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(54) **KINETIC FLAME DEVICE**
(75) Inventors: **Douglas M. Patton**, Irvine, CA (US);
Gary W. Schnuckle, Altadena, CA (US)
(73) Assignee: **Disney Enterprises, Inc.**, Burbank, CA (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 163 days.

This patent is subject to a terminal disclaimer.

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Primary Examiner — Laura Tso
(74) *Attorney, Agent, or Firm* — Marsh Fischmann & Breyfogle LLP; Kent A. Lembke

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(60) Provisional application No. 61/293,516, filed on Jan. 8, 2010, provisional application No. 61/101,611, filed on Sep. 30, 2008.

(57) **ABSTRACT**

An apparatus creating a flickering flame effect. The apparatus includes a housing with an interior space with first and second stages. A drive mechanism generates a time varying electromagnetic field extending into the first stage. A first pendulum member is pivotally mounted in the interior space of the first stage and includes first and second magnets on first and second ends, with the first end proximate to the drive mechanism such that the first magnet interacts with the varying electromagnetic field to cause movement of the pendulum member. The apparatus includes a second pendulum member pivotally mounted in the second stage with a magnet on a first end proximate to the second end of the first pendulum member. A flame silhouette element extends from the second pendulum member, and a light source transmits light onto the flame silhouette, which is moving due to the magnetic coupling of the pendulum members.

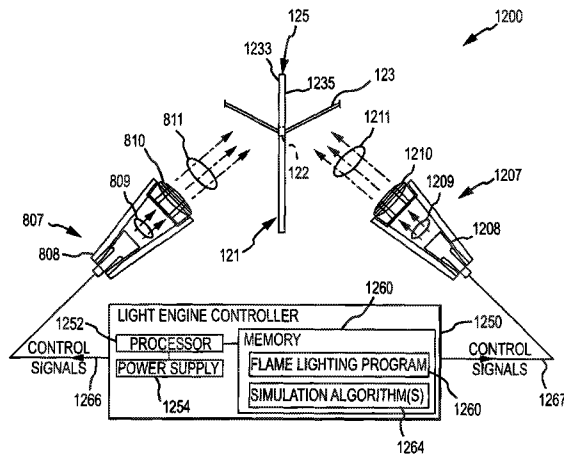
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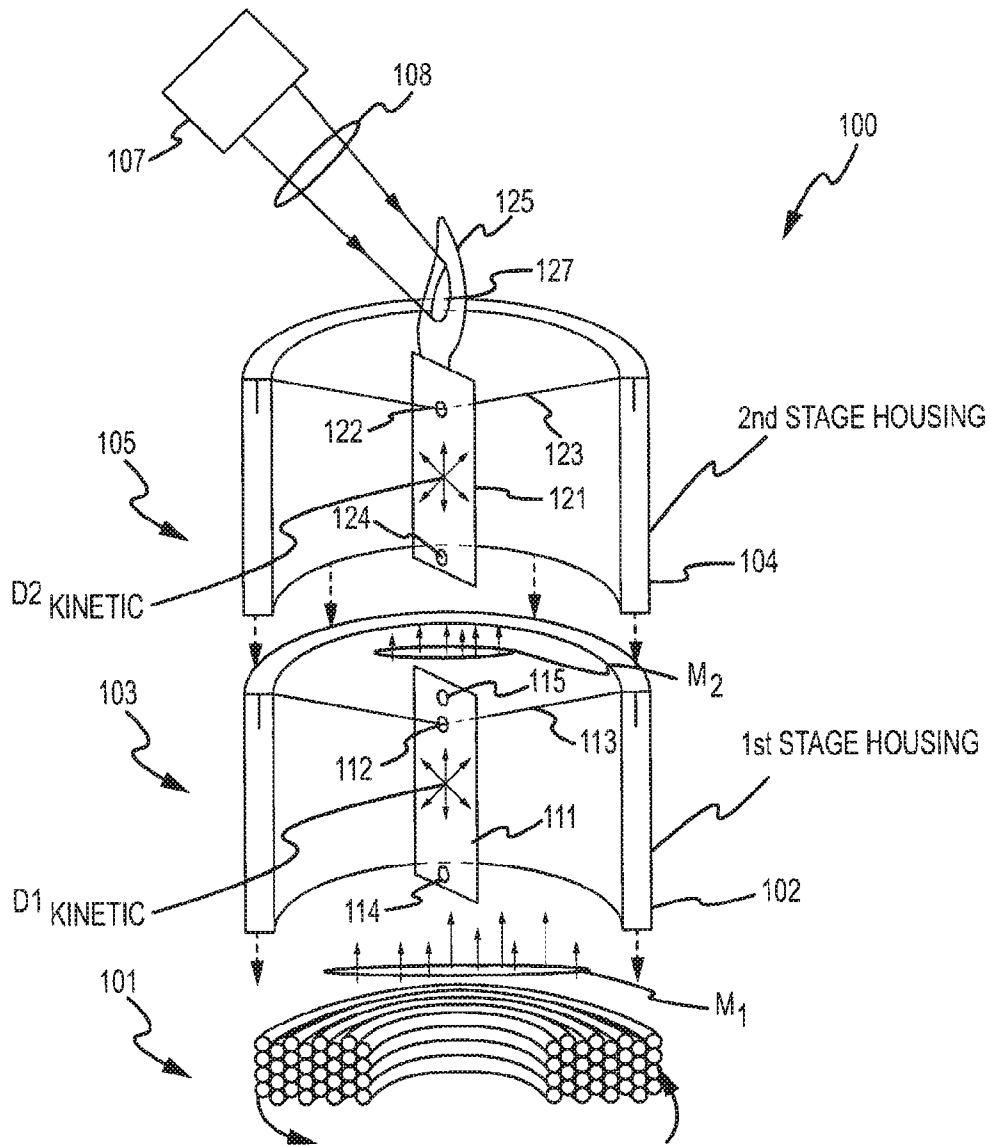


