bowl is washed, in a wash basin or in a dishwasher. The use of a capillary pedestal 36 in the heat plate 20, in conjunction with heat fins 62 on the wick holder 48, also reduces or eliminates retention of solidified excess fuel when the candle is allowed to burn itself out, and permits more complete and uniform burning of fuel elements 24 which are other than round, e.g., square, oval, triangular, or in the shape of a flower or decorative object, etc. Further, the melting plate 20, when used in conjunction with a capillary pedestal 36 and complimentary wick holder 48, provides a device which may be self extinguishing, and improves or eliminates typical burning problems encountered with candles, such as tunneling, drowning, collapsing, cratering, and wick drift. Fuel elements, such as candles, utilizing the melting plates described herein are also more forgiving of formulation or process variances. Furthermore, the presence of a magnetic retention assembly to retain the wick holder 48 on the capillary pedestal 36 provides a margin of safety and convenience.

[0065] Turning now to FIGS. 7-11, another candle assembly 100, similar to the melting plate candle shown in FIGS. 4A and 4B, includes a support base 102, a melting plate 104, a wick holder 106, a wick 108, and a fuel element 110. The support base 102 carries the melting plate 104, which is generally saucer shaped, and includes a centrally disposed capillary pedestal 112. Optional decorative etchings 114 are disposed on an upper exposed surface of the melting plate 104 to provide enhanced attractiveness or visual information. The wick holder 106 includes a base portion 116 that fits over the capillary pedestal 112, a

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wick retainer sleeve in the shape of an elongate cylindrical barrel 118, and heat conductive elements, such as fins 120. The barrel 118 receives the wick 108 therein such that the wick extends from the base portion 116 with a portion of the wick exposed above the barrel. The fuel element 110 is disposed over and around the wick holder 106 and includes a duct or slot 122 through which the wick 108 extends. The slot 122 has a width w_1 sufficient to allow the wick 108 to extend through the slot and a length l_1 sufficient to accept at least a portion of the fins 120 therethrough. In one embodiment, the fuel element 110 has a mass of wax approximately 15 grams, and the melting plate candle 100 burns continuously between about 3 and 3 ½ hours on a single fuel element, such as the wax fuel element 110, before the fuel is completely consumed.

[0066] As seen in FIG. 8, the base portion 116 of the wick holder 106 includes an end plate 124 encompassed by a generally conical base skirt 126, and an upper portion including the barrel 118 extending upwardly from the base skirt and the fins 120 extending from the barrel and end plate 124. The base portion 116 is adapted to fit closely over and around the capillary pedestal 112 such that the barrel 118 is maintained in an upright, or substantially vertical, orientation when placed on the capillary pedestal. The base skirt 126 includes indentations or spacers 128, and holes 130 extend through the end plate 124. Ferromagnetic structures, such as steel rivets 132 or magnets (not shown), are secured to the base portion 116, such as through the holes 130, so that the wick holder 106 may be releasably secured over the capillary pedestal 112 by magnetic forces. The barrel 118 is sized to receive the wick 108 with either a close fit or an interference fit so as to retain the wick therein and defines an opening 134 in the end plate 124 such that the wick can extend through the end plate. The fins 120 extend laterally outwardly on opposite sides of the barrel 118 and extend upwardly above the barrel. In one embodiment, the fins 120 are shaped to simulate a flame outline. In other embodiments, the fins 120 may have square, circular, oval, triangular, or other non-geometric shapes, and in still other embodiments, the fins 120 may have insulated areas (not shown) as described more fully in U.S. Patent Application No. 10/939,039, filed September 10, 2004, and incorporated herein by reference in its entirety. The fins 120 are relatively thin strips of heat conductive material, such as metal, for transmitting heat from a flame burning on the wick 108 outwardly toward the fuel element 110. In one embodiment,

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the wick holder 106 is formed from a single sheet of aluminum that is cut and folded about a fold 136 and thereby forming a capillary space 138 between opposite sides 140 and 142 and channels or gaps 144 in the base skirt 126. In other embodiments, the wick holder 106 may be formed by other methods from other heat resistant materials, such as ceramic, other metals, heat resistant plastics, etc. If the wick holder 106 is formed of a ferromagnetic material, such as steel, the steel rivets 132 may optionally be omitted. The two sides 140 and 142 are secured together by any convenient means, such as with rivets 146 through holes 148 in the heat fins 120, welds, clips, heat resistant adhesives, etc. The gaps 144 and the holes 130 allow melted fuel material from the fuel element 110, to drip or seep underneath the base skirt 126, and the capillary space 138 allows melted fuel material to traverse up the fins 120 by capillary action and thereby provide a source of fuel material in non-consumable wick areas 150. An example of such capillary action is described in U.S. Patent Application No. 10/938,453, filed September 10, 2004, and incorporated herein by reference in its entirety.

[0067] As seen in detail in FIG. 9, the fuel element 110 includes a body 152 of fuel material and has an upper surface 154 and a lower surface 156. The fuel element 110 in one embodiment is a wax puck and in other embodiments may have other shapes and include other meltable or flowable fuel materials, such as paraffin or animal fat, having a solid or semi-solid state or otherwise maintainable in a fixed form at room temperature. The lower surface 156 of the fuel element 110 defines a cavity 158 having an upper cavity wall 160 shaped to conform closely to the base portion 116 of the wick holder 106. The slot 122 extends from the upper surface 154 to the cavity wall 160 and has a width w_1 at the upper surface that is smaller than a width w_2 at the cavity wall. The width w_1 is adapted to prevent melted wax from the fuel element 110 from falling or trickling down the slot 122 without engaging the wick 108, or put another way, the width w_1 is narrow enough to ensure that melted fuel material from near the upper portion of the slot 122 will engage the wick 108 as it falls or trickles down the slot. In one embodiment, w_1 is not more than approximately 0.02" (0.5 mm) larger than a diameter of the wick at an upper end of the slot 122. In another embodiment, w_1 is approximately the same as a diameter of the wick 108. In yet another embodiment, the width w_1 is less than a width of the wick 108 so that an interference fit exists between the wick and the body 152 at the upper end of the slot 122. In a further

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embodiment, the width w_1 is less than or equal to approximately 0.12" (3 mm), and the wick 108 has a diameter of approximately 0.1" (2.5 mm). In yet a further embodiment (not shown), the slot 122 may have a width that is initially more than 0.02" (0.5 mm) larger than a diameter of the wick 108 to allow for easy insertion of the wick 108 and wick holder 106 into the slot 122, and the slot is filled subsequently with additional fuel material in a second manufacturing step so that the width w_1 is less than 0.02" (0.5 mm) larger than the diameter of the wick. Having a slot width w_1 as described herein helps ensure successful initial lighting and sustained burn of the wick 108 at a higher success rate than with a slot width that is larger. The slot width w_1 as described herein also reduces or eliminates the need for a starter bump to provide fuel to the flame and wick during the initial ignition and sustained burn of the candle. The larger width w_2 at the cavity wall 160 facilitates easily inserting the wick holder 106 and the wick 108 into the slot 122, and the cavity 158 and cavity wall 160 help conceal the wick barrel 118 and base skirt 126 and ensure proper placement of the fuel element 110 around and along the wick holder 106. The widths w_1 and w_2 also provide a convenient way to ensure that the wick holder 106 is inserted correctly into the slot 122 in a predetermined spatial relationship.

[0068] As shown in FIG. 10, the support base 102 carries the melting plate 104 within an upper chamber 162, which is generally bowl-shaped. The melting plate 104 in one embodiment is secured to a sidewall 164 of the upper chamber 162 with adhesive 166 thereby providing an empty air space 168 between the melting plate and an intermediate wall 170 of the support base 102. The air space 168 provides additional insulation between the melting plate and the support base 102 to reduce heat loss through the melting plate to the support base. In another embodiment (not shown) the melting plate 104 is adjacent to the intermediate wall 170 with adhesive 166 placed therebetween such that no air space 168 is disposed between melting plate and the intermediate wall. Of course, other arrangements and support configurations for the melting plate 104 are also suitable for supporting the melting plate 104.

[0069] In one embodiment of the fuel element 110, the slot 122 has a length l_1 in the upper surface 154 that is longer than a length l_2 in the lower surface 156. The length l_1 is shorter than a largest width w_f of the fins 120 and the length l_2 is longer than the largest width w_f of the heat fins. Such a configuration of the slot lengths l_1 and l_2 in relation to w_f , in

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addition to the slot widths w_1 and w_2 as described herein above, facilitates easily inserting the wick holder 106 fully into the slot from the lower surface 156. Such configuration of the slot 122 and cavity 158 also prevents the slot from fully receiving the wick holder if the fins 120 are inserted into the slot through the upper surface 154 rather than through the lower surface 156, thereby preventing or discouraging improper assembly of the fuel element 110 and the wick holder 106.

[0070] Although a slot 122 has been described in particular, ducts having shapes other than slotted are also contemplated that facilitate inserting the wick 108 through the fuel element 110 and immersing the wick in melted or flowing fuel material traveling down the duct. For example, the duct may have the shape of a cone if the wick holder 106 does not include any fins 120 extending outwardly from the barrel 118. In another example, the duct may have a square, rectangular, triangular, or other non-geometric shape that is adapted to allow the wick 108 to pass through the fuel element 110 and accommodate insertion of any structures of the wick holder 106 that surround or extend from the wick and may be, for example, funnel shaped, substantially cylindrical, and/or curved.