FIG.1

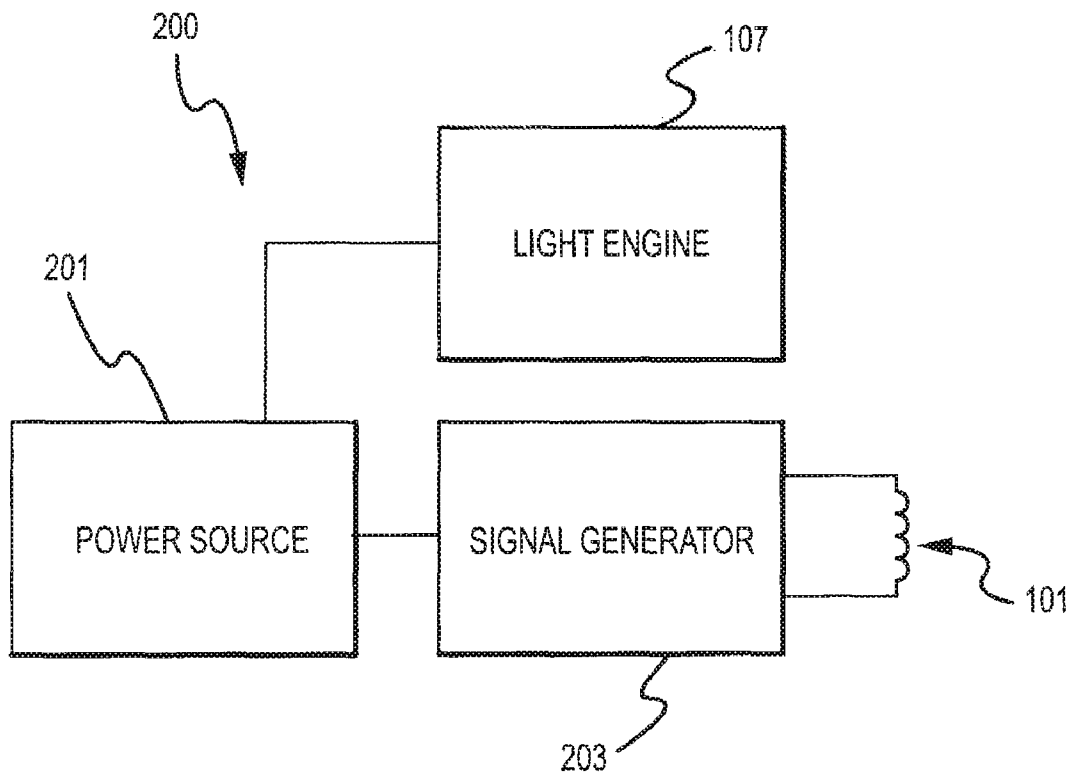


FIG.2

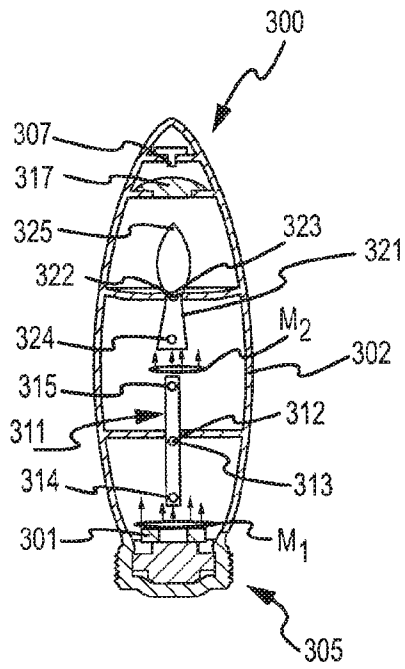


FIG. 3

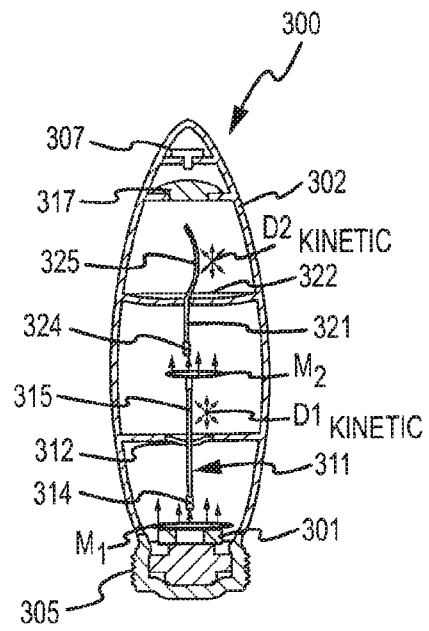


FIG. 4

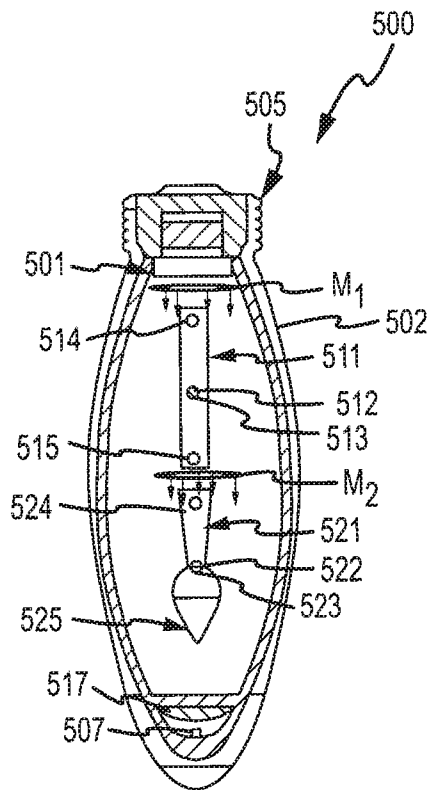


FIG.5

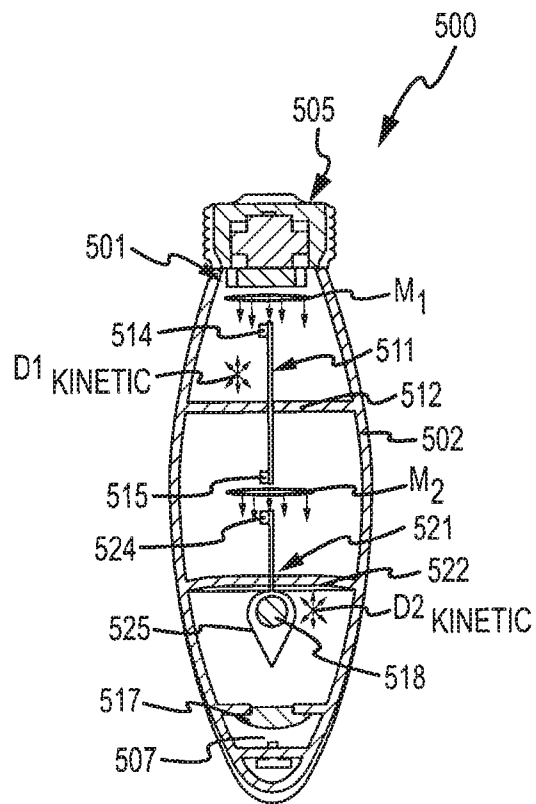


FIG.6

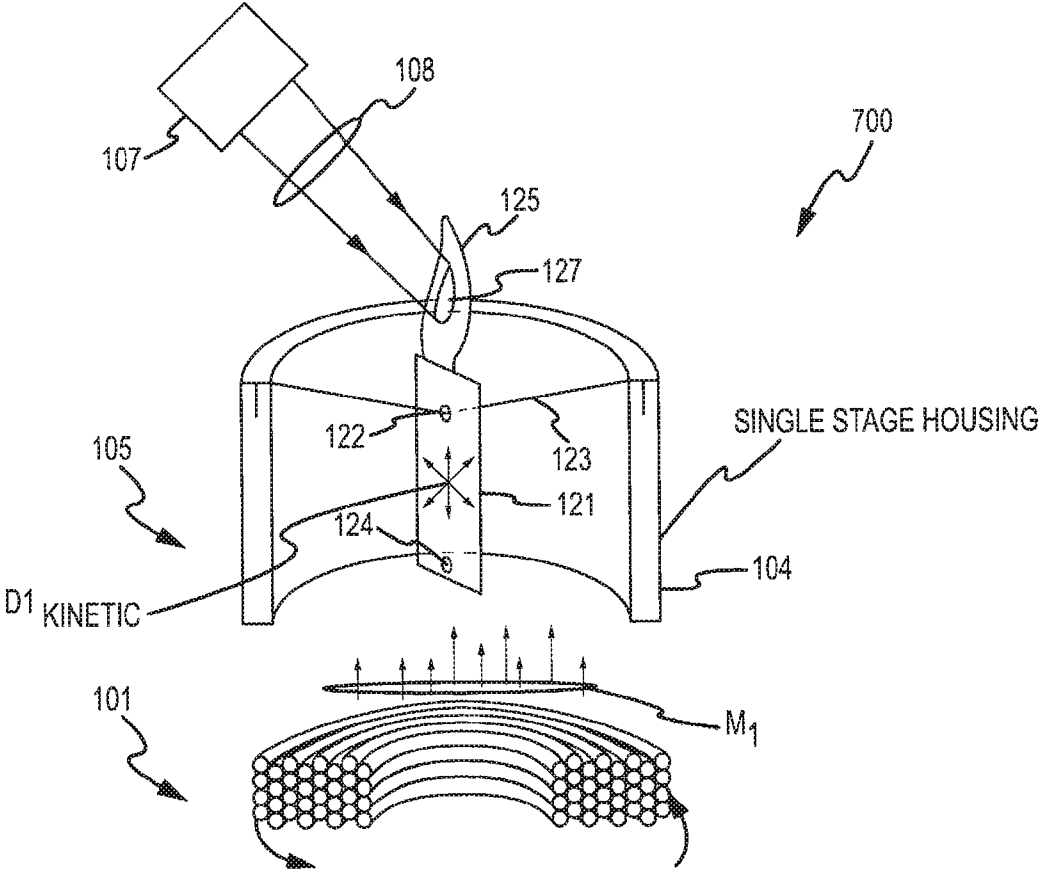


FIG. 7

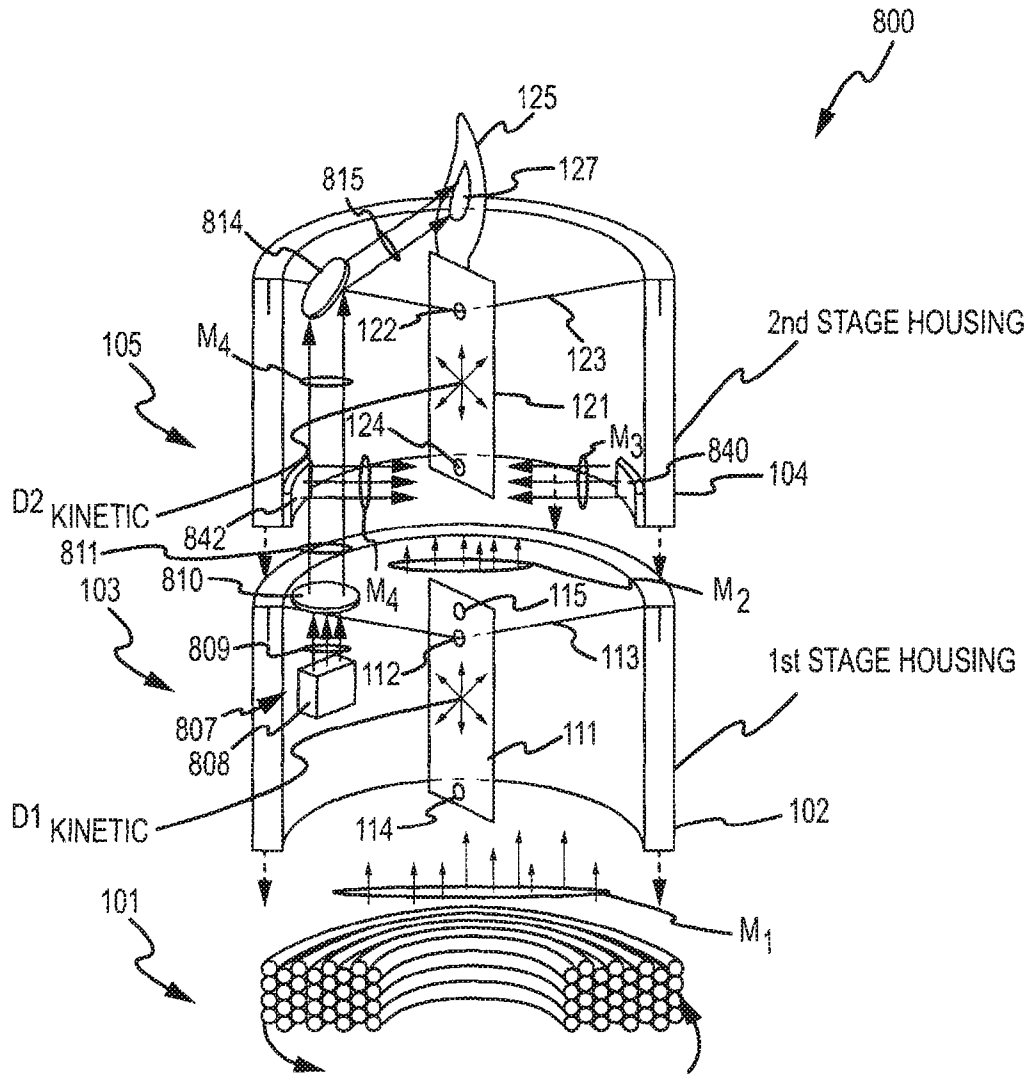


FIG. 8

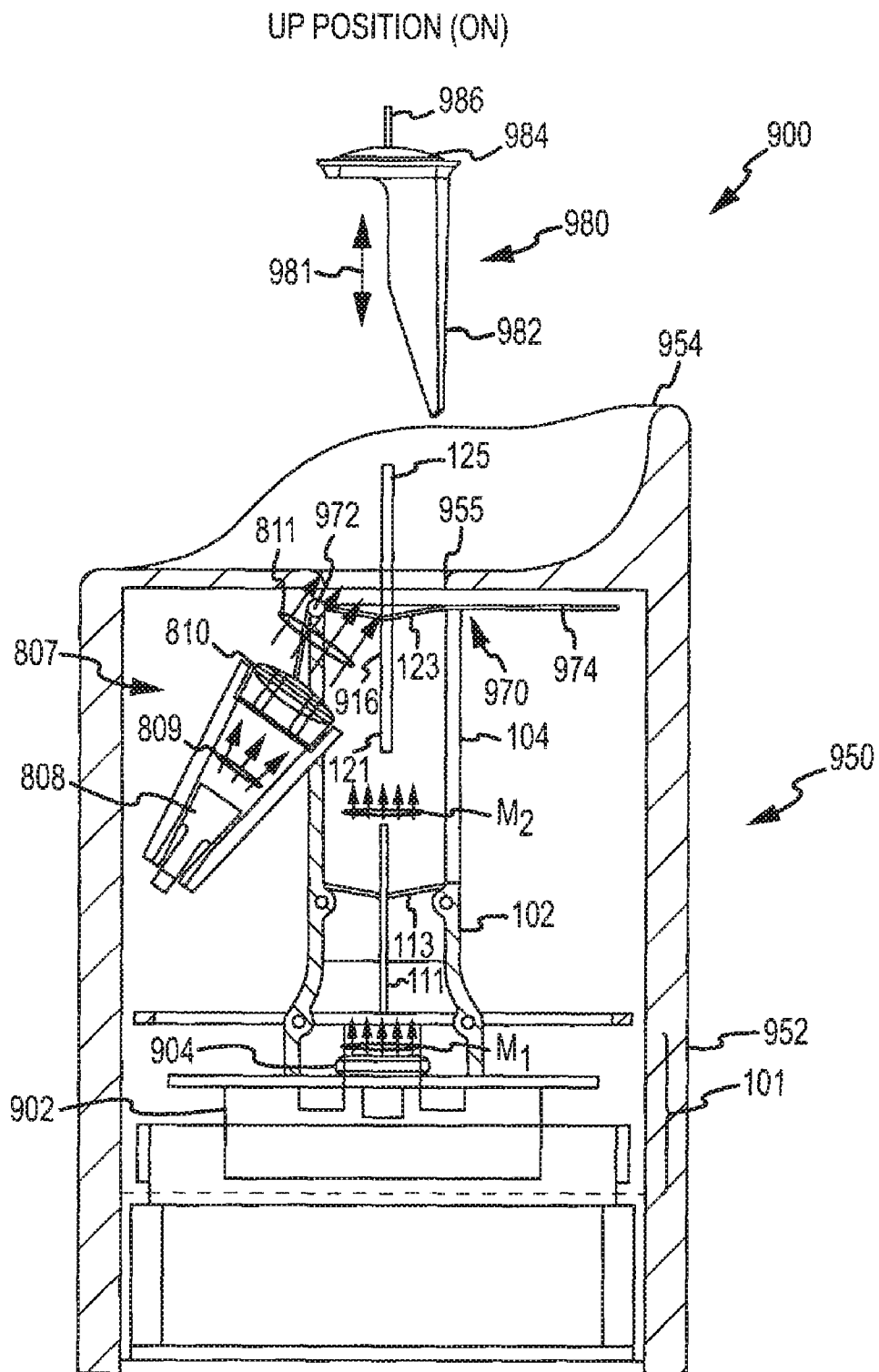


FIG. 9

DOWN POSITION (OFF)