[0071] As illustrated in FIG. 11, a portion of the melting plate 104, capillary pedestal 112, wick holder 106, fuel element 110, and wick 108 are shown assembled and ready for use or initial ignition by a user. In one embodiment, the capillary pedestal 112 includes an inclined sidewall 172 having an annular groove 174 extending therearound in a medial position between a floor 176 of the melting plate 104 and a top wall 178 of the capillary pedestal. A magnet 180 is secured to an underside of the top wall 166 with adhesive 182. In another embodiment, the magnet 180 may be disposed on an upper side of the top wall 178 or at another location sufficient to attract the wick holder 106. The spacers 128 are adapted to seat in the annular groove 174 to provide a capillary space 184 between the base skirt 126 and the inclined sidewall 172 sized to facilitate capillary movement of melted or liquid fuel material toward the wick 108. The spacers 128 also help retain the wick holder 106 on the capillary pedestal 112 by seating in the annular groove 174. In addition, the steel rivet 132 in the wick holder 106 is attracted to the magnet 186 when placed over the capillary pedestal 112 and thereby prevents the wick holder from accidentally falling or slipping off of the capillary pedestal. When placed on an underside of the end plate 124, the steel rivets 132

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also act as spacers to help maintain the capillary space 184. In another embodiment, magnets 186 may be secured to the end plate 124 by any convenient means, such as with an adhesive or by a rivet, in order to maintain the wick clip 106 in position on the capillary pedestal 112. The cavity wall 160 of the fuel element 110 is shaped to closely fit around the base skirt 126 and barrel 118 of the wick holder 106 and rest on the floor 176 of the melting plate in order to minimize open space 188 between the fuel element and the wick 108, the wick holder 106, and the melting plate floor 176. Minimizing the open space 188 increases the likelihood of having melted fuel material feed directly to the wick 108 rather than falling downwardly to the floor 176 or accumulating in the open space and thereby potentially starving the wick of fuel material while burning. However, as melted liquid fuel material accumulates about the base of the capillary pedestal, whether due to melting from the melting plate 104 or from direct melting by a flame on the wick 108, the liquid fuel material is drawn upwardly along the capillary space 184 by capillary action toward the non-consumable wick areas 150 while the candle is burning. The wick 108 in one embodiment extends through the open end 134 of the barrel 118 to touch or nearly touch the top wall 178 of the capillary pedestal 112 so that liquid fuel material drawn up the capillary space 184 will engage the wick 108 and be drawn upwardly therein for eventual burning by a flame burning atop the wick. The wick barrel 118 has an inside diameter sufficient to receive the wick 108. The inside diameter of the barrel 118 may be larger, smaller, or the same as the diameter of the wick and may be uniform or have different diameters along a length thereof. In one embodiment, the inside diameter of the barrel 118 is larger than the diameter of the wick 108 so that the wick may be easily inserted into the barrel. In another embodiment, the inside diameter of the barrel 118 is uniformly approximately 0.012" (0.3 mm) larger than the diameter of the wick 108. In yet other embodiments, the inside diameter of the barrel 118 is the same size as or smaller than the wick 108. Melted fuel material can seep into the capillary space 184 through the weep holes 130 and thereby prime or facilitate capillary action upward through the capillary space 184. Liquid fuel material may also be drawn upwardly in the capillary space 138 between opposing sides 140, 142 of the fins 120 and drawn to the non-combustible wick areas 150 where the fuel material may be vaporized and ignited by a flame on the wick 108.

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[0072] Turning now to FIG. 12, another wick holder 200 and melting plate 202 are shown that are similar to the wick holder 106 and melting plate 104 shown in FIGS. 7-11, except that a capillary pedestal 204 includes a smooth inclined sidewall 206 without the annular groove 174, and the wick holder 200 does not include the spacers 128 in the base skirt 126. A capillary space (not shown), similar to 184, is maintained between the base skirt 126 and the sidewall 206 by steel rivets 132 protruding below an end wall, such as 124, of a base portion 116 of the wick holder 200. In this embodiment, the wick holder 200 is maintained on the capillary pedestal 204 substantially by the attraction between the steel rivets 132 and magnet 180 (not shown) in the capillary pedestal and any weight of the fuel element 110.

[0073] Turning to FIGS. 13 and 14, a wick holder 300 of another embodiment for use in a candle assembly, such as 100, is similar to the wick holder 106 (or 200) except that the wick holder 300 also includes a medial portion of a barrel 118 having a cross-sectional area that is less than a cross-sectional area of any other portion of the wick barrel. An indentation 302 in a sidewall 304 of the barrel 118 defines a constricted portion 306 of the barrel located or disposed intermediate opposite ends 308 and 310 of the barrel and having a cross-sectional area less than any other portion of the barrel. A wick 108 extends through the barrel 118 such that a portion or end of the wick adapted to absorb melted or fluid fuel material extends downwardly through the end 310 and another portion or end of the wick adapted for ignition extends upwardly through end 308. The constricted portion 306 reduces an effective wick cross-sectional area, and thereby may reduce or restrict a capillary fluid flow capacity of the wick between the first open end and the second open end. The restricted flow capacity, and subsequently reduced volume flow rate, of fluid fuel material up the wick from end 310 toward a flame region above end 308, in turn may reduce the fuel material burn rate and extend the life of the fuel element 110. Because a constricted portion 306 having a larger cross-sectional area allows a faster volume flow rate, or increased capillary fluid flow capacity, than a constricted portion having a smaller cross-sectional area, the capillary fluid flow capacity of the wick may be substantially reduced by reducing the cross-sectional area of the constricted portion. Such a constriction on the flow rate of fuel material upwardly along the wick 108 past the constricted portion 306 is enhanced when the sidewall 304 is substan-

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tially liquid impervious (i.e., does not allow fuel material to pass therethrough to the wick 108) which thereby restricts the flow of fuel material into the wick to coming only through the end 310 located in the end plate 124 or above the end 308 of the barrel 118. The indentation 302 also helps maintain the wick 108 in a predetermined position within the barrel 118 such that, for example, an end portion of the wick extends through or to the end 310 in order to prevent the wick from being pulled out of the barrel and thus potentially losing contact with the flow of fuel material toward the wick through the capillary space 184 and weep holes 130.

[0074] Other variations and embodiments of the candle assembly and wick holder 300 described in detail herein are also specifically contemplated. For example, in one embodiment, the barrel 118 may take the form of a sleeve having a cylindrical shape or a tubular shape having other cross-sectional areas and shapes. In another embodiment, the constricted portion 306 in the barrel 118 is formed by an inner annular ridge (not shown), which may be formed by indenting or crimping the sidewall 304 entirely around the wick barrel 118 or by an inner annular shoulder disposed on an inner surface of the sidewall 304. The constricted portion 306 in another embodiment may be formed by a single indentation 302 or by a plurality of indentations, which may be either in opposing relationship or offset from each other. In another embodiment (not shown) the barrel 118 may have form of a wick casing that is not generally tubular, but rather includes a longitudinally curved sidewall that encases a portion of the wick 108 and has first and second openings in the sidewall through which the wick extends.

[0075] In another aspect, shown in FIG. 14 and incorporable into any of the embodiments disclosed herein, the wick holder 300 includes a skirt 126 having an underside with a textured surface 312, such as formed by small protrusions 314, indentations, striations, ridges, grooves, etchings, or adhered particles, for example, opposing a capillary pedestal 204. In one embodiment, the textured surface 312 has a substantially random texture and extends across the entire underside of the skirt 126. In another embodiment, the textured surface 312 has a repeating texture pattern and extends across only portions of the underside of the skirt 126. The textured surface 314 in one embodiment is adapted to help remove excess solidified fuel, such as cooled wax, from an outer surface 316 of a sidewall 206 of the capillary pedestal

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204 when the wick holder 300 is removed from the capillary pedestal. The textured surface 314 in another embodiment helps maintain a minimum capillary space 184 between the skirt 126 and the capillary pedestal 204.

[0076] In another aspect of the present invention, which is shown in FIG. 14 but which is also applicable to any combination of any of the capillary pedestals and any of the capillary pedestals described herein, the capillary space 184 defines a volume, or capillary well 350, between a base portion 116 of the wick holder 300 and the capillary pedestal 204 that has a dimension preselected to promote a successful sustained relight of the wick 108 after a pool 352 (shown in dashed lines) of wax or other meltable fuel has been formed in melting plate 202 around the peripheral skirt 126 and capillary pedestal and then allowed to solidify. During a sustained burn, liquefied wax from the pool 352 is drawn into the capillary well 350 and up to the wick 108 by capillary action to feed a flame 354 at wick 108. If the flame 354 is extinguished prior to consuming the entire fuel element 110, the pool 352 of wax solidifies and extends across the bottom of the melting plate 202, through the capillary well 350, and into the wick 108. In one embodiment, when the wick 108 is re-lit after the pool 352 of wax has solidified, the capillary space 184 is dimensioned such that a supply of liquefied wax is quickly formed and available in the capillary well 350 to feed the flame via the wick 108 until the wax surrounding the peripheral skirt 126 has melted sufficiently to provide a supply of liquefied fuel to replace the wax in the capillary well. For example, if the capillary space 184 is dimensioned too small, there may not be enough wax in the capillary well 350 to sustain the flame on the wick during a sustained relight before the wax pool 352 surrounding the peripheral skirt 126 has melted enough to provide additional liquefied fuel to the wick 108. Also for example, if the capillary space 184 is too large, heat transfer through the solidified wax in the capillary well 350 may be too slow to melt enough of the wax therein to provide liquefied fuel to the wick 108 before wax in the wick is burned. Under either circumstance, the flame 354 may run out of fuel and extinguish prior to melting a sufficient amount of wax in the pool 352 to begin or sustain substantially continuous capillary movement of the melted wax from outside of the capillary space 184, into the capillary well 350, and up the wick 108 to feed the flame 354. Therefore, to assist in a successful sustained relight of the wick 108 in one embodiment, the capillary well 350 has a volume not less than

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a volume sufficient to provide melted fuel to the relit wick 108 until a sufficient amount of liquefied fuel is formed from the pool 352 of solidified wax adjacent to or surrounding the peripheral skirt 126 to continuously feed the flame 354 by capillary action through the capillary space 184, and in another embodiment, the volume of the capillary well 350 is not more than a volume able to allow heat from the flame 354 to melt the solidified fuel disposed in the capillary space 184 sufficiently rapidly to feed the flame 354 after solidified fuel carried in the wick is burned. In a further embodiment, a successful relight can be achieved if the volume of the capillary well 350 is proportional to a thermal mass of an entire candle assembly, such as 100, in order to provide a sufficient source of rapidly melted fuel to the wick until the pool 352 of solidified wax has melted sufficiently to provide an adequate flow of fuel to the wick 108 to maintain a sustained burn of the flame 354. The thermal mass of the candle assembly 100 is a measure of the amount of energy needed to change the temperature of the entire melting plate candle by a measured amount and is equal to the sum of the products of the mass of each portion of the candle assembly multiplied by the specific heat of that portion. According to one aspect, the volume of the capillary well 350 is between about 0.00006 cubic inches per calorie per degree centigrade (hereinafter, $\text{in}^3/\text{cal}/^\circ\text{C}$) ($1 \text{ mm}^3/\text{cal}/^\circ\text{C}$) and about $0.0006 \text{ in}^3/\text{cal}/^\circ\text{C}$ ($10 \text{ mm}^3/\text{cal}/^\circ\text{C}$) is more preferably between about $0.0001 \text{ in}^3/\text{cal}/^\circ\text{C}$ ($2 \text{ mm}^3/\text{cal}/^\circ\text{C}$) and about $0.0004 \text{ in}^3/\text{cal}/^\circ\text{C}$ ($6 \text{ mm}^3/\text{cal}/^\circ\text{C}$), and is even more preferably between about $0.00018 \text{ in}^3/\text{cal}/^\circ\text{C}$ ($3 \text{ mm}^3/\text{cal}/^\circ\text{C}$) and about $0.00024 \text{ in}^3/\text{cal}/^\circ\text{C}$ ($4 \text{ mm}^3/\text{cal}/^\circ\text{C}$). Accordingly, in one embodiment, the thermal mass of the candle assembly is between about $135 \text{ cal}/^\circ\text{C}$ and $10 \text{ cal}/^\circ\text{C}$, and more preferably between about $75 \text{ cal}/^\circ\text{C}$ and $40 \text{ cal}/^\circ\text{C}$, and even more preferably, between about $61 \text{ cal}/^\circ\text{C}$ and about $50 \text{ cal}/^\circ\text{C}$, and the volume of the capillary well 350 is preferably between about 0.006 in^3 (100 mm^3) and about 0.03 in^3 (500 mm^3), more preferably between about 0.009 in^3 (150 mm^3) and 0.018 in^3 (300 mm^3), and even more preferably about 0.012 in^3 (200 mm^3).

[0077] For example, the thermal mass of an embodiment of a candle assembly, such as 100, includes a support base 102, melting plate 202, and wick holder 300 having a combined thermal mass of about $50 \text{ cal}/^\circ\text{C}$ and a fuel element 110 of approximately 0.53 oz. (15 g) of wax having a thermal mass of about $10.5 \text{ cal}/^\circ\text{C}$ before being burned. The capillary pedestal 204 has a generally frustoconical shape with a height h_1 between about 0.39" (10

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mm) and 0.04" (1 mm), and more preferably about 0.2" (5 mm), a bottom radius $\Phi 1$ between about 1.18" (30 mm) and 0.39" (10 mm), and more preferably about 0.83" (21 mm), and a top radius $\Phi 2$ between about 0.04" (1 mm) and 0.79" (20 mm), and more preferably about 0.43" (11 mm). The base 116 has a frustoconical shape generally complementary to the capillary pedestal with the peripheral skirt 126 having an upper diameter $\Phi 3$ of between about 0.08" (2 mm) and about 0.83" (21 mm), and more preferably between about 0.43" (11 mm) and about 0.55" (14 mm), and even more preferably about 0.51" (13 mm); a bottom diameter $\Phi 4$ between about 1.22" (31 mm) and about 0.43" (11 mm), more preferably between about 0.79" (20 mm) and about 0.91" (23 mm), and even more preferably about 0.87" (22 mm); a height h_2 between about 0.43" (11 mm) and 0.08" (2 mm), more preferably between about 0.28" (7 mm) and about 0.16" (4 mm), and even more preferably about 0.2" (5 mm); and a height h_3 of the rivets 132 from the end plate 124 of between about 0.004" (0.1 mm) and 0.04" (1 mm), more preferably between about 0.03" (0.8 mm) and about 0.02" (0.5 mm), and even more preferably about 0.02" (0.6 mm). In another embodiment, the capillary pedestal 204 has a height h_1 about 0.18" (4.7 mm), a bottom radius $\Phi 1$ about 0.81" (20.5 mm), a top radius $\Phi 2$ about 0.44" (11.1 mm), and the base 126 has a skirt 126 having an upper diameter $\Phi 3$ about 0.5" (12.6 mm), a bottom diameter $\Phi 4$ about 0.85" (21.6 mm), and a height h_2 about 0.2" (5.05 mm). When the base 116 is placed on top of the capillary pedestal 204, the end plate 124 is a perpendicular distance of about 0.03" (0.65 mm) from a top wall 178 of the capillary pedestal, and the peripheral skirt 126 is perpendicular distance of about 0.02" (0.38 mm) from the sidewall 206, which defines a capillary well 350 having a volume of approximately 0.012 in³ (200 mm³).

[0078] Turning now to FIG. 15, a candle holder 400 for a melting plate candle assembly according to another aspect of the invention is shown including a holder or base 402 and a generally concave melting plate 404 carried within a recessed portion 406 of the base. (A solid fuel element and wick holder similar to those already described herein that rest on the melting plate are not shown for purposes of clarity) The melting plate 404 has high thermal conductivity and is similar to other melting plates described previously herein, including a capillary pedestal 408 protruding upwardly therefrom at a centrally disposed wick location. The base 402 includes a wall 410 extending around and angularly disposed

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outwardly at a zenith angle θ from the melting plate 404 and having an uppermost or top edge 412 disposed above the melting plate. In one aspect, the base 402 and the melting plate 404 have a geometry that is adapted to increase or promote substantially laminar air flow (when surrounded by a calm atmospheric environment) over a pool of molten or liquefied fuel when a flame is disposed in close proximity above the pool during a burn, such as, for example, when a flame is present on a wick such as the wick 108. Such laminar air flow controls the overall temperature of the pool by reducing eddy currents over the pool and reducing or minimizing localized hot spots in the pool, which slows volatilization of active volatile ingredients in the fuel, such as a fragrance or insecticide, and thereby extends an effective fragrancing period of the fuel until the fuel is completely burned. Ideally, when all the fuel is liquefied in the pool during the burn of the melting plate candle, air is drawn in substantially laminar flow over the top edge 412 of the wall 410 into the recessed portion 406, over the melting plate 404 and a pool of liquefied fuel, such as melted wax, by a heat chimney, or upward air currents, caused by a flame on a wick disposed over the capillary pedestal 408. The air currents ascending up the heat chimney also distribute the volatilized active ingredient into the surrounding environment.

[0079] In one embodiment, the base 402 and the melting plate 404 have a geometry to increase or promote substantially laminar air flow described by the following relationships:

1. $20,000 \text{ mm}^2 + (P_{\min}^2 - P_{\max}^2) \geq SA \geq 2,500 \text{ mm}^2 + (P_{\max}^2 - P_{\min}^2)$;
2. $D_{p\max} \leq (SA/1,000 \text{ mm}) + \{[(H_{\min} - P_{\min})/2]\sin\theta\}$;
3. $P_{\min} \geq 6(D_p)(\cos\theta)$; and/or
4. $H_{\min} \cong P_{\min} + 2[R + (D_p - R)\tan\theta]$;

in which:

$P_{\max}$ is a maximum width across the melting plate 404 in mm;

$P_{\min}$ is a minimum width across the melting plate 404 in mm;

SA is a projected surface area, or surface area of a two-dimensional projection of an outline, of the melting plate 404 in square millimeters;

$H_{\min}$ is a minimum width of the base 402 at the top edge 412 in mm;

D_p is a depth of the melting plate 404 from the top edge 412 of the base 402 in mm;

$D_{p\max}$ is a maximum value for D_p in mm;

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R is an outside radius of the upper edge of the base 402 in mm; and

θ is the zenith angle of the wall 410 in degrees.

[0080] Equation 1 quantifies an approximate relationship of the projected surface area of the melting plate and the width across the melting plate, within upper and lower constant boundaries, to promote the laminar air flow. Equation 2 quantifies an approximate relationship of the projected surface area of the melting plate 404 and the depth of the melting plate 404 from the top edge 412 of the base 402 to promote the laminar air flow. Equation 3 quantifies an approximate relationship of the minimum melting plate across the melting plate and the depth of the melting plate 404 from the top edge 412 of the base 402 and the zenith angle of the base wall 410 to promote the laminar air flow. Equation 4 quantifies an approximate minimum width of the base 402 at the top edge 412 as a function of the geometries of the melting plate 404 and the base to promote the laminar airflow. Although the relationships 1-4 above have been described in relation to a generally rectangular base and holder, the relationships may also be used with other candle holder shapes, such as oval and circular, in order to approach an optimized candle holder geometry. For example, in one embodiment comprising a circular base and melting plate, such as the base 102 and melting plate 104 shown in FIG. 7, Hmin is approximately 3.94" (100 mm), Pmax and Pmin are both equal to approximately 3.15" (80 mm), Dp is approximately 0.4" (10 mm), R is approximately 0.08" (2 mm), and θ is approximately 45°.

[0081] In FIG. 16A, another embodiment of a fuel charge 500 for use with the candle assembly, includes a solid outer shell 502 and an inner core 504 that is encompassed by the outer shell. The outer shell 502 is made of a substantially solid mass of a meltable fuel material, such as pressed candle wax. The inner core 504 is made of fuel material in a different form than the meltable fuel material of the outer shell 502. In this embodiment, the inner core 504 is made substantially of closely packed discrete solid fuel particles 506, such as wax beads, having a matrix of interstitial spaces 508 extending between the wax beads. The inner core 504 may also include, or alternatively be made substantially of, fuel materials in other different forms, such as, gelled fuels, liquid fuels, low melting temperature solid fuels, wax prill, and mixtures thereof, for example. The outer shell 502 may be formed by compressing a charge of the wax beads 506 in a heated press, which melts wax beads around

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the periphery of the charge to form the outer shell 502 as a smooth, substantially solid exterior wall. The outer shell 502 includes an inner peripheral wall portion 510, which defines an opening 512, such as an elongate slot, through a medial portion of the fuel charge 500, and a bottom cavity 514. The opening 512 and bottom cavity 514 are sized to accept a wick 22 and wick holder 48 such that the wick, wick retainer 58, and heat fins 62 extend through the opening, and the base portion 52 is disposed within the bottom cavity. As shown in broken lines, the base 52 of the wick holder 48 fits closely around a capillary pedestal 36 to form a capillary space 68 extending from near the melting plate 20 upwardly toward the wick 22 with the fuel charge 500 disposed at least partly on the melting plate. Liquid fuel, such as melted wax from the fuel charge 500, is collected on the melting plate 20 to form a pool 516 around the capillary pedestal 36. The liquid fuel travels upwardly from the pool 516 to the wick 22 through the capillary space 68 by capillary action.