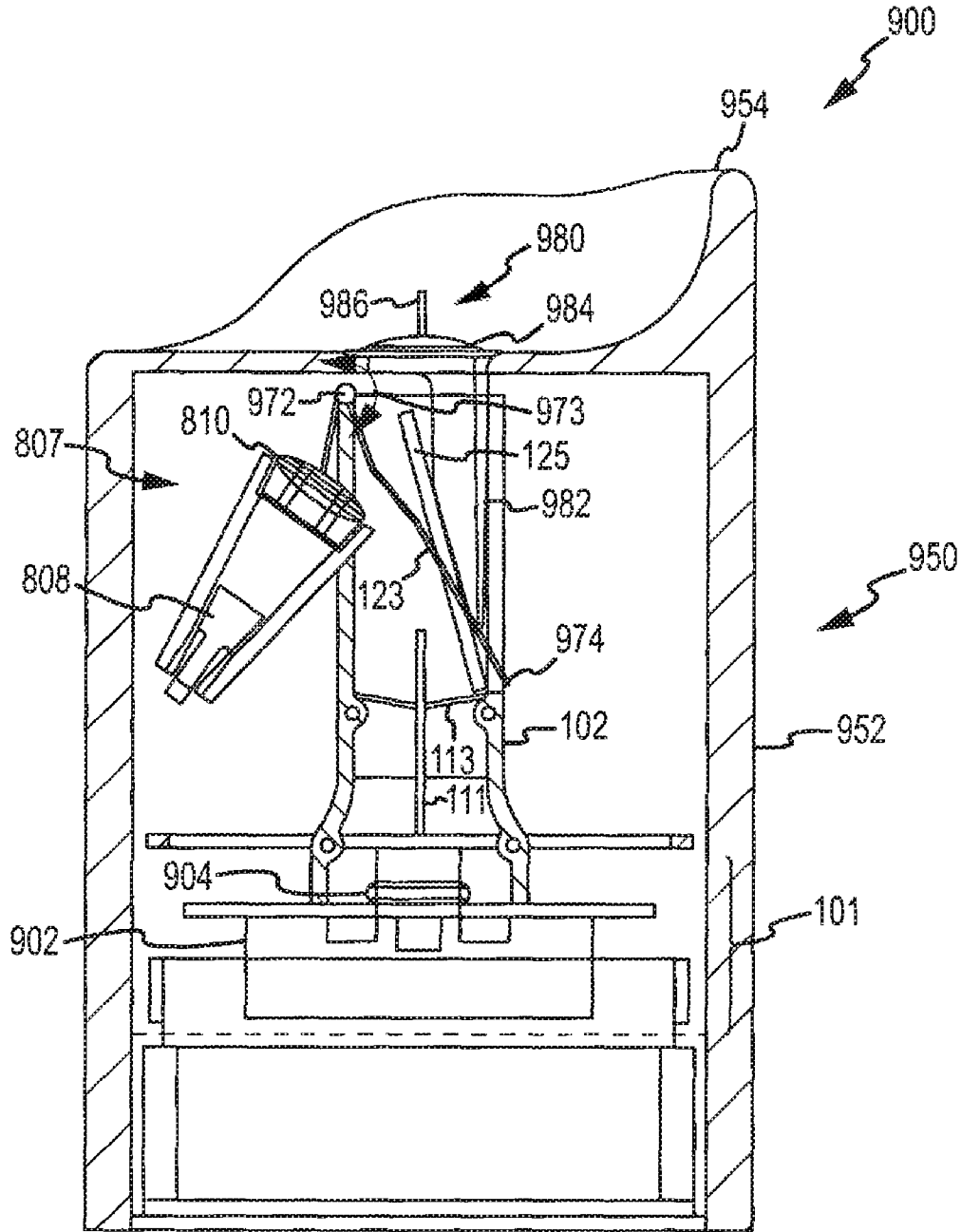


FIG. 10

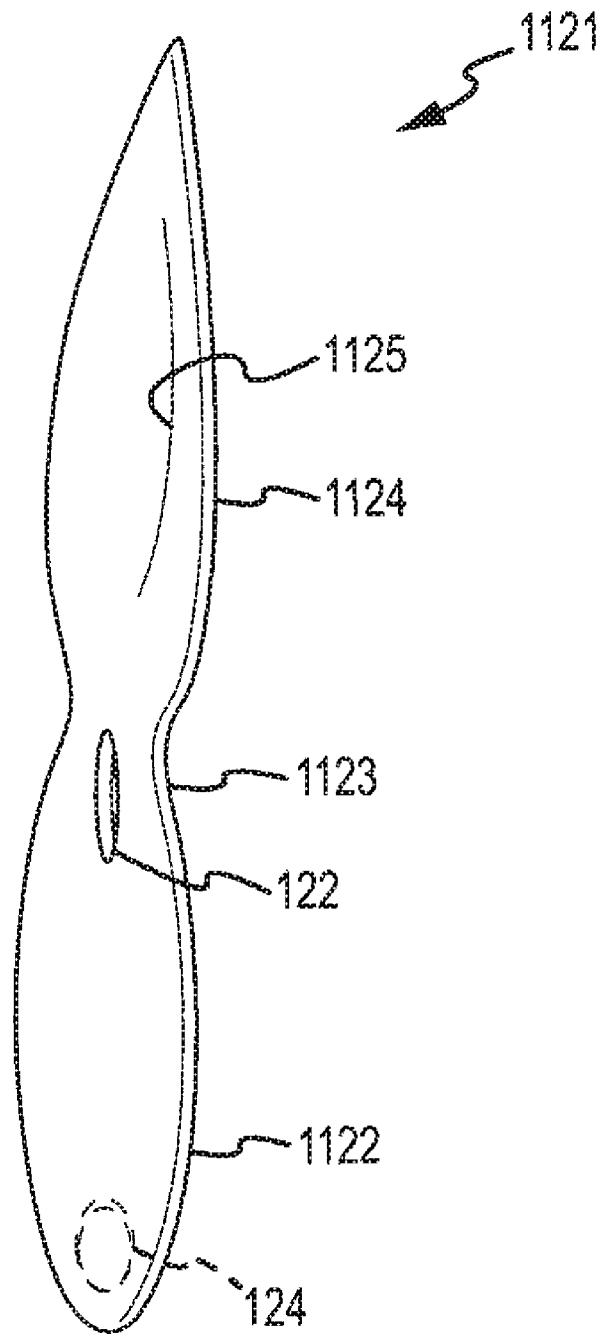


FIG. 11

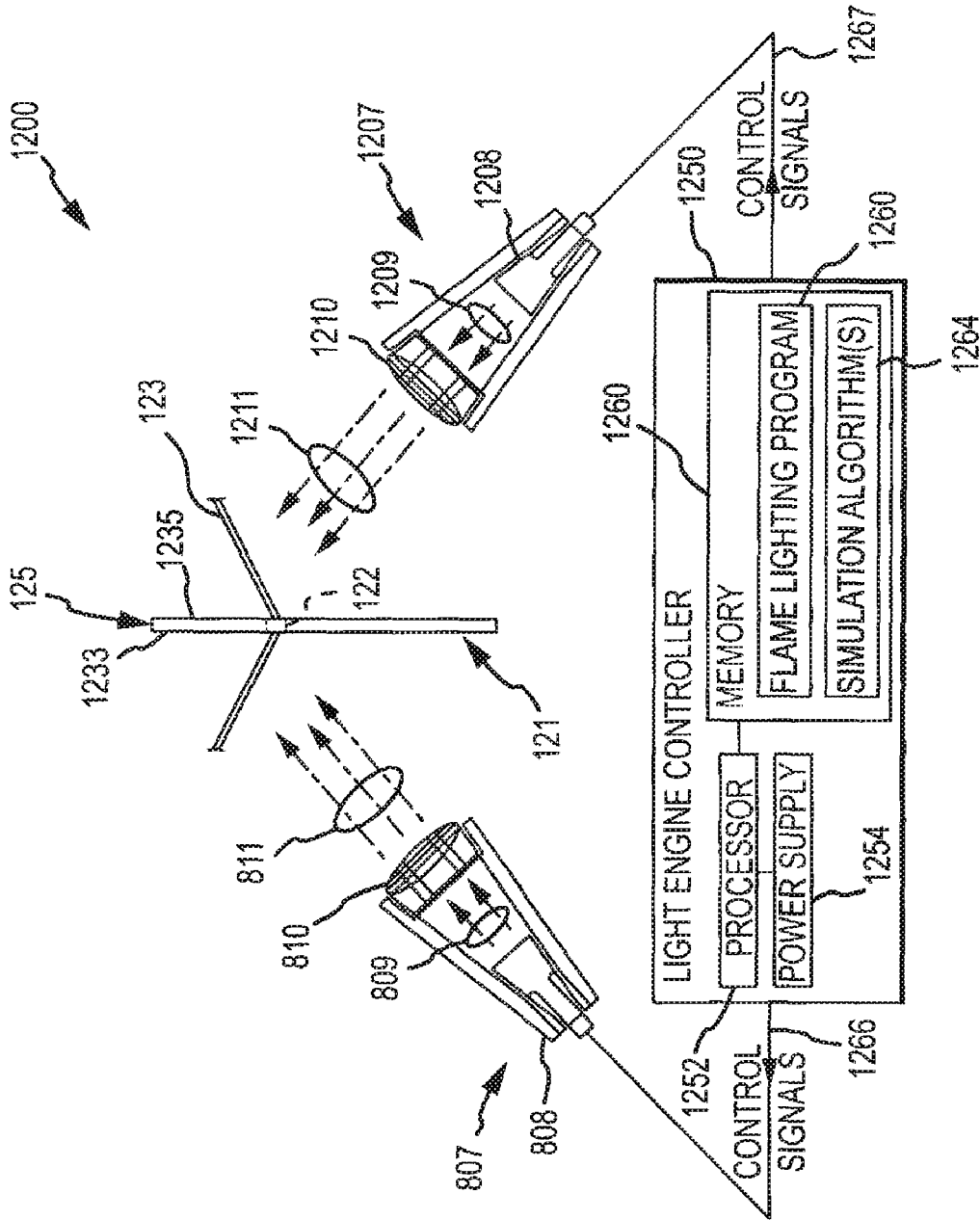


FIG.12

KINETIC FLAME DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/293,516, filed Jan. 8, 2010, and is also a continuation-in-part of U.S. patent application Ser. No. 12/851,749, filed Aug. 6, 2010, which is a continuation-in-part of U.S. patent application Ser. No. 12/506,460, filed Jul. 21, 2009, issued as U.S. Pat. No. 7,837,355, which claimed the benefit of U.S. Provisional Application No. 61/101,611, filed Sep. 30, 2008, all of which are incorporated herein by reference in their entireties.

BACKGROUND

1. Field of the Description

The present description relates, in general, to methods and systems for animated lighting, and, more particularly, to systems, devices, and methods for simulating a flickering flame providing kinetic light movement.

2. Relevant Background

A difficult challenge for a special effects artist is the simulation of a single candle flame. Simulated flames in large fires such as fireplaces or stage sets are comparatively easy to design because they are normally viewed from a distance, and much of the effect of a large fire involves glow and embers, which can be readily simulated. A single candle, however, is often viewed at short distances with the focus of the effect falling on the flickering light of the solitary flame moving kinetically or randomly on a wick.