[0082] A fuel additive 518 that slows capillary flow of liquid fuel to the flame through the wick and/or clogs interstitial spaces in the wick and/or breaks down wick fibers fuel thickener 518, such as ethyl cellulose, is contained within a portion of the fuel charge 500 in one embodiment of the invention. Some examples of the fuel additive 518 include a non-aqueous viscosity modifier, such as ethyl cellulose, stearamide, polyamide, hydroxypropylene cellulose, and mixtures thereof. The fuel additive 518 may also or alternatively include materials that slow capillary flow of liquid fuel to the flame, such as additives that clog interstitial spaces in the wick or that break down wick fibers. The fuel additive 518 in some embodiments may also include useful properties, such as being in the form of a dye, insect repellent, and/or fragrance. The fuel additive thickener 518 is disposed in the fuel charge 500 such that the fuel additive thickener is not immediately introduced into the pool 516 of liquid fuel. In this manner a flame 70 is initially provided with as much liquid fuel as possible to cause the flame to burn vigorously and melt the fuel charge 500 as quickly as possible. After the fuel additive thickener 518 is introduced into the pool 516, migration of liquid fuel up the wick 22 is slowed (as compared to migration of the liquid fuel without the fuel thickener additive) an amount sufficient to continue feeding the flame 70, but which decreases the size and vigorousness of the flame after a substantial amount of the fuel charge 500 has been melted. Such action in some cases may reduce the heat transfer from the flame 70 and lowers

the temperature of the pool 516 after the fuel charge 500 has been substantially melted. In one embodiment, the fuel additive thickener 518 is disposed in an outer peripheral portion 520 of the outer shell 502, which may be one of the last areas of the fuel charge 500 to be melted. In another embodiment, the fuel additive thickener 518 may also be retained in portions of the fuel particles 506 that are disposed in the fuel charge 500 to be some of the last particles to be melted. In another embodiment (not shown), the fuel charge 500 includes two or more discrete pieces, such as vertically stacked sections, radially concentric sections, and/or partial circumferential sections, which may be assembled around the wick 22 and wick holder 48. Each discrete piece may carry a different volatile active, such as a fragrance, such that each volatile active is dispersed into the surrounding environment at different times.

[0083] In operation, the fuel charge 500 may completely melt in a shorter period of time from the flame 70 on the wick 22 than a completely solid fuel charge due in part to the increased surface area of the fuel particles 506 in contact with melted wax from the pool 516. More rapid melting of the fuel element 500 may allow for more rapid release of volatile actives, such as odorants fragrances or insect repellents, entrained within at least some portions of the fuel charge. Once the fuel charge 500 is completely or almost completely melted, lowering the temperature and consumption rate of the melted fuel in the pool 516 may allow for a more sustained, longer lasting release of the volatile actives into the surrounding environment, thereby providing the benefits of the volatile active for a longer time period.

[0084] In FIGS. 16B and 17, a further embodiment of a fuel charge 600 adapted for use with a candle assembly, includes an outer shell 602 surrounding an inner core 604. The outer shell 602 is in the form of a substantially solid wall of meltable fuel material, such as candle wax, and the inner core 604 is in the form of a liquid fuel material, such as flammable lamp oil, for example. The outer shell 602 defines an outer peripheral wall portion 606 spaced radially outwardly from an inner peripheral wall portion 608. The inner peripheral wall portion 608 defines an opening 610 through a medial portion of the fuel charge 600 extending from a bottom cavity 612. The opening 610 in one embodiment is an elongate slot adapted to receive the wick holder 48 and wick 22 therethrough in a manner as described

previously herein. One or more volatile actives 614, such as fragrances and/or insect repellents, may be dispersed in one or both of the outer shell 602 and the inner core 604. In operation with a melting plate 20, wick 22, and wick holder 48, the fuel element charge 600 rapidly forms a pool of liquid fuel on the melting plate once the outer shell 602 is melted to release the liquid fuel in the inner core 604, which may allow even more rapid release of the volatile actives 614 into the surrounding environment than the fuel element 500.

[0085] The outer shell 602 in one embodiment further defines an inner medial wall 616a spaced between the inner peripheral wall 608 and the outer peripheral wall 606. Another medial wall 616b extends between the inner peripheral wall 608 and the outer peripheral wall 606. The medial walls 616a, 616b divide the inner core 604 into four compartments 618a, 618b, 618c, and 618d. In one embodiment, each compartment 618 is isolated from the adjacent compartments, and each compartment is filled with a liquid fuel carrying a different volatile active 614, so that different combinations of volatile actives may be emitted into the surrounding environment as the fuel charge 600 melts to form the pool. Although four compartments 618 are shown in FIG. 17, any number – from one to many – of compartments may be formed by providing fewer or additional medial walls 616, and different combinations of volatile actives, including having the same or no volatile active throughout all the compartments of the inner core, may be formed. In another embodiment, the fuel charge 600 may be divided into discrete sections in a similar manner as described previously herein. Each discrete section of the fuel charge 600 may carry a different volatile active 614, such as a fragrance, such that a user may assemble different combinations of volatile actives around the wick 22 and wick holder 48 to provide different selected effects and/or dispense different volatile actives into the surrounding environment at different times.

[0086] In one embodiment, a fuel thickener additive 620 that slows capillary flow of liquid fuel to the flame through the wick, such as ethyl cellulose, is disposed in a portion of the fuel charge 600 in a manner to cause the flame to burn less vigorously after a substantial portion of the fuel charge has melted as described previously herein. The fuel thickener additive 620 may be disposed in a peripheral portion of the outer shell 602, as shown in FIGS. 16B and 17, and/or may be disposed in liquid fuel contained in an outer compartment 618.

[0087] The fuel charge 600 may be formed in one embodiment by heat pressing candle wax into two opposing portions, such as an upper portion 622 and a lower portion 624, and heat welding the opposing portions together at a seam 626. In one method, the compartments 618 of the inner core may be filled with the liquid fuel prior to heat welding the opposing portions 622 and 624 together. In another method, the compartments 618 may be filled after the opposing portions 622 and 624 are heat welded together by injecting the liquid fuel through an injection hole into the compartments and subsequently plugging the injection hole.

[0088] In FIGS. 18 and 19, yet another embodiment of a fuel element 700 for use with a candle assembly includes a wick 22 and a wick holder 48 disposed in a fuel charge 702. The wick 22 and heat fins 62 extend axially above a top end of the fuel charge 702, and a base portion 52 is disposed within a cavity 704 in a bottom end of the fuel charge. The fuel element 700 is adapted to be placed on a melting plate 20 with a capillary pedestal 36 disposed in the base portion 52 and the bottom end of the fuel charge 702 disposed on the melting plate 20 in a similar manner as described previously herein. The fuel charge 702 has an outer shell 706 of meltable fuel material, such as candle wax, surrounding an inner core 708 of meltable fuel material, which surrounds the wick 22 and the wick holder 48. Each of the outer shell 706 and the inner core 708 is a substantially solid mass at room temperature. The outer shell 706 is spaced a distance from the wick 22 sufficient to allow a flame 70 on the wick to melt the outer shell. Fuel thickener additive 710 that slows capillary flow of liquid fuel to the flame through the wick, such as ethyl cellulose, is disposed in the outer shell 706 but not in the inner core 708. When initially lit, the flame 70 may be larger and rapidly melt the inner core 708 to form a pool of molten wax due to the free flow of melted wax to the flame through the wick 22. As the outer shell 706 is subsequently melted, the fuel thickener additive 710 is introduced into the pool, which may slow the rate of migration of the molten wax up the wick 22 to the flame 70 and thereby decrease the size of the flame. An amount of the fuel thickener additive 710 is disposed in the outer shell 706 that is sufficient to decrease the flame size and yet provide enough fuel flow through the wick 22 to continue feeding the flame 70.

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[0089] In operation, the flame 70 melts the fuel charge 702 by direct convection and by conduction through heat transmissive surfaces such as the heat fins 62, base portion 52, and melting plate 20. The melted fuel collects into a pool of liquid fuel on the surface of the melting plate 20, and the liquefied fuel is delivered from the pool upwardly to the wick 22 by capillary action through a capillary space 68 formed between the base portion 52 and a capillary lobe 36 on the melting plate. The fuel material of the outer shell 706 introduces the fuel thickener additive 710 into the pool after the pool has been formed, and in one embodiment, introduces an amount of the fuel thickener additive into the pool that is sufficient to slow migration of the liquefied fuel in the wick to the flame without extinguishing the flame only after a substantial portion of the fuel charge 702 has been melted.

[0090] The fuel charge 702 in one embodiment is substantially cylindrical, having the wick extending axially through a cylindrical inner core, which is surrounded by an adjacent outer shell. In other embodiments, the fuel charge 702 may have other shapes and may include intermediate layers and/or materials between the inner core and the outer shell and surrounding the outer shell. In yet another embodiment, the wick 22 is disposed in the fuel charge 702 without the wick holder 48 or carried by a wick holder that does not include the heat fins 62 and base portion 52, and no cavity 704 is disposed in the bottom end. In a further embodiment, the fuel charge 702 has only an axial opening through the inner core 708 adapted to accept a wick and/or wick holder therethrough. In an even further embodiment, the axial opening extends through the outer shell to allow a wick and/or wick holder to enter the axial opening from a side of the fuel charge 702.

[0091] The invention having been described in an illustrative manner, it is to be understood that the terminology used is intended to be in the nature of description rather than of limitation. The various components of the various melting plate candle assemblies described herein may be packaged as an assembled unit, as an unassembled kit including all or a portion of the components, as individual components, and in any combination thereof. Other variations, modifications, and equivalents of the present invention possible in light of the above teachings are specifically included within the scope of the impending claims.

[0092] While the present invention has been described with respect to what are at present considered to be the preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments. To the contrary, the invention is intended to cover various modifications and equivalent arrangements within the spirit and scope of the appended claims. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent formulations and functions.

INDUSTRIAL APPLICABILITY

[0093] The melting plate and heat conductive element candles of the present invention, utilizing a capillary pedestal and correspondingly shaped wick holder, can be used in connection with a large variety of solid fuels. The conductive materials of which the melting plate and heat fins may be constructed are commonly available, and the various configurations are readily produced. There is considerable interest for candles having extended burn times, and for refillable candles or solid fuel lamps, particularly for melting plate candles which are resistant to accidental release of the wick holder assembly. In addition, a solid fuel charge carrying a volatile active is quickly melted on the melting plate to begin rapid disbursement of the active volatile to the surrounding atmosphere. The capillary pedestal construction allows for complete or nearly complete consumption of the fuel element while a peaked apex configuration of the pedestal ensures or promotes proper positioning of the complementary fuel element thereon to take advantage of the benefits of the melting plate candle assembly.