Flames are the visible, light-emitting part of a fire. Solitary flames are complex kinetic interactions of fuel, temperature gradients, convection, and ambient airflow. These interactions produce a continuously and randomly moving light having loosely defined regions of various colors where the regions change size and shape kinetically or in unpredictable manners in space. Despite the complexity, people are so familiar with the appearance of natural flames that it is very difficult to provide a convincing simulation that appears real or natural to a viewer, especially at short viewing distances of several feet or less.

Combustion-based candles create safety issues in many environments because of the presence of flame and heat. These conventional candles are high-maintenance and, so, are not suitable for long-term usage such as in religious buildings, theme parks, memorials, window displays, museums, and the like without continuous maintenance. On the other hand, conventional wax candles produce a light that appeals to many people and can be readily manufactured for a wide variety of applications such as table lighting, room lighting, wall sconces, spiritual ceremonies, theatrical lighting, decorative lighting, and lighting for holidays and special events. Hence, a continuing need exists for an artificial flame simulator that can be used more safely and with less maintenance than conventional wax or combustion candles, and the artificial flame simulator or device should produce a pleasing and realistic simulation of solitary flames and be adaptable to a variety of form factors.

There are a variety of flame imitation novelty products that utilize various methods to simulate a real flame for display purposes such as those disclosed in U.S. Pat. Nos. 7,125,142, 6,454,425 and 4,550,363. Specifically, U.S. Pat. No. 7,125,142 describes a device that uses multiple colored lights affixed to a translucent shell where the lights are energized according to a computer program that attempts to animate the

light without moving parts. U.S. Pat. No. 6,454,425 discloses a candle flame simulating device that includes a blowing device for generating an air flow and for directing the flowing air toward a flame-like flexible member, in order to blow and oscillate or to vibrate the flame-like flexible member so as to simulate a candle. U.S. Pat. No. 4,550,363 discloses an electric-light bulb fitted with a light permeable and light-scattering lamp casing. These and other attempts result in flame displays that are relatively poor imitations of a real flame and have not been widely adopted by the commercial or retail markets. In addition, such devices typically require substantial energy inputs and require frequent battery replacement, which can drive up purchase and operating costs and require undesirable levels of maintenance for ongoing use.

SUMMARY OF THE INVENTION

The present invention addresses the above and other problems by providing kinetic flame devices that create lighting effects driven by real but chaotic physical movements and by providing methods for making and using such kinetic flame devices. Some embodiments of the present invention may include a drive mechanism that stimulates and/or perturbs a complex interaction between gravity, mass, electromagnetic field strength, magnetic fields, air resistance, and light to achieve a kinetic or random flame effect, but, interestingly, the complex interaction is not directly modulated or controlled so as to reduce control and/or driving requirements or components. The motion and light generated by the kinetic flame devices produce light that convincingly reproduces the kinetic light output of a solitary flickering flame such as may be provided by a conventional combustion or wax candle.

More particularly, an apparatus is provided for simulating a flame such as a flame of a candle or the like. The flame simulating apparatus may include a housing with one or more sidewalls (or housing portions) that define an interior space with a first stage and a second stage (or upper and lower spaces). A drive mechanism such as an electric coil may be provided for generating a time varying electromagnetic field that extends into the first stage. The apparatus may also include a first stage pendulum member that is pivotally mounted within the interior space of the first stage. The first stage pendulum member may include a first magnet on a first end (e.g., embedded or attached permanent magnet) and a second magnet on a second end (e.g., embedded or attached permanent magnet). In some cases, the first end is positioned proximate to the drive mechanism such that the first magnet interacts with the time varying electromagnetic field to kinetically displace (or displace in a random pattern) the first stage pendulum member over time (or over/during an operating period for the drive mechanism).

The apparatus may also include a second stage pendulum member that is pivotally mounted within the interior space of the second stage. The second stage pendulum member includes a magnet on a first end (e.g., a permanent magnet attached or embedded to the member), and this end of the second stage pendulum member is positioned proximate to the second end of the first stage pendulum member. In other cases, ferromagnetic materials are provided in place of the magnets, e.g., the drive mechanism may apply a force on a tag or element of ferromagnetic material with the other end of this first stage pendulum having a magnet or another ferromagnetic material (with the second stage pendulum having either a magnet or a ferromagnetic tag/element depending on the first stage pendulum's inclusion of a magnet or ferromagnetic material as one of these two proximate components would be a magnet). In some cases, the two ends of the pendulum

members are spaced apart to avoid physical/mechanical interference but close enough that their magnets interact to transmit the kinetic movement of the first stage pendulum member to the second stage pendulum member. The second stage pendulum member may further include a flame silhouette element extending from a second end of the second stage pendulum member. The apparatus also may include a light source adapted to selectively transmit light onto the flame silhouette element. The drive mechanism may include a coil of wire and a signal generator providing time-varying current to the coil to create the time-varying magnetic field.

During use, in response to the interaction between the first magnet and the time-varying magnetic field, the first stage pendulum member may be displaced in a random pattern over time. Further during use, in response to the displacement of the first stage pendulum member in the random pattern, the second stage pendulum member may be displaced in another random pattern, whereby the flame silhouette element has kinetic motion concurrently with receiving the light from the light source.

In some embodiments of the apparatus, the first and second stage pendulum members each comprise an elongated, planar body. The body of the first stage pendulum member may be pivotally supported by a first support element at a first location proximate to the second end of the first stage pendulum member while the body of the second stage pendulum member may be pivotally supported by a second support element at a second location proximate to the second end of the second stage pendulum member. The first support member may include a rigid body (such as a wire, rod, shaft, or the like) that extends across the interior space of the housing and through a hole at the first location in the first stage pendulum member. Similarly, the second support member may include a rigid body that extends across the interior space of the housing and through a hole at the second location in the first stage pendulum member. In other embodiments the first (and, in some cases, the second) support member may be a flexible member such as a thread or the like so as to allow a more chaotic movement of the lower pendulum such as by allowing a side-to-side movement of the flexible member relative to its tethered ends. The first location in the first stage pendulum member may be disposed between the first and second magnets and more proximate to the second magnet than to the first magnet.

In some embodiments of the apparatus, the first and second support members each extend, at a central portion mating with the first and second stage pendulum members, respectively, a distance toward the drive mechanism. According to some embodiments, the apparatus includes a base that is mated with or a part of the housing and is located adjacent the first stage. In such embodiments, the base houses the drive mechanism and may be configured to electrically couple to a light socket to provide a power source for the drive mechanism and for the light source. In other embodiments, the electrical coupling may be provided with the base having a plug such as for a standard wall socket to allow the base to be plugged directly into a wall socket (e.g., similar to a night light but with a flame effect).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a cut-away perspective view of an embodiment of a kinetic flame effect device in accordance with the present invention;

FIG. 2 shows an exemplary drive mechanism in accordance with an embodiment of the present invention as may be used with the device of FIG. 1, for example;

FIG. 3 shows a cross section of an alternative embodiment of a kinetic flame device in accordance with the present invention;

FIG. 4 shows the embodiment of FIG. 3 at a different perspective such as rotated about 90 degrees;

FIG. 5 shows a cross section of another alternative embodiment of a kinetic flame device in accordance with the present invention; and

FIG. 6 shows the embodiment of FIG. 5 at a different perspective such as rotated about 90 degrees;

FIG. 7 shows a cut-away perspective view of another embodiment of a kinetic flame effect device similar to that shown in FIG. 1 with a single stage providing kinetic movement of a flame silhouette element;

FIG. 8 shows a cut-away perspective view of an embodiment of a kinetic flame effect device similar to that shown in FIGS. 1 and 7 (and its aspects may be used in a single stage or two or more stage device) showing use of housing-contained lighting as well as the use of sidewall magnets to shape and/or effect kinetic movement of the flame body or upper pendulum member;

FIG. 9 illustrates one embodiment of a kinetic flame effect device similar to that shown in FIG. 8 further including an outer casing (or candle body) used, in part, to enclose the drive mechanism and its power source (here, a battery) and also showing a retractable flame feature for displaying the candle when it is not operating (e.g., with an unlit wick as expected for a conventional candle), with FIG. 9 showing the device operating (e.g., with the cover/cap in the up position);

FIG. 10 illustrates the kinetic flame effect device of FIG. 9 in the off mode with the cover/cap in the down position (e.g., with the flame body or upper pendulum member retracted into the second stage housing or simply housing when the two stages are provided in a unitary housing/body);

FIG. 11 illustrates one particular implementation of the upper pendulum member or flame body that utilizes an "hour glass" body along with a concave or recessed flame silhouette element to provide a desired kinetic movement of the silhouette element and light reflection/absorption effects; and

FIG. 12 is a partial view similar to that of FIG. 9 showing schematically the inclusion of two or more light sources/engines along with a light engine controller to selectively operate the light sources to provide an enhanced flame effect device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention involves devices that create lighting effects driven by real, chaotic, and physical movements and methods for making and using such devices. Prior devices that attempt to simulate flickering flames generally used modulated or controlled motion to mimic a flame, but these devices produced less than ideal results in part because the complexity of a natural flame is difficult to mimic or simulate. Alternatively, some prior devices attempted to control or modulate the intensity, color, and/or other characteristics of a light source such as by blinking, which also produced a less than realistic result. In contrast, the present invention stimulates and/or perturbs a complex interaction between gravity, mass, electromagnetic field strength, magnetic fields, air resistance, and light, but the complex interaction is not directly modulated or controlled. Accordingly, the motion and light generated by the system in accordance with the present invention produces light that convincingly reproduces the kinetic or random light output of a flickering flame.

The present invention can be adapted to a wide variety of form factors to meet the needs of particular applications. FIG. 1 shows a single-flame candle implementation whereas the implementations of FIGS. 3-6 demonstrate lamp-base form factors that can be used as a bulb alternative with many conventional lighting fixtures. Embodiments of the invention can vary in scale to meet the functional and aesthetic needs of a particular application. Power supplies described herein may be provided by batteries, AC/DC power supplies, solar cells, or other available power sources. Although the invention involves complex interactions between many forces, it is typically preferred that the elements of the invention be implemented simply to enhance reliability and longevity of the product. Accordingly, although specific examples of particularly robust construction and components are described herein, actual implementations may vary in complexity.

FIG. 1 shows a cut-away perspective view of an embodiment of a kinetic flame device 100 in accordance with the present invention that resembles a conventional wax candle such as a pillar, taper, container candle, votive, tea light and the like depending on the scale and dimensions of the particular application. FIG. 1 shows a two stage assembly for convenience in manufacture, but the invention can be implemented as a unitary, single stage body, in two stages as shown in FIG. 1, or as three or more stages if desired. Additional stages affect both the form factor as well as the range, speed and variability of the light produced. A stage may damp or amplify these characteristics depending on the particular geometry of the elements within the particular stage.

A drive mechanism (or electrically driven motion engine) 101 is provided that acts to create a time-varying magnetic field, M_1 , and this mechanism may take a variety of forms such as a coil as shown in FIG. 1. Drive mechanism or coil 101 at the base of the embodiment in FIG. 1 includes a wound wire coil, which may be formed, for example, using a conductive wire coated with an insulator. The windings of coil 101 may be held in place with tape, adhesive, epoxy or other material (not shown) that holds the wire together in a desired shape. The coil 101 may be generally circular as shown in FIG. 1 or any other convenient shape such as oval, square, triangular, or an irregular shape. Coil 101 may have an air core or hollow space/void as shown in FIG. 1, or may use a magnetic core such as iron, iron alloys, ferrite, permalloy and other available magnetic core materials. The core may be substantially centrally located within coil 101 with a generally cylindrical shape or may be off-center in particular applications with a differing or similar shape.

In some embodiments, permanent magnets (not shown) may be integrated in, placed on the surface of, or otherwise placed in proximity to coil 101 to provide a static magnetic field that is cumulative with the time varying electromagnetic field produced when coil 101 is energized (as shown in FIG. 2). Although a single coil 101 is shown in FIG. 1, it is contemplated that two or more independently or synchronously energized coils may also be used that are distributed symmetrically or asymmetrically about a central axis of the candle device (e.g., an axis that extends upward through the first and second stage housings 102, 104 and in some cases through pendulums or pendulum members 111, 121) so as to produce more complex magnetic fields; however, this complexity and attempt to explicitly control the magnetic field shape may offer diminishing returns or even detrimentally effect the convincing result produced by the single coil implementation shown in FIG. 1.

In operation, coil 101 is energized by a time-varying electric current to produce a time-varying magnetic field, M_1 , in the vicinity of coil 101. In some embodiments, core material

is used to focus and direct the magnetic field that is produced and to alter the power requirements for the operation of the present invention. In the same or other embodiments, permanent magnets are used in or near the coil 101 to superimpose a static magnetic field on top of the time-varying field, M_1 , created by energizing coil 101. The additional static magnetic field may be used to alter power requirements as well as to selectively modify or define the shape of the magnetic field, M_1 , in the vicinity of coil 101.

The first stage 103 serves to translate the time varying electromagnetic field, M_1 , produced by coil 101 into kinetic motion, $D1_{Kinetic}$. The first stage 103 is positioned such that at least its base is within the electromagnetic field, M_1 , produced from coil 101 and elements within first stage 103 are magnetically coupled to coil 101 when its electromagnetic field, M_1 , is present. Specifically, a magnet 114 positioned or mounted at a lower end of pendulum or first stage pendulum member 111 is within the time varying electromagnetic field, M_1 . Magnet 114 is preferably a small permanent magnet with sufficient magnetic field strength to be moved in response to either repulsive or attractive forces resulting from interaction with the time varying electromagnetic field, M_1 , produced by coil 101 such that the pendulum member 111 is displaced in a random or kinetic manner as shown with arrows $D1_{Kinetic}$. For example, the pendulum member 111 may have an elongate body such as a thin planar design with a rectangular, elliptical, or other shape that may be formed of plastic or other non-ferrous material (e.g., a plastic rectangle with a width of about 0.25 to 2 inch width, a length of about 0.5 to 4 inches, and a thickness of 0.2 inches or less). The displacement, $D1_{Kinetic}$, may vary widely to practice the invention but may be a random pattern with movements of up to 0.5 inches or more in any direction from an original or at rest position.

While the present invention operates with any polar alignment of magnet 114, the polar alignment of magnet 114 and that of the electromagnetic field produced by coil 101 is coordinated or selected to produce desired results or kinetic movement/displacement, $D1_{Kinetic}$, of the lower or first stage pendulum member 111. For example, when coil 101 produces a north pole facing upward then aligning magnet 114 (which may be termed as a first or lower magnet of the lower pendulum member herein) with a south pole facing downward will increase the net attractive coupling force, whereas aligning magnet 114 with a north pole facing downward will increase the net repulsive coupling force, and either arrangement may be useful in some embodiments of the device 100. Aligning magnet 114 at an angle will have a predictable effect on the mix between attractive and repulsive coupling forces and may be suitable or desirable in particular applications. Rare earth permanent magnets, ferrite magnets, ceramic magnets and the like are suitable for magnet 114. It is also possible to replace magnet 114 with a ferrous material that is attractively coupled to the electromagnetic field.

First stage or lower housing 102 may be generally tubular in shape with a sidewall defining an interior space or void for containing the lower pendulum member 111 and an interaction space or area for the magnetic field/forces, M_1 , and the lower magnet 114 of pendulum member 111. The housing 102 may have a sidewall formed of plastic, glass, ceramic, molded epoxy, or other material that can be formed into a desired shape for the particular application. Housing 102 may in some cases, include metal, however, some metals may affect the electromagnetic field. Housing 102 may be open at each end as shown or on one end, or, in some cases, it may be sealed at upper and/or lower ends with a magnetically permeable material such as glass, plastic, or the like. First stage or lower housing 102 may be sealed with a vacuum and/or may

be sealed and contain air or fluid so as to manipulate or control the damping of pendulum 111 to obtain a desired responsive kinetic or random displacement/motion, $D1_{Kinetic}$, in response to the input magnetic field, M_1 , from coil 101. In some cases, the first stage housing 102, pendulum 111, and the support 113 may also be considered or called a coupling member that is provided in the drive mechanism or motion engine 101 (or coupled to such mechanism, engine, or coil), and, additionally, the second pendulum member 121 along with its flame silhouette 125 may be considered a flame body.

Lower or first stage pendulum member 111 is pivotally mounted within or pivotally supported by a support element provided within first stage housing 102. Such pivotal support may be provided in a variety of ways to allow the pendulum to be kinetically displaced, $D1_{Kinetic}$, about the pivot point or mounting location. For example, but not as a limitation, the pendulum member 111 may have a pivot hole 112 formed to allow a pendulum support 113, such as a rod, axle, wire, string, or the like, to pass through. In some embodiments, the support 113 is flexible and/or has a range or span of travel to allow it to move with the pivotally supported member 111, e.g., a string or thread that is flexible and is able to move side-to-side some amount (not completely taut) to introduce more chaotic movement to the lower pendulum member 111. For example, the support element 113 may be a flexible wire, line, or thread with a length greater than a diameter of the housing (or the distance between the sidewalls of housing 102) such that it has a bit of play or slack that allows it to move in any direction from an at rest or original position (e.g., move 360 degrees from an at rest position a distance or displacement such as up to 0.5 inches or more but often less than about 0.25 inches). In other embodiments, though, it is preferable that the support element 113 is rigid or semi-rigid and does not move with the pendulum member 111.

Hole 112 is formed in the upper half of pendulum 111 such that more of the mass of pendulum 111 is below the pivot hole 112 than is above pivot hole 112 (e.g., at 0.1 to 0.45 times the length of the pendulum member 111 as measured from the top edge or the like). Note, as the location of pivot point approaches equilibrium near the center of pendulum 111, pendulum 111 becomes increasingly unstable and exhibits increasingly chaotic motion. With this in mind, in the exemplary embodiment shown in FIG. 1, the pivot point or location of hole 112 is moved upward with respect to the midpoint of pendulum 111 (e.g., in the range of 0.1 to 0.3 of the pendulum length), which increases stability and decreases the movement, $D1_{Kinetic}$, of the flame illusion, but this positioning of the pivot point or hole 112 decreases the range of motion of the upper end of pendulum 111, which may be desirable in some embodiments. The location of pivot point 112 can be selected to meet the needs of a particular application. This arrangement allows pendulum 111 to hang in a stable position absent the affects of the electromagnetic field and allows gravity to act on the mass of pendulum member 111 and lower magnet 114 attached to pendulum 111. Other mechanisms, such as a gimbal or other joint(s), allowing multi-axis movement may be used as an alternative to the pivotal mounting provided by the combination of the pivot hole 112 and support element 113.

Pendulum support wire 113 is attached to the walls of housing 102 for support at locations selected to place pendulum 111 generally in the center of the hollow space defined by walls of housing 102 so that support wire 113 spans a diameter when housing 102 has a circular cross section. In some preferred embodiments, support element 113 may include a rigid or semi-rigid wire such as a steel or steel alloy wire or rod and is preferably bent to form a low spot at a location

where it is desired for pendulum 111 to rest (e.g., the mounting locations for the ends of the wire 113 may be about 0.1 to 0.5 or more inches above the low, center point or pivotal supporting portion of the wire 113). Hole 112 in pendulum member 111 is sufficiently larger than the diameter of support wire 113 such that pendulum 111 swings or pivots freely about support wire 113 but at the same time is held in generally the same location and orientation unless pendulum 111 is perturbed by the electromagnetic field, M_1 . In this manner, the top portion of pendulum member 111 is able to move back and forth with pendulum movement, $D1_{Kinetic}$, within a generally cone-shaped extent having hole 112 as an apex, as well as flutter.

A small permanent magnet 115, which may be similar in composition and alignment to magnet 114, is positioned at the upper end of pendulum 111, e.g., between the hole 112 and an upper side or edge of the pendulum member 111. Pendulum member 111 is sized with respect to housing 102 such that it moves freely within housing 102 about the pivot location defined by the apex, dip, low point, or valley in support wire 113. In the particular embodiment, the length of pendulum 111 is selected such that when assembled as shown in FIG. 1 the lower portion of pendulum 111 is above the lowest portion of wall 102 and the upper portion of pendulum 111 is below the highest portion of wall 102. This arrangement inhibits or prevents the mechanical interaction between elements in the first and second stages 103 and 105 as well as mechanical interaction between pendulum 111 and coil 101. Although some mechanical interaction can be tolerated, by preventing mechanical interaction the end result or kinetic flame effect is believed to be smoother while more kinetic/random and realistic.

In operation, the electromagnetic field causes magnet 114 to move either repulsively or attractively. That motion, $D1_{Kinetic}$, is translated through pendulum 111 to which magnet 114 is affixed. The extent of motion of the lower end of pendulum 111 is greater than the extent of motion of the upper end of pendulum 111 to a degree determined by the position of hole 112 (e.g., $D1_{Kinetic}$ for the pendulum 111 may be thought of as having a lower component that is greater than an upper component such as two to four times as much in the lower component or the like). Gravity tends to return pendulum 111 to an upright position whereas the time varying electromagnetic field, M_1 , may continuously perturb pendulum 111 and may be used to prevent a steady state return to the upright position. In a particular example of using a sinusoidal varying electromagnetic field, pendulum 111 dances about quite energetically and in random directions with varying magnitudes of displacement, $D1_{Kinetic}$.

Air resistance acting on the surface area of pendulum 111 damps the motion of pendulum 111. Accordingly, the size and shape of pendulum 111 can be altered to provide the speed and degree of kinetic movement desired for a particular application. In some embodiments, air resistance is controlled by using a more irregular shape such as an hour glass shaped member 111 and in other cases air dampening is controlled by providing one or more mesh or porous sections to allow air flow through the body of member 111. In other cases, the lower portion of the pendulum member 111 may be made heavier with more surface area/mass or with addition of weights to achieve a desired and tunable kinetic movement/displacement, $D1_{Kinetic}$, of the member 111.

Second stage 105 comprises a housing 104 that preferably has a composition and size that is substantially similar to housing 102 so that the stages 103 and 105 (or the corresponding houses 102, 104) can be mated or coupled together to form a candle or device body with solitary or unitary appear-

ance. Second stage **105** generally serves to couple to the kinetic energy in the moving upper end of pendulum **111** and translate that kinetic energy into motion of flame silhouette element or extension **125**. The construction and operation of second stage **105** is similar to that of first stage **103**. Upper stage pendulum member **121**, which is slightly shorter than the length of housing **104**, is pivotally mounted via a pivot hole **122** on a pendulum support element **123**, e.g., a rigid or semi-rigid wire or the like in some embodiments with a lower supporting portion or area in the center of the element **123**. The support element **123** is mounted at each end to the sidewall of the housing **104** (such as at the upper edges of the sidewall at opposite locations to stretch across the space or void defined within the sidewall of housing **104**). A first or lower magnet **124** (similar in composition, size, and alignment to the first or lower magnet **114** of the first stage pendulum member **111** and second or upper magnet **115** of the first stage pendulum member as described hereinbefore) is mounted at a lower (or first) portion or end of pendulum member **121**. Magnet **124** is positioned so as to be magnetically coupled to magnet **115** or influenced by magnetic field or forces, M_2 . The magnetic coupling, M_2 , is preferably repulsive, but it may also be attractive or a mix between attractive and repulsive coupling. For example, in one useful implementation, the magnetic couplings are attractive, and gravity is used to bring the pendulum members back to a central or neutral position. In use, the coil in such a case may provide a donut shaped magnetic field such that attractive magnetic coupling provides an auto-start upon power up as it moves the nearby pendulum away from the neutral position.