[0094] The fuel charges of the present invention may be used to provide fuel to a flame on a wick portion of a melting plate candle assembly. Providing an inner core of fuel material different than a surrounding outer shell can allow the fuel charges to completely liquefy quickly, and thereby hasten emission of volatile actives that may be contained therein. Providing a fuel thickener additive that slows capillary flow of liquid fuel to the flame through the wick in only a portion of the fuel charges can slow flow of the liquefied fuel to the flame after the fuel charge is substantially liquefied and thereby slow consumption of the

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liquefied fuel and increase the useful life of the fuel charge. Other useful benefits of the present invention will be apparent to those skilled in the art.

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Claims

I claim:

1. A candle assembly, comprising:

a meltable fuel element;

a melting plate comprising a heat conductive surface upon which the meltable fuel element rests; and

a wick retainer positioned on the melting plate comprising at least one of a pedestal that cooperatively and lockingly engages a base portion of a wick holder or a magnetic means that engages and magnetically retains the wick holder to prevent accidental removal from the melting plate;

wherein the wick holder comprises a wick, and the wick holder is adapted to conduct heat from a flame optionally disposed on the wick to the melting plate and engage the meltable fuel element.

2. The candle of claim 1, wherein the wick holder further comprises at least one heat conductive fin, and optionally at least one magnetic metal insert.

3. The candle as in any one of the preceding claims, wherein the wick holder further comprises at least one of a skirt configured to engage an undercut portion of at least one of the pedestal or the bottom surface of the melting plate, or a magnet located beneath the pedestal to magnetically attract a metal insert in the wick holder.

4. The candle assembly of claim 1, wherein the base portion of the wick holder engages the wick retainer and forms a capillary space therebetween, wherein the capillary space is configured to at least one of define a capillary well configured to supply the wick with fuel for a period of time required to melt an amount of the meltable fuel element adjacent to the wick holder sufficient to provide a substantially continuous flow of melted fuel into the capillary space, define a volume sufficient to contain an amount of meltable fuel to feed the flame on the wick, or define a volume proportional to a thermal mass of the candle assembly.

5. The candle assembly of claim 1, wherein the melting plate and the base are dimensioned to promote laminar airflow across a melted pool of fuel element carried in the melting plate when the flame is disposed in close proximity above the pool and the surrounding air is substantially calm.

6. A meltable fuel element adapted for use with a candle assembly having a bottom wall and a wick retainer to engage or retain a wick holder, the meltable fuel element, comprising:

a body of substantially solid fuel material defining a duct adapted to receive a wick therethrough in an assembled condition; and

the duct having a first width adapted to ensure that liquid passing through the duct engages the wick in the assembled condition.

7. The meltable fuel element of claim 6, further comprising at least one of a depression disposed in a lower surface thereof, wherein the depression is adapted to receive the wick retainer extending upwardly from a low point of the bottom wall of the candle assembly, or a shape to be in thermal communication with the bottom wall when the wick retainer is received in a depression disposed in a lower surface thereof.

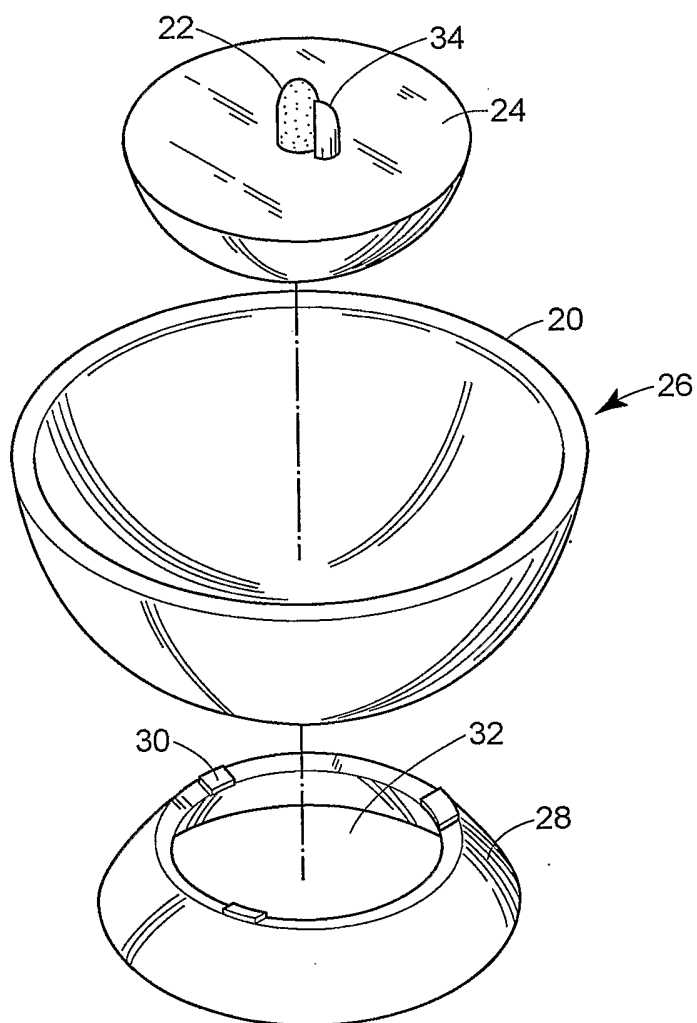
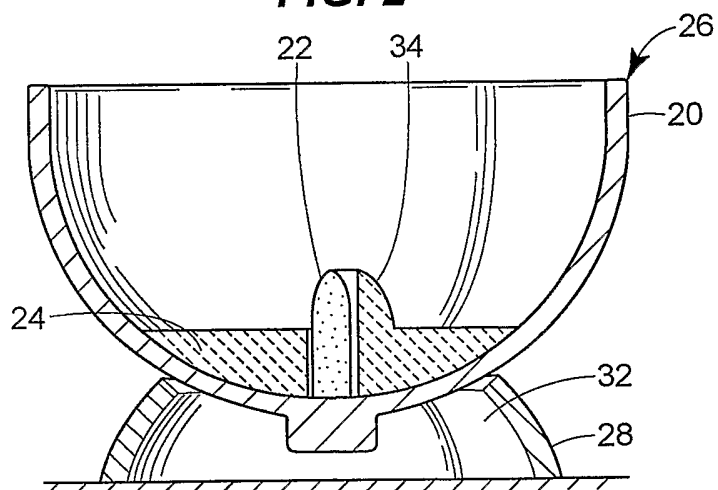
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8. The meltable fuel element of claim 6, further comprising at least one of
- a solid outer shell of meltable first fuel material, the shell forming an inner peripheral wall defining an opening through a medial portion of the meltable fuel element;
 - a second fuel material including a plurality of discrete fuel particles composed of a meltable fuel material and a plurality of interstitial spaces dispersed between the fuel particles;
 - an inner core encompassed within the outer shell, the inner core comprising the second fuel material in a second form different than the outer shell, and where the inner core optionally comprises a substantially liquid fuel material comprising a volatile active and an inflammable oil;
 - a volatile active;
 - a fuel additive that slows capillary flow of liquid fuel through a wick, wherein the fuel additive optionally comprises a non-aqueous viscosity modifier disposed only in an outer peripheral portion of the outer shell; or
 - a heat transmissive element disposed near a location on the wick where the flame would burn and extending through a portion of the fuel element.
9. The meltable fuel element of claim 6, the wick holder, comprising:
- an enclosed wick casing having a first open end and a second open end;
 - a wick extending between the first open end and the second open end with a portion of the wick surrounded by the wick casing; and
 - means for restricting a capillary fluid flow capacity of the wick between the first open end and the second open end;
 - wherein the wick holder optionally comprises a base portion disposed at one end of the wick casing, wherein the base portion includes a surface adapted to substantially conform about a pedestal, and further wherein the optional base portion is adapted to provide a supply of melted fluid fuel material to a base end of the wick when the base end is engaged over the pedestal.

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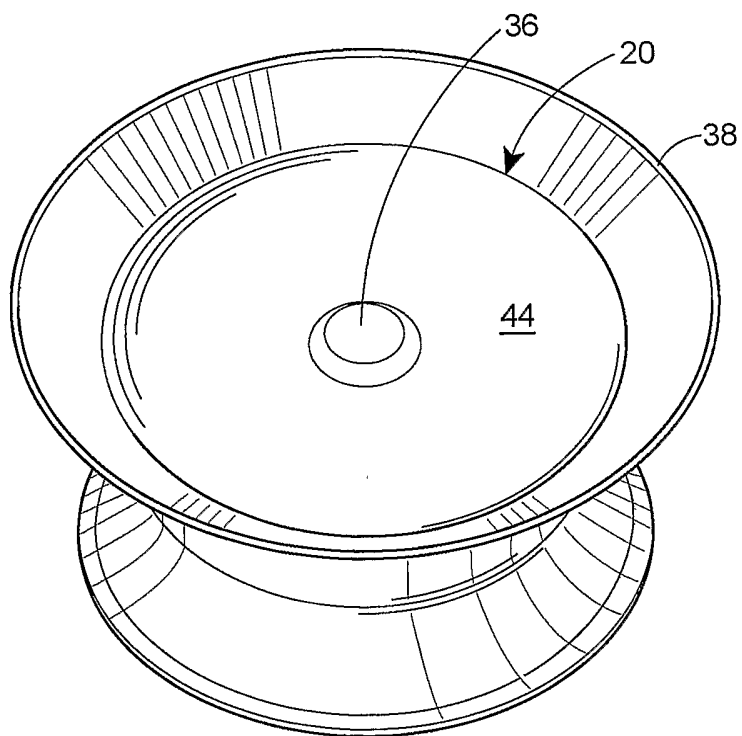
10. A method of supplying liquefied fuel to a wick in a candle assembly, comprising:
- melting a portion of a meltable fuel element into the liquefied fuel by direct convection from a flame on the wick and by conduction of heat from the flame to a melting plate supporting the meltable fuel element;
 - collecting the liquefied fuel into a pool on the melting plate;
 - delivering the liquefied fuel from the pool to the wick; and
 - introducing a fuel additive that slows capillary flow of liquid fuel through the wick into the pool after the pool has been formed.