Flame silhouette element **125** comprises a flat or dimensional body of material preferably formed with a flame-shaped outline or peripheral pattern. Flame silhouette element **125** extends outward from an edge or side of the upper (or second) portion/end of the second stage pendulum member **121**. Element **125** may include a sheet of material such as paper or plastic and/or is formed of the same or differing material as the body of pendulum member **121**. Flame silhouette element **125** may be two dimensional or a distorted sheet material that extends in three dimensions, or may be a fully three dimensional object. The mass and air resistance of flame silhouette **125** adds to the mass and air resistance of pendulum **121** and so its configuration is typically taken into consideration when locating pivot hole **122** relative to the upper or second end of the pendulum member **121**.

In operation, the magnetic field, M_2 , produced by magnet **115** causes magnet **124** to move either repulsively or attractively. That motion is translated through pendulum **121** to which flame silhouette **125** is affixed as shown with second kinetic or random motion or displacement, $D2_{Kinetic}$. As with the pendulum member **111** of the first stage **103**, the extent or magnitude of motion or kinetic displacement of the lower end of pendulum **121** is greater than the extent of motion of the upper end of pendulum **121** to a degree determined by the position of hole **122** relative to the edge of the upper portion of pendulum **121** (e.g., the kinetic displacement, $D2_{Kinetic}$, has a larger component in the lower or first end/portion of the pendulum **121** than in the upper or second end/portion of the pendulum **121** such as 2 to 4 times as much movement or the like in the lower or first end/portion). In one embodiment, the first stage or lower pendulum member **111** is longer ranging while the upper pendulum **121** is shorter ranging, and this may be controlled by selecting the distance of each of these pendulum members **111**, **121** from their pivot point (e.g., make the lower pendulum **111** have more movement by hav-

ing pivot hole **112** farther away from magnet/ferromagnetic material component **114** than pivot hole **122** from component **124**).

In some embodiments, pivot hole **122** is provided at a location comparable to the base of a wick in a combustion candle (e.g., 0.1 to 1 inch or more below upper lip or edge of the second stage housing **104**). Gravity tends to return pendulum **121** to an upright position whereas the magnetic influence, M_2 , of moving magnet **115** continuously perturbs pendulum **121** and inhibits a steady state return to the upright position. Air resistance acting on the surface area of pendulum member **121** and flame silhouette element **125** damps the motion, $D2_{Kinetic}$, of pendulum member **121**. Accordingly, the size and shape of pendulum member **121** can be altered to provide the speed and degree of kinetic movement, $D2_{Kinetic}$, desired for a particular application or embodiment of device **100**. Note, that the components **114**, **115**, **124** may be magnets or ferromagnetic material with one embodiment providing a ferromagnetic tag for element **114** and then a ferromagnetic tag for element **115** or **124** while another embodiment uses a magnet for element **114** and ferromagnetic material for element **115** or **124** (e.g., only one of each magnetic coupling pair of components is a magnet to provide desired driving forces).

Although the arrangement described hereinbefore produces kinetic motion in flame silhouette **125**, it is not this motion or the shape of element **125** alone that produces a convincing flame simulation. The nature of the light reflected from or produced by the device **100** is also significant in producing the convincing effect, not the motion and shape of its elements. To this end, some embodiments of the device **100** may include a flame silhouette element **125** that is shaped as a simple geometrical shape such as a triangle, circle, or arbitrary shape to produce a desirable effect while the illustrated element **125** has a shape or peripheral pattern similar to a candle or solitary flame.

In the particular implementation **100** of FIG. 1, a spotlight **107** mounted above flame silhouette **125** is aimed to direct light **108** toward the element **125** to produce a spot of light **127** on the surface of flame silhouette element **125**. One or more light sources **107** may be used, and, when used, the multiple light sources may be aligned so that their produced spots of light **127** are aligned with each other in the vicinity of silhouette element **125** even as silhouette element **125** moves in normal operation with the kinetic movement, $D2_{Kinetic}$, of upper or second stage pendulum member **121**.

Light source **107** includes, for example, a light emitting diode(s) (LED(s)) or other efficient low power light source coupled with a converging lens to optically direct the produced light into a desired size and shape. An incandescent light, organic light emitting diode (OLED), or other device is also suitable for light source **107**. Alternatively, a narrow beam light source, even a laser, may be used with a diverging lens to produce the desired shape and size of light spot **127**, e.g., a shape similar to the pattern/shape of the element **125** and size similar to or smaller than the element **125** to control blow by. The light source **107** may also include fiber optic light pipes to transport light from a remote light-emitting device to a desired location and angle. Light source **107** may project downward as shown in FIG. 1, or upward, or at any angle to meet the needs of a particular application or implementation of device **100**. In some cases, flame silhouette **125** can be bent slightly out of a vertical alignment or alignment with pendulum **121** so as to reflect light from light source **107** to an expected location of a viewer.

Light source **107** may be colored using a colored light source or filters. Light source **107** may comprise multiple

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light sources to produce several colors, and the light sources may be energized statically or dynamically to provide color variation. These types of controlled light production may enhance the effect of the present invention but are not necessary in most instances and may actually detract from the effect in certain applications because, as noted hereinbefore, simulating flame effects with direct modulation and control by itself does not produce suitable results in many instances. However, as an augmentation of the basic kinetic light movement principle in accordance with the present invention such direct manipulation and control of the light output may produce desirable results in particular applications.

Alternatively, or in addition, the surface of flame silhouette **125** is colored with a single color, gradient color, or a color pattern including yellows, oranges, reds, and/or blues used alone, together, or in addition to white light emitting devices in source **107**. In some cases, the coloring may be a fluorescent color (e.g., a day glow type color(s)) to achieve a desired result such as a feel of heat or raised temperature associated with a real flame. White or colored light spot **127** on element **125** reflects light having a color dependent on both the color of the light produced by light source **107** and the color of the surface of silhouette element **125** where the light spot **127** falls. As silhouette element **125** moves in space with kinetic displacement, $D2_{Kinetic}$, of pendulum member **121**, its angle with respect to light source **107** continuously changes and, in response or concurrently, the intensity of the reflected light changes in a complex, kinetic manner. This effect can be modified when silhouette element **125** is distorted or three dimensional in configuration. To get front and back lighting with one source **107**, the element **125** (and its coloring/materials) may be chosen such that a portion of the received light **108** is reflected and a portion is allowed to pass through to an opposite or back side. For example, the texture, color, and/or material of the element **125** may be such that about 40 to 60 percent of the light (e.g., about half) is reflected while the remaining light (e.g., about half) is passed through with the element **125** being at least partially translucent. In this manner, both the front and back of the display element **125** is lighted by light **108** from a single source **107**.

FIG. 2 schematically illustrates a simple drive device **200** in accordance with an embodiment of the present invention such as for use with kinetic flame device **100** (with components of flame device **100** having like numbers in drive **200**). In the implementation of FIG. 2, a power source **201** is provided that may include batteries, an AC/DC power supply, solar power supply, or a combination or variant thereof that produces power of sufficient voltage, current, and frequency content for use by light source or engine **107** and signal generator **203**. In some exemplary embodiments, both light engine **107** and signal generator **203** are driven by direct current and are not explicitly managed or controlled. Alternatively, a controller circuit (not shown) may be included and operated to vary the output to light engine **107** and/or signal generator **203** to produce varied results.

In one embodiment, signal generator **203** generates a sinusoidal output in the exemplary embodiments, but, in other cases, it may produce a square wave, pulse modulated, amplitude modulated, frequency modulated, or other output form with expected effect on the electromagnetic field, M_1 , produced by coil **101**. In one preferred embodiment, the generator **203** provides a square wave that is intermittently interrupted (e.g., every so many pulses (such as 32 pulses) it drops off and then restarts after a pause/interruption to enhance the chaotic effect). In another exemplary implementation, signal generator **203** is similar to a conventional clock circuit producing a 60 Hz sinusoidal output coupled to coil **101**. When

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multiple coils **101** are used, signal generator **203** may be adapted to produce multiple outputs that may be synchronous or asynchronous. It is contemplated that when power source **201** is coupled to AC mains or a line source that a simple transformer may be used to produce a desired waveform for coil **101** and eliminate need for signal generator **203**.

FIG. 3 and FIG. 4 show an alternative embodiment of kinematic flame device **300** in which a mechanism in accordance with the present invention is embodied in a form factor that is compatible with standard light fixtures with standard light sockets. As such, the embodiment **300** shown in FIG. 3 and FIG. 4 enables a screw-in replacement for conventional bulbs that transforms a conventional lighting fixture into a bulb or device with a flickering candle-like flame appearance. FIG. 3 and FIG. 4 show the same embodiment of device **300** from perspectives that differ approximately orthogonally. Like numbered elements correspond to similar elements in the two figures. In general, the materials, construction and operation of the embodiment shown in FIG. 3 and FIG. 4 are analogous to that described in reference to the stand-alone candle implementation of FIG. 1 (e.g., with interaction of magnets and an electrically generated magnetic field used to create a first kinematic motion/displacement that is then passed to a second stage pendulum member via interaction between two permanent magnets).

A bulb base **305** is configured to electrically couple to a light socket such as a standard screw-in type bulb base. However, the invention is readily adapted to other types of bulb bases including two prong press fit, bayonet, candelabra base, miniature screw, and varieties of bases used for halogen and low voltage lighting systems. Housing **302** comprises a transparent or translucent material such as plastic or glass and is used to provide the first and second stages described with reference to device **100** of FIG. 1. Unlike conventional bulbs it is not necessary to maintain reduced pressure within the bulb (within housing **302**), so a wider variety of materials and construction technology can be used for the present invention as compared to conventional bulb technology. However, it may be desirable in some implementations to contain a gas within housing **302** or its sidewall(s) or to contain reduced pressure within bulb **302**. In such an embodiment of device **300**, an air-tight seal between base **305** and housing **302** may be provided. Housing **302** (or at least its translucent sidewall(s)) may be coated with a colored film, a fluorescent or phosphorescent film, or other coating either in whole or in part, in a gradient, as well as in a regular or irregular pattern to meet the needs of a particular application **300**.

Although not shown in FIG. 3 and FIG. 4, devices to implement the functionality of power source **201** and signal generator **203** can be embedded in base **305**. A typical embodiment in accordance with the invention uses low power as compared to conventional light bulbs, and the components necessary to implement that functionality can be very small and readily assembled within or integrated with base **305** and coupled to drive coil **301**. Lower or first stage pendulum member **311** moves about a pendulum support **312** that extends through hole **313** in member **311**. The pendulum member **311** has a lower magnet **314** and an upper magnet **315** that are analogous in position, function, composition, and construction to lower magnet **114** and upper magnet **115** described in reference to FIG. 1. Operation of pendulum member **311** is analogous to the movement and operation of pendulum **111** shown in FIG. 1, with lower magnet **314** being driven by magnetic field, M_1 , by coil/components embedded in base **305**. A magnetic field, M_2 , produced by upper or second magnet **315** is coupled to a lower magnet **324** on upper pendulum member **321**. Upper pendulum **321** is attached to or

integrated with a flame silhouette **325** and operates in a manner akin to upper pendulum **121** in FIG. 1 with a support element **322** extending through hole **323** to pivotally mount the pendulum member **321**.