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FIG. 1**FIG. 2**

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FIG. 3A



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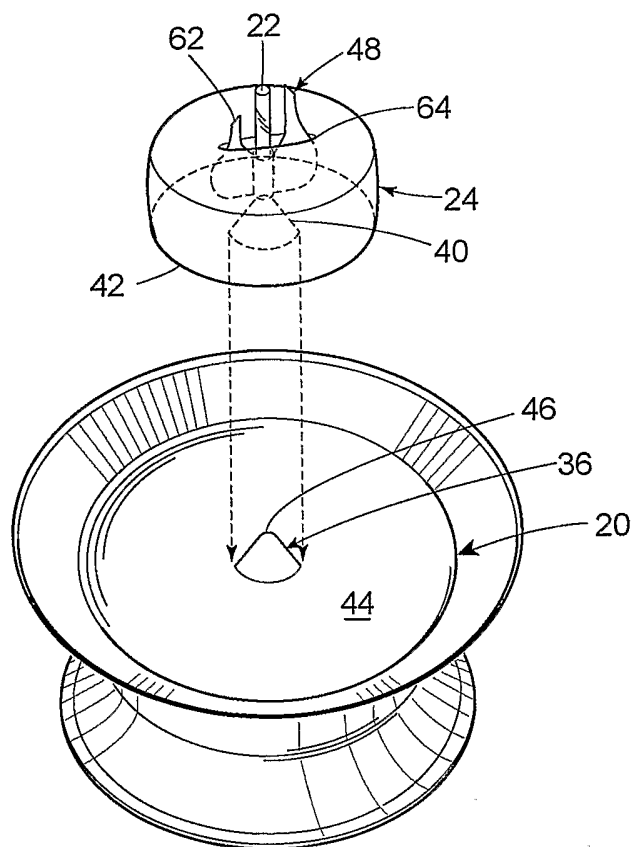
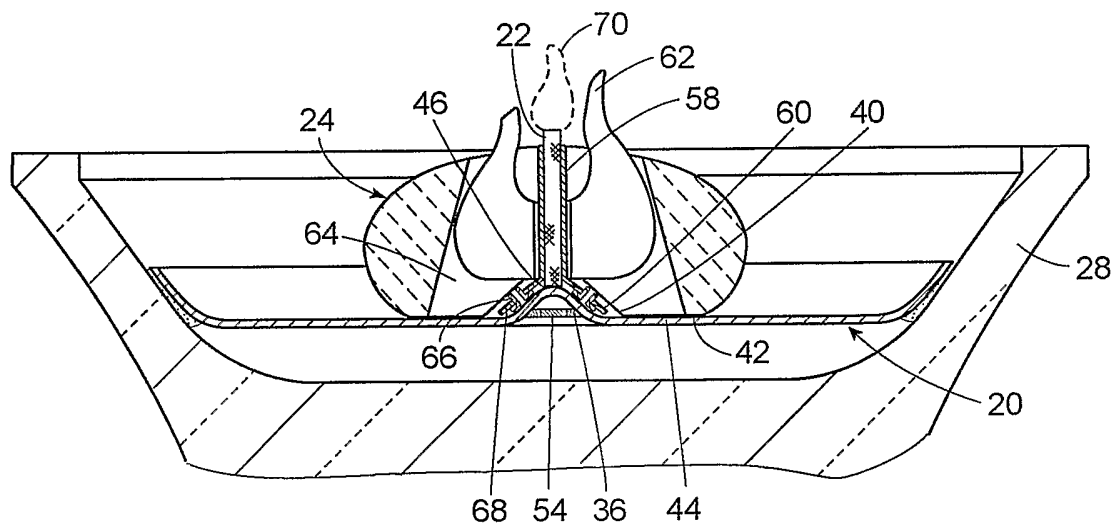
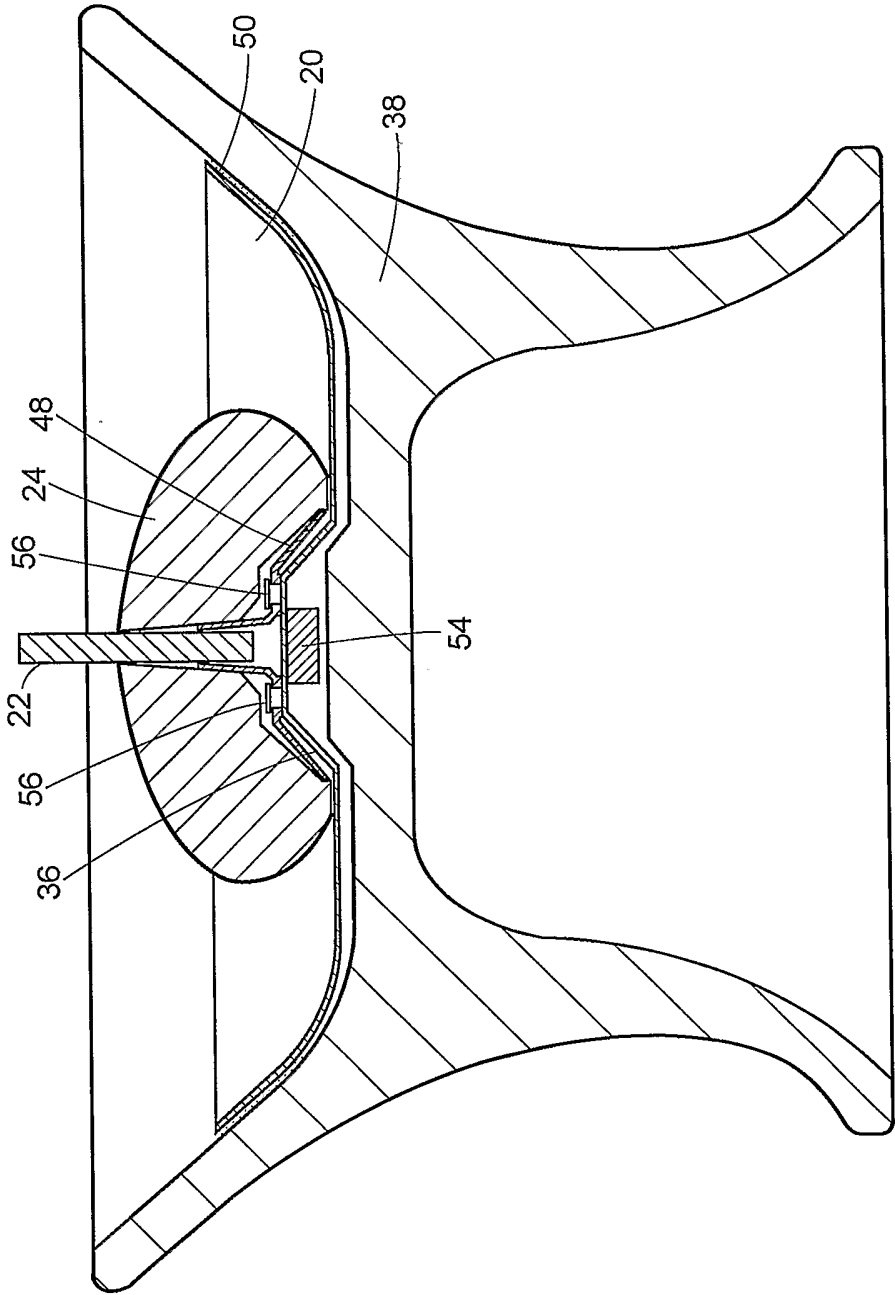
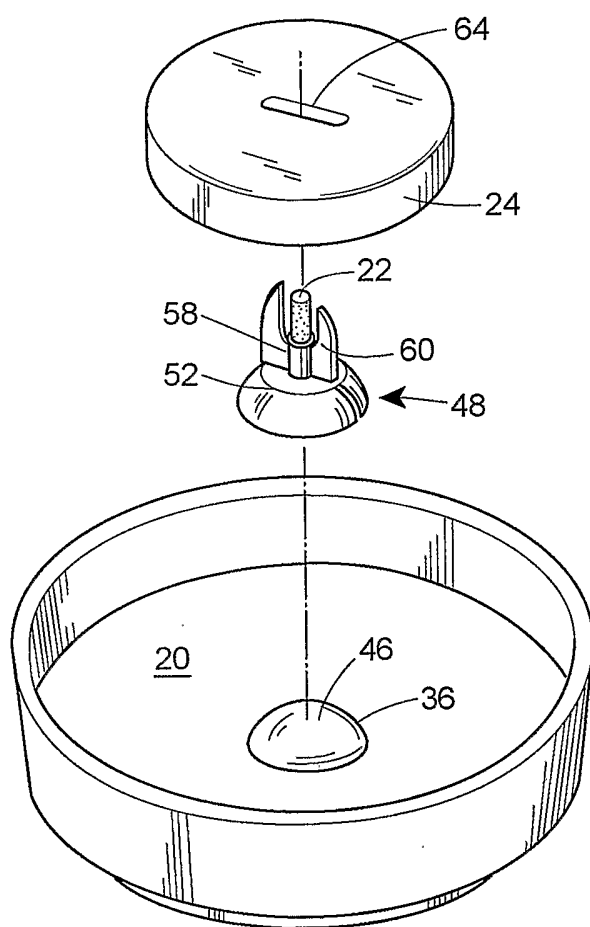
FIG. 3B**FIG. 4B**