In operation, a light source **307** such as an LED receives power from conductors (not shown) running up from power supply **201** in base **305**. These conductors may run along the interior or exterior wall of housing **302**. Light output from light source **307** is formed into a spot of desired size and directed downward onto a surface of flame silhouette **325** (as discussed, for example, with reference to device **100**) such as with lens/concentrator **317**. Alternatively, the light output from light source **307** can be redirected using reflectors formed on the interior surface of housing **302** so that the light reflects and is directed towards flame silhouette **325** at an angle. Light source **307** may also be located in base **305** and directed upward either directly or using reflectors to form a spot on the surface of flame silhouette **325**. For example, by making the upper end of housing **302** reflective with a parabolic or other convex shape it will have a focal point which can be adjusted to occur at a location where the light spot is desired. A relatively diffuse light source **307** located in the vicinity of base **305** will transmit diffuse light upward which is then concentrated into a spot occurring at flame silhouette **325**.

FIG. 5 and FIG. 6 show an alternative embodiment in which a mechanism/device **500** in accordance with the present invention is embodied in a form factor that is compatible with standard light fixtures with standard light sockets, but in which the mechanism **500** is arranged so that the base **505** is above the kinetic movement mechanism (first and second stage arrangement for transmitting kinetic motion via magnetic field interactions through pivotally mounted pendulum members) that provides driving motion of a flame silhouette element **525**. FIG. 5 and FIG. 6 show the same embodiment from perspectives that differ approximately orthogonally. Like numbered elements correspond to similar elements in FIG. 5 and FIG. 6. Like the embodiment shown in FIG. 3 and FIG. 4, the embodiments of FIG. 5 and FIG. 6 desirably enable a screw-in replacement for conventional bulbs that transform a conventional lighting fixture into a flickering candle-like flame appearance. In general, the materials, construction and operation of the embodiment shown in FIG. 5 and FIG. 6 are analogous to that described in reference to the stand-alone candle implementation of FIG. 1 and the bulb implementations of FIG. 3 and FIG. 4.

A bulb base **505** is configured to electrically couple to a light socket such as a standard screw in type bulb base, although the invention is readily adapted to other types of bulb bases including two prong press fit, bayonet, candelabra base, miniature screw as well as varieties of bases used for halogen and low voltage lighting systems. Housing **502** includes a transparent or translucent material such as plastic or glass. Unlike conventional bulbs, it is not necessary to maintain reduced pressure within the bulb housing **502**, so a wider variety of materials and construction technology can be used for the present invention as compared to conventional bulb technology. However, it may be desirable in some implementations to contain a gas or to contain reduced pressure within bulb **502** in which case an airtight seal between base **505** and housing **502** may be provided. Housing **502** may be coated with a colored film, a fluorescent or phosphorescent film, or another coating either in whole or in part, in a gradient, as well as in a regular or irregular pattern to meet the needs of a particular application.

Devices to implement the functionality of power source **201** and signal generator **203** may be embedded in base **505** in

some embodiments, e.g., to selectively generate driving magnetic field, M_1 . A typical embodiment **500** in accordance with the invention uses low power as compared to conventional light bulbs, and the components necessary to implement that functionality can be very small and readily assembled within or integrated with base **505** and coupled to drive coil **501**. First stage pendulum **511** moves about a pendulum support **512** extending through hole **513** to pivotally mount or support pendulum **511**. The pendulum **511** has a first or "lower" magnet **514** and a second or "upper" magnet **515** that are analogous in position, function, composition, and construction to lower magnet **114** and upper magnet **115** described in reference to FIG. 1, e.g., first magnet **514** interacts with magnetic field, M_1 , to create kinetic displacement or motion, $D1_{Kinetic}$, of pendulum **511**. Operation of pendulum **511** is analogous to the movement and operation of pendulum **111** shown in FIG. 1. A magnetic field, M_2 , produced by upper magnet **515** is coupled to a lower magnet **524** on upper pendulum **521** to cause it to move chaotically or with kinetic/random displacement or motion, $D2_{Kinetic}$. Upper pendulum **521** is attached to or integrated with a flame silhouette element **525** and operates in a manner akin to upper pendulum **121** in FIG. 1 as it is pivotally mounted via hole **523** through which support element **522** extends. Flame silhouette element **525** may include an inverted cone that may be, for example, a hollow blow molded part (e.g., a 3D body in this example).

In operation, a light source **507** such as an LED receives power from conductors (not shown) running down from power supply in base **505**. These conductors may run along the interior or exterior wall of housing **302**. Light output from light source **507** is formed, such as by lens/concentrator **517**, into a spot **518** of desired size and directed upward onto a surface of flame silhouette **525**. Alternatively, the light output from light source **507** can be redirected using reflectors (not shown) formed on the interior surface of housing **502** so that the light reflects and is directed towards flame silhouette **525** at an angle. Light source **507** may also be located in base **505** and directed downward either directly or using reflectors to form a spot on the surface of flame silhouette element **525**.

The present invention is amenable to many variations in implementation to meet the needs of a particular application. The form factor, for example, can be altered to serve as a nightlight, table light, wall sconce, or any form factor where a flickering flame light output is desired. The invention may be applied in fixed and portable outdoor lighting, ceiling mounted fixtures, wall mount fixtures, landscape lighting, holiday lighting, handheld lighting, and the like. Additionally, a number of the kinetic flame elements as shown as **100** in FIG. 1 may be driven by a single assembly that includes a signal generator and power source and that may be plugged into a wall socket or other power source.

Multiple light sources may be used, and the effect in accordance with the present invention may be enhanced by light sources on or in the flame silhouette element to directly emit light in addition to or in place of light projected onto the silhouette element. Other optical elements may be included in the light path from the light source such as scattering devices, reflectors and masks to shape the light source. Similarly, the device housing can be augmented with scattering devices, reflectors, and masks to alter the light reflected from the flame silhouette.

In one embodiment, the kinetic flame assembly **100** is positioned within an outer housing or cup that supports the first and second stage housings **102**, **104**. These housings may be replaced by a single internal support such as a candle-shaped column that may be useful when the outer housing or cup is formed of optically clear/translucent material such that

the “candle” is visible to a user, and the candle-shaped support may have an inner shaft or channel in which the pendulums **111**, **121** are supported as shown in FIG. **1** or at some offset, e.g., the support **123** may be rotated relative to the support **113** such these supports **113**, **123** are not generally parallel but are at some angular offset such as being transverse or even orthogonal when viewed from above or below. In some implementations, the magnetic/ferromagnetic tags/components **114**, **115**, **124** are provided on the body of the pendulums **111**, **121** while in some cases it may be useful to have these extend from the pendulum bodies such as by having a magnet holder that is rigidly or pivotally supported by a bottom portion of the upper pendulum **121** or the like. The light source **107** may be an LED or similar device, and one or more lenses may be positioned between the light source **107** and the flame **125** to shape the light **108** to achieve a particular effect (e.g., to be about the size and/or shape of the flame **125**). The cup/outer housing may include a valance above the candle-shaped column to support the light source/lens **107** and to also hide these from view from a user (e.g., this valance may be opaque such as with a decorative chrome or other exterior coloring so as to disguise the presence of light source **107**).

As discussed above with reference to FIG. **1**, the invention can be implemented as a unitary, single stage body instead of using two stages as shown in FIG. **1**. Generally, this may be achieved by removing the first stage **103** from the assembly **100**. FIG. **7** shows a cut-away perspective view of a single stage embodiment of a kinetic flame device **700** in accordance with the present invention that resembles a conventional wax candle such as a pillar, taper, container candle, votive, tea light and the like depending on the scale and dimensions of the particular application. In the device **700**, a single pendulum member **121** is provided with a magnet (or ferrous member) **124** on one end (the lower end) and with a flame silhouette element **125** on the other end (or upper end). This device may derive more of its motion from the nature of the varying electromagnetic field, M_1 , and, as a result, the device **100** may benefit from a more complex EM field and driver **101**. However, the device **100** may be useful for providing a more robust and less expensive assembly.

As with the device **100**, a drive mechanism **101** is provided that acts to create a time-varying magnetic field, M_1 . Drive mechanism **101** at the base of the embodiment in FIG. **1** includes a wound wire coil, for example. In some embodiments, permanent magnets (not shown) may be integrated in, placed on the surface of or otherwise placed in proximity to coil **101** to provide a static magnetic field that is cumulative with the time varying electromagnetic field produced when coil **101** is energized (as shown in FIG. **2**). Although a single coil **101** is shown in FIG. **7** (and as discussed with reference to FIG. **1**), it is contemplated that two or more independently or synchronously energized coils may also be used that are distributed symmetrically or asymmetrically about a central axis of the candle device (e.g., an axis that extends upward through the single stage housing **104** and in some cases through pendulums or pendulum member **121**).

In operation, coil **101** is energized by a time-varying electric current to produce a time-varying magnetic field, M_1 , in the vicinity of coil **101**. In some embodiments, core material is used to focus and direct the magnetic field that is produced and to alter the power requirements for the operation of the present invention. In the same or other embodiments, permanent magnets are used in or near the coil **101** to superimpose a static magnetic field on top of the time-varying field, M_1 , created by energizing coil **101**. The additional static magnetic field may be used to alter power requirements as well as to

selectively modify or define the shape of the magnetic field, M_1 , in the vicinity of coil **101**.

The single stage **105** serves to translate the time varying electromagnetic field, M_1 , produced by coil **101** into kinetic motion, $D1_{Kinetic}$. The stage **105** is positioned such that at least its base is within the electromagnetic field, M_1 , produced from coil **101** and elements within single stage **105** are magnetically coupled to coil **101** when its electromagnetic field, M_1 , is present. Specifically, a magnet **124** positioned or mounted at a lower end of pendulum or single stage pendulum member **121** is within the time varying electromagnetic field, M_1 . Magnet **124** is preferably a small permanent magnet with sufficient magnetic field strength to be moved in response to either repulsive or attractive forces resulting from interaction with the time varying electromagnetic field, M_1 , produced by coil **101** such that the pendulum member **121** is displaced in a random or kinetic manner as shown with arrows $D1_{Kinetic}$. For example, the pendulum member **121** may have an elongate body such as a thin planar design with a rectangular, elliptical, or other shape that may be formed of plastic or other non-ferrous material (e.g., a plastic rectangle with a width of about 0.25 to 2 inch width, a length of about 0.5 to 4 inches, and a thickness of 0.2 inches or less). The displacement, $D1_{Kinetic}$, may vary widely to practice the invention but may be a random pattern with movements of up to 0.5 inches or more in any direction from an original or at rest position.

Single stage housing **104** may be generally tubular in shape with a sidewall defining an interior space or void for containing the pendulum member **121** and an interaction space or area for the magnetic field/forces, M_1 , and the magnet **124** of pendulum member **121**. The housing **104** may have a sidewall formed of plastic, glass, ceramic, molded epoxy, or other material that can be formed into a desired shape for the particular application. Single stage **105** generally serves to translate the magnetic field/forces, M_1 , (that cause its lower end via magnet/ferrous tag **124** to move chaotically) into kinetic energy or motion of flame silhouette element or extension **125**.

Single stage pendulum member (or flame body) **121**, which is slightly shorter than the length of housing **104**, is pivotally mounted via a pivot hole **122** on a pendulum support element **123**, e.g., a rigid or semi-rigid wire or the like in some embodiments with a lower supporting portion or area in the center of the element **123**. The support element **123** is mounted at each end to the sidewall of the housing **104**. The magnet **124** (similar in composition, size, and alignment to the first or lower magnet **114** of the first stage pendulum member **111** and second or upper magnet **115** of the first stage pendulum member as described hereinbefore with regard to FIG. **1**) is mounted at a lower (or first) portion or end of pendulum member **121**. Magnet **124** is positioned so as to be magnetically coupled to or influenced by magnetic field or forces, M_1 . The magnetic coupling, M_1 , is preferably repulsive, but it may also be attractive or a mix between attractive and repulsive coupling. For example, in one useful implementation, the magnetic couplings are attractive, and gravity is used to bring the pendulum members back to a central or neutral position. In use, the coil in such a case may provide a donut shaped magnetic field such that attractive magnetic coupling provides an auto-start upon power up as it moves the nearby pendulum away from the neutral position.