FIG. 4A



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FIG. 5B



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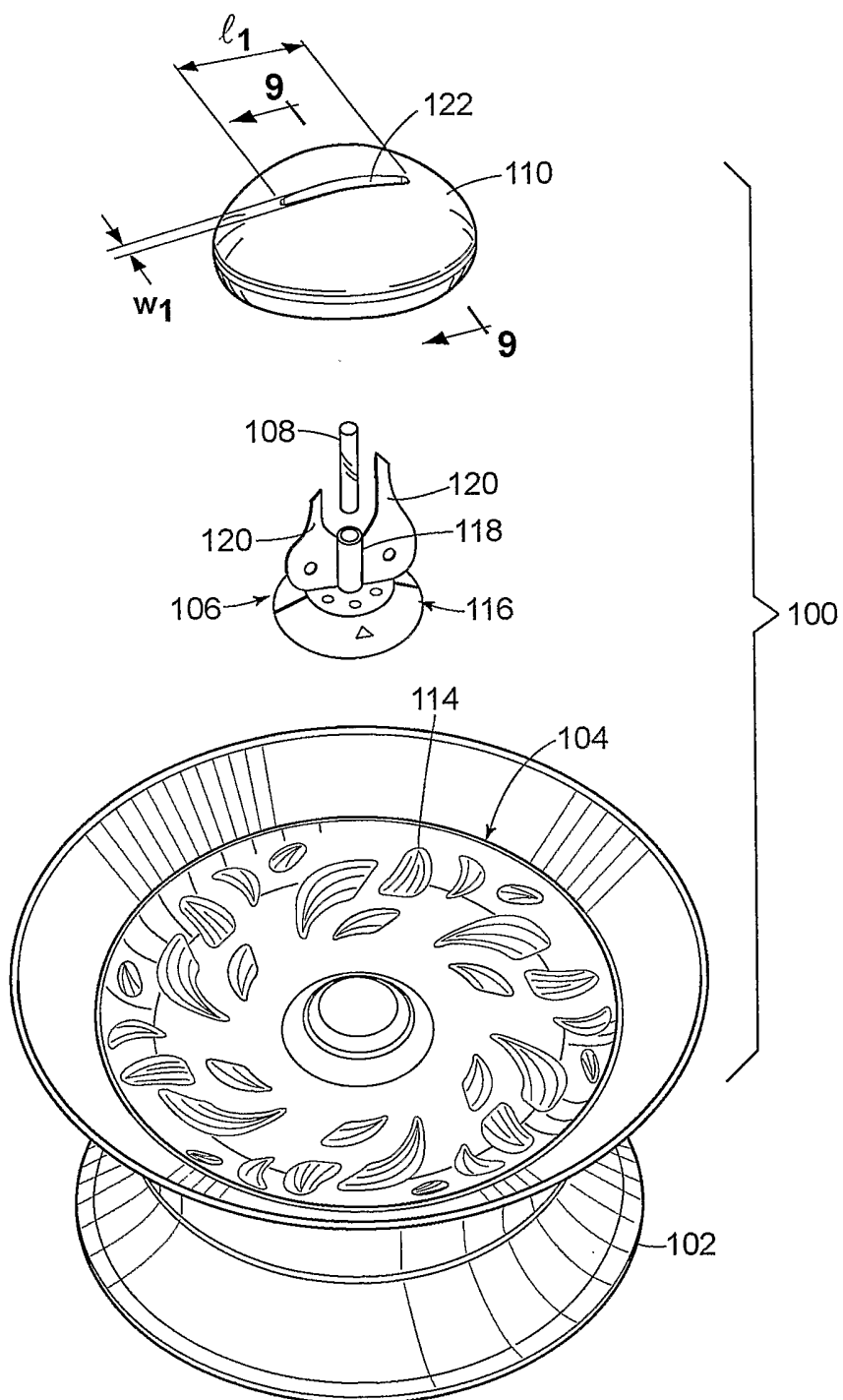
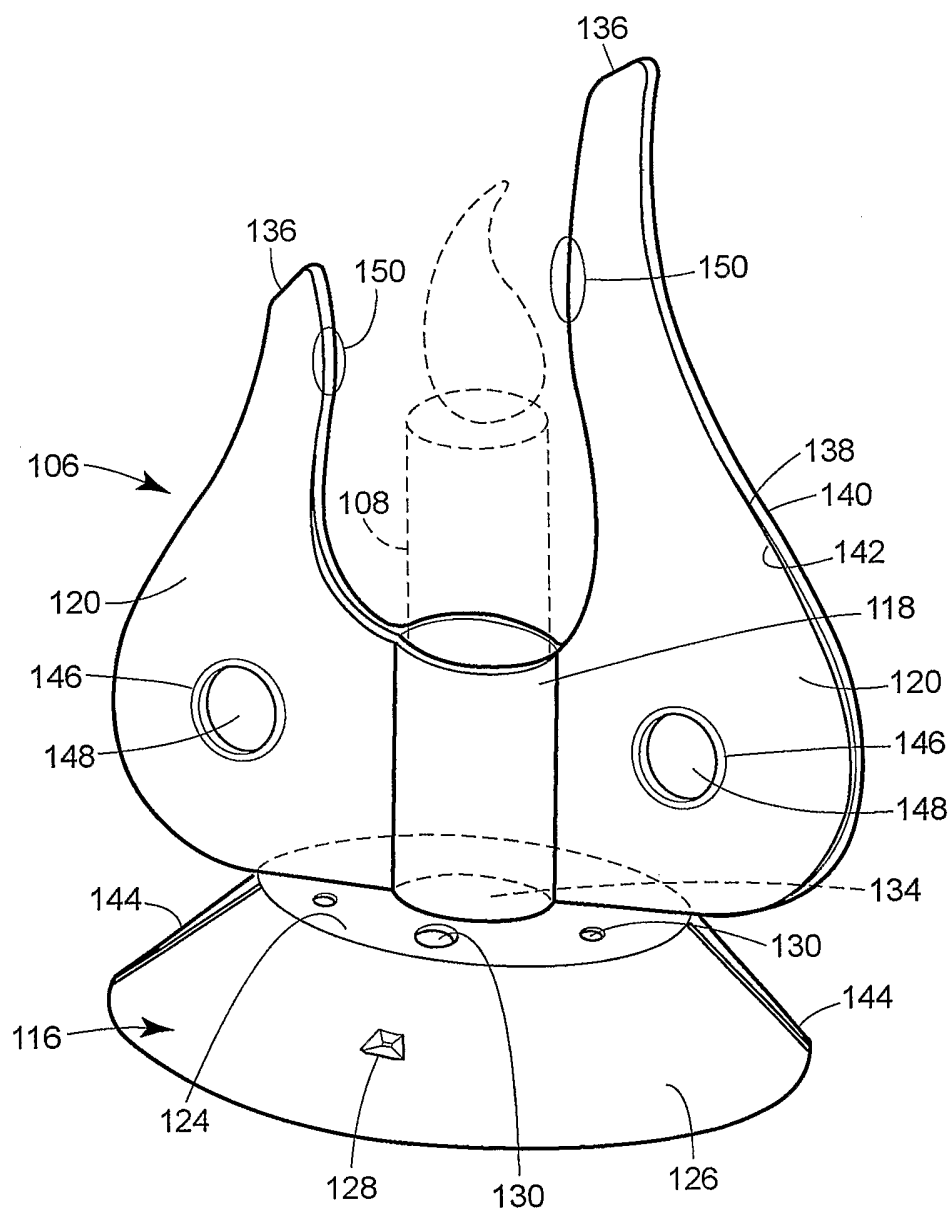
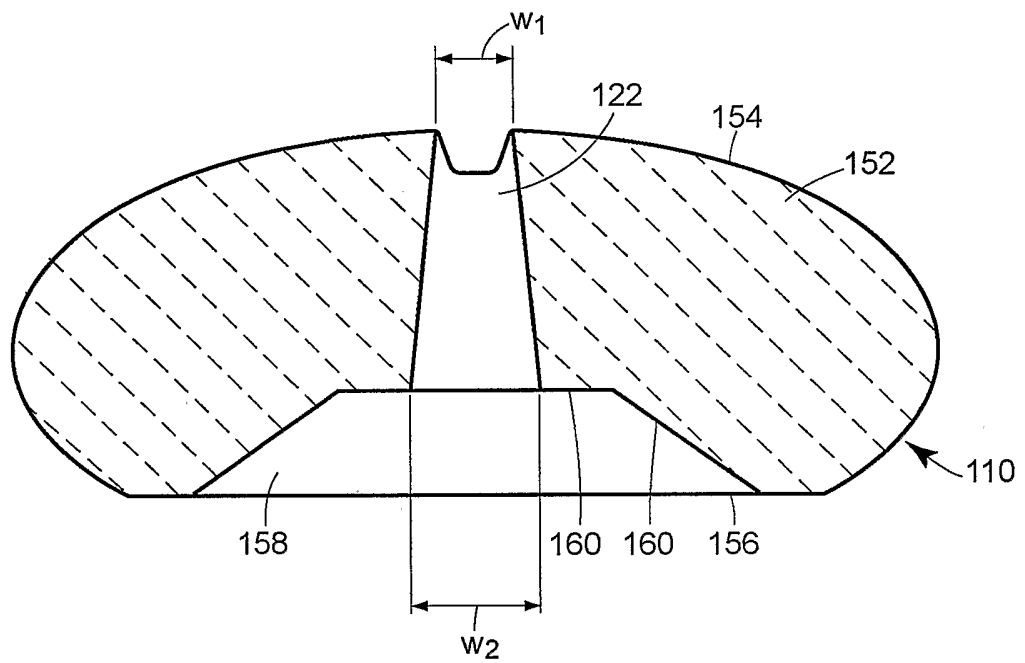
FIG. 7

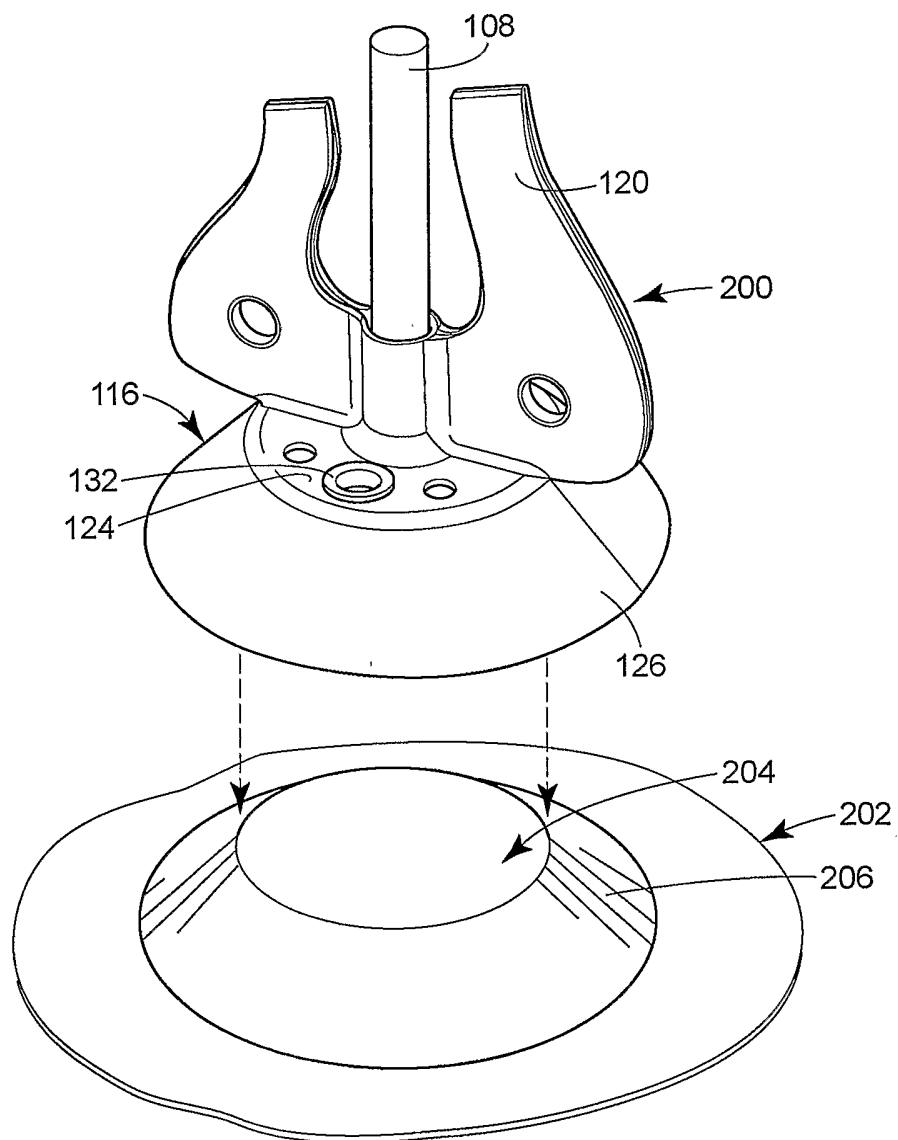
FIG. 8

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FIG. 9



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FIG. 12

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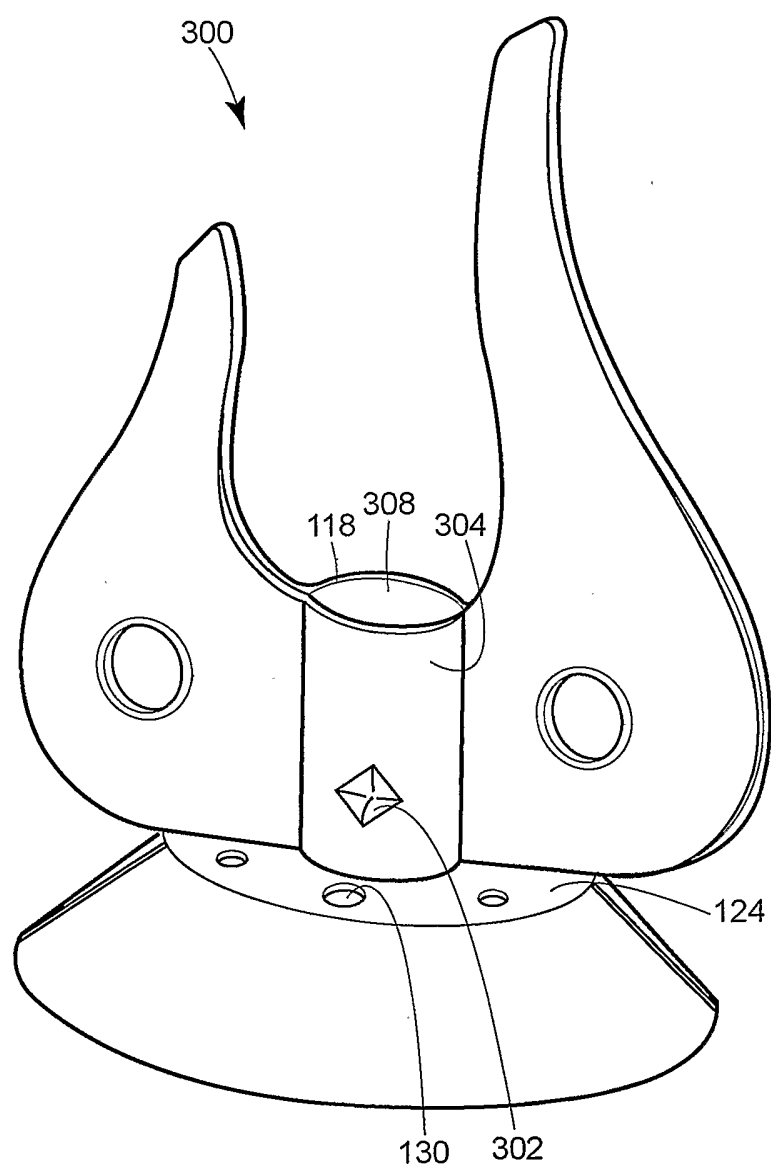
FIG. 13

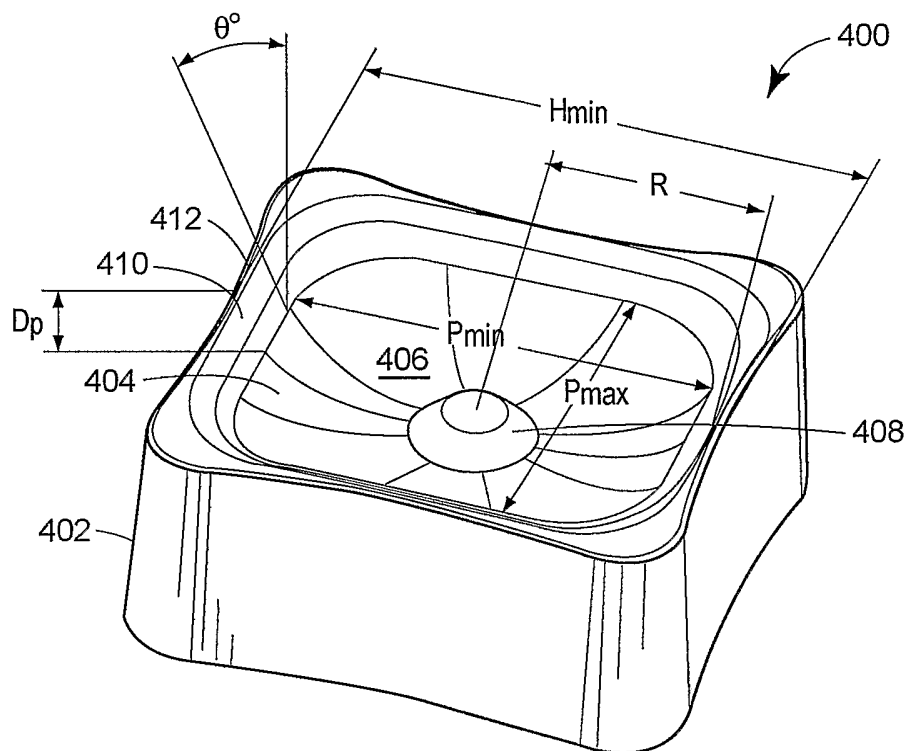
FIG. 15

FIG. 16A

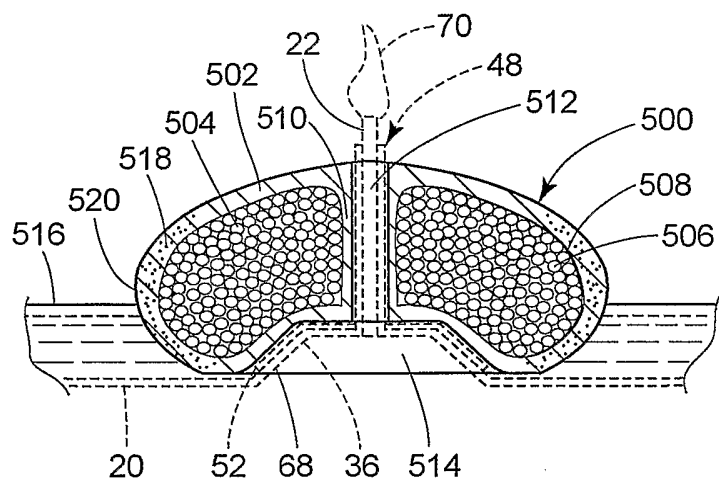


FIG. 16B

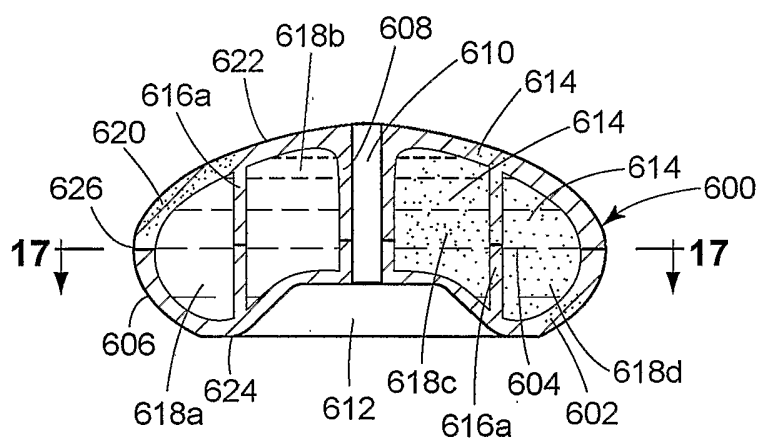
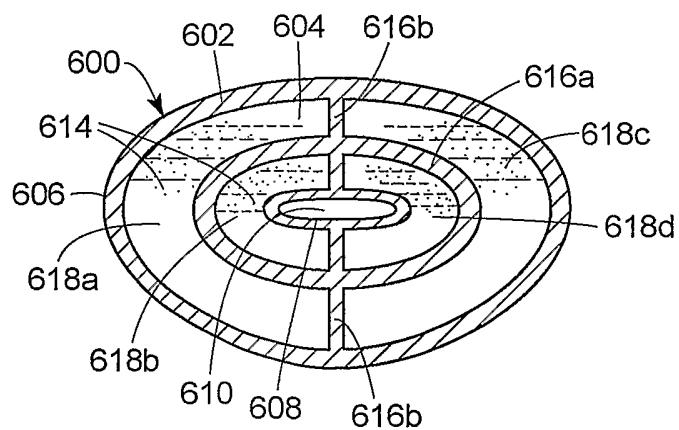
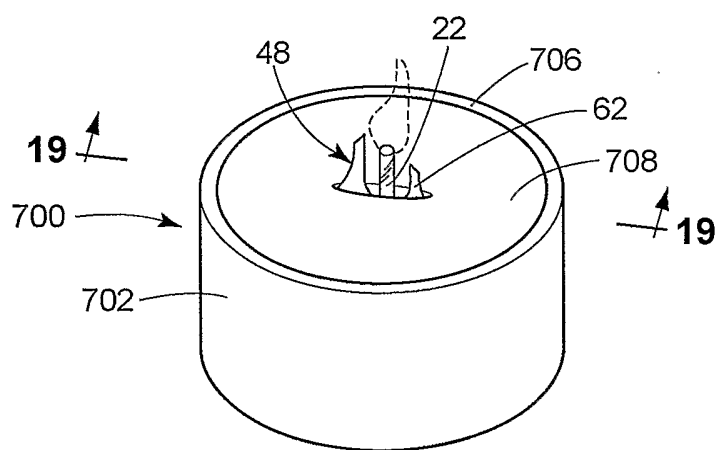


FIG. 17



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FIG. 18**FIG. 19**