Flame silhouette element **125** includes a flat or dimensional body of material preferably formed with a flame-shaped outline or peripheral pattern. Flame silhouette element **125** extends outward from an edge or side of the upper (or second) portion/end of the second stage pendulum member **121**. Element **125** may include a sheet of material such as

paper or plastic and/or is formed of the same or differing material as the body of pendulum member 121. Flame silhouette element 125 may be two dimensional or a distorted sheet material that extends in three dimensions, or may be a fully three dimensional object. The mass and air resistance of flame silhouette 125 adds to the mass and air resistance of pendulum 121 and so its configuration is typically taken into consideration when locating pivot hole 122 relative to the upper or second end of the pendulum member 121.

In operation, the extent or magnitude of motion or kinetic displacement of the lower end of pendulum 121 is greater than the extent of motion of the upper end of pendulum 121 to a degree determined by the position of hole 122 relative to the edge of the upper portion of pendulum 121 (e.g., the kinetic displacement, $D1_{Kinetic}$, has a larger component in the lower or first end/portion of the pendulum 121 than in the upper or second end/portion of the pendulum 121 such as 2 to 4 times as much movement or the like in the lower or first end/portion). In some embodiments, pivot hole 122 is provided at a location comparable to the base of a wick in a combustion candle (e.g., 0.1 to 1 inch or more below upper lip or edge of the second stage housing 104).

Gravity tends to return pendulum 121 to an upright position whereas the magnetic influence, M_1 , continuously perturbs pendulum 121 and inhibits a steady state return to the upright position. Air resistance acting on the surface area of pendulum member 121 and flame silhouette element 125 damps the motion, $D1_{Kinetic}$, of pendulum member 121. Accordingly, the size and shape of pendulum member 121 can be altered to provide the speed and degree of kinetic movement, $D1_{Kinetic}$, desired for a particular application or embodiment of device 700. The device 700 may include a flame silhouette element 125 that is shaped as a simple geometrical shape such as a triangle, circle, or arbitrary shape to produce a desirable effect while the illustrated element 125 has a shape or peripheral pattern similar to a candle or solitary flame.

In the particular implementation 700 of FIG. 7, a spotlight 107 mounted above flame silhouette 125 is aimed to direct light 108 toward the element 125 to produce a spot of light 127 on the surface of flame silhouette element 125. One or more light sources 107 may be used, and, when used, the multiple light sources may be aligned so that their produced spots of light 127 are aligned with each other in the vicinity of silhouette element 125 even as silhouette element 125 moves in normal operation with the kinetic movement, $D1_{Kinetic}$, of single stage pendulum member 121. As silhouette element 125 moves in space with kinetic displacement, $D1_{Kinetic}$, of pendulum member 121, its angle with respect to light source 107 continuously changes and, in response or concurrently, the intensity of the reflected light changes in a complex, kinetic manner.

In the above description, it was explained that it may be useful in some embodiments or applications to have the light source project upward (or from within the device body or housing interior) onto the flame silhouette element. It was also discussed that some embodiments may utilize additional magnet elements to shape or alter the movements of the pendulum elements such as by providing permanent magnets near the drive mechanism 101 or by placing magnets at one or more locations within the interior of the housings 102, 104. Briefly, some embodiments may include a pillar-style or bulb-style kinetic flame device where the flame member is lit from below (or from within the housing). A downside of such an implementation may be blow by of light that is visible from above, but, for a wall sconce or lighting that is above the viewer, such from-below lighting may provide a useful or even more pleasing effect.

FIG. 8 illustrates a kinetic flame device 800 that includes components similar to those shown in the device 100 of FIG. 1 but modified to utilize a from-below or in-housing lighting assembly 807 and to also include side-mounted (or interior-placed) magnetic elements 840, 842 to alter the movement of the upper pendulum member 121. In some embodiments, only one of these two new aspects may be utilized and the number or specific location of these components may be varied to practice the device 800 (e.g., only use one magnet 840, 842 or use more magnets, place the magnets either higher or lower in the housing 104 or within housing 102, use more than one light source 808, use the light source 808 in combination with the light source 107 of FIG. 1, and so on).

In the embodiment shown in FIG. 8, the device 800 lights flame silhouette element 125 from below (or from the interior space defined by housings 102, 104) using a lighting assembly 807 that is mounted within the interior space of housings 102, 104. The lighting assembly 807 includes a lighting source 808 (such as a monochromatic LED or multiple color LED or the like) that is mounted on the inner surface of first stage housing 102 (but may, in some embodiments, be placed apart from the housing sidewall or in second stage housing 104). The lighting source 808 projects light 809 upward (e.g., in a funnel or light source housing as shown) where it is focused in this embodiment by lens 810 to provide focused light 811, which may be focused to provide a beam(s) of light 811 about the size/shape of spot 127 (e.g., smaller in size than about the size/shape of element 125 to limit blow by out of the device 800).

The lighting assembly 807 may also include a reflector or mirror 814 that is configured to reflect or redirect the light 811 as shown at 815 on to the element 125 to provide illuminated spot 127. The mirror 814 may be positioned near the top of the second stage housing 104 such that the light 815 is striking the flame silhouette element 125 at an incidence angle that is nearer orthogonal to further limit blow by such as at an angle over 45 degrees such as 60 to 80 or more degrees. In some embodiments, though, the mirror 814 is not included and the light 811 is focused by the lens 810 directly onto the element 125.

In addition to the drive mechanism 101 (e.g., an EM coil) providing time-varying magnetic field, M_1 , the kinetic flame device 800 includes magnets 840, 842 positioned within the interior of device 800 defined by housings 102, 104. As shown, the magnets 840, 842 are side-mounted magnets (e.g., permanent magnets, electromagnetic devices, or the like) that generate magnetic fields M_3 and M_4 to effect the kinetic movements, $D2_{Kinetic}$, of the upper pendulum member 121. The magnets 840, 842 may be affixed to the inner surfaces of second stage housing 104 proximate to the lower end of the pendulum 121 and magnetic member or ferrous tag 124.

The magnets 840, 842 may be positioned opposite each other as shown or offset to achieve a desired result. In some embodiments, the magnetic fields, M_3 and M_1 , are of equal strength but in opposite directions such that the magnetic fields, M_3 and M_4 , both act to similarly repel (or attract) the magnet 124, which may have a north (or south) pole facing one magnet 840 and a south (or north) pole facing another magnet 842. In this manner, the kinetic movement, $D2_{Kinetic}$, may be dampened (or amplified) when compared to its magnitude in response only to magnetic field, M_2 . In other embodiments, three or more magnets are positioned on the inner surfaces or in the interior of housing 104 to create a desired movement, $D2_{Kinetic}$, of upper pendulum 121 and flame element 125, with the strength of the magnets being similar in some cases and differing in others. In other embodiments, a single magnet 840 or 842 is used in the device 800.

The magnets **840**, **842** may be permanent magnets in some embodiments while others may utilize electromagnetic coils similar to that used for drive mechanism **101** such that the fields, M_3 and/or M_4 , may be varied over time and/or turned completely on or off to change the movement, $D2_{Kinetic}$.

As shown, the kinetic flame device **800** includes magnets **840**, **842** on sides of a candle body such as on second stage housing **104**. The inclusion of magnets **840**, **842** creates static magnetic fields. M_3 and M_4 , when the magnets **840**, **842** are permanent magnets or a non-time varying EM device is used. The static magnetic field(s) can be used to aid the chaos and to interact with the dynamic magnetic field, M_2 . Static magnets **840**, **842** may be shaped (or selected so as) to produce a shaped magnetic field, M_3 and M_4 , to more effectively dampen, heighten, or otherwise modify the magnitude of the kinetic movement, $D2_{Kinetic}$, or its chaotic nature (e.g., make the movement, $D2_{Kinetic}$, more unpredictable). The use of permanent magnets for magnets **840**, **842** may allow the drive mechanism **101** to only be operated periodically such as to initiate kinetic movement, $D2_{Kinetic}$, followed by a period where movement, $D2_{Kinetic}$, is only caused by the momentum of the pendulum **121** and fields, M_3 and M_4 , on magnet/tag **124**. After a period of time, the drive mechanism **101** may be restarted to bring kinetic movement, $D2_{Kinetic}$, back up to some desired maximum amount and the drive mechanism **101** then shut down again (and this process repeated on a regular or irregular cycle).

FIGS. **9** and **10** illustrate a particular implementation of a kinetic flame effect device **900**, with FIG. **9** showing the device **900** in an operating or on mode and FIG. **10** showing the device in a non-operating or off mode. The device **900** makes use of components of device **100** of FIG. **1** and device **800** of FIG. **8**, and these components have like numbers. For example, the device **900** includes first and second stage housings **102**, **104** that may be provided as a unitary, cylindrical structure as shown and are used to define an interior space or volume for containing the lower or first stage pendulum member **111** on support **113** and upper or second stage pendulum member **121** on support **123** (which may be part of flame retraction bar or member **974**). Also, the device **900** includes a drive mechanism **101** with power source or battery **902** driving or powering coil **904** to selectively produce time-varying magnetic field, M_1 , which moves pendulum **111** chaotically (which then uses magnetic field, M_2 , to couple with pendulum **121** and cause it and flame silhouette element **125** to move chaotically on support **123**).

The device **900** further includes an outer casing or candle body **950** to support and hide the other working components/parts of the device **900**. The outer casing **950** includes a tubular sidewall **952** that supports the drive mechanism **101** and a housing **102/104** platform such that the stage housings **102** and **104** are centrally positioned within the casing **950**. The housings **102** and **104** extend upward from the drive mechanism **101** toward a candle top or cover **954** that may have irregular sidewalls (as shown) simulating melted wax of a conventional wax candle and further include a planar portion with a centrally located opening or hole **955** through which the flame silhouette element **125** may extend. In this manner, of the kinetically moving components, only the flame silhouette element **125** extends outward from the casing **950** and is readily visible by a viewer.

The device **900**, as shown for device **800**, includes a light assembly or engine **807** positioned within the casing sidewall **952** to illuminate a surface or side **916** of the flame element **125** from below or from within the casing **950** (e.g., from above if a bulb implementation as shown in FIGS. **5** and **6**). The light engine **807** includes an LED or other light source

808 operable (as shown) to generate light **809** that is focused by lens **810** to provide focused light **811** to illuminate a spot or all/most of flame silhouette element **125** as it moves with pendulum element **121** in response to varying magnetic field, M_2 . The hole/opening **955** may be sized and shaped to allow the light **811** to reach the element **125**, but small enough that blow by is controlled or limited.

The hole/opening **955** may also purposely block all or portions of the light **811** in a range of positions of the element **125** to further vary lighting of element **125** to cause more of a flickering light effect (e.g., such as to at least partially block light **811** when the silhouette element **125** moves "forward" or to the left from a vertical position as shown in FIG. **9**). Hence, the flame element **125** may be more dimly lit (or unlit) in one third to half of its range of movement and brightly lit in the other half to two thirds of its range of movement.

The device **900** is also adapted to allow the flame silhouette element **125** to be retracted below the cover **954** and an unlit wick to be displayed when the device **900** is turned off (or no power is provided to the coil **101** and LED/light source **808** (as shown in FIG. **10**)). FIG. **9** illustrates the device **900** with a cover/cap assembly **980** removed from the casing **950**. In this position, the retracting assembly **970** uses spring **972** on second stage housing **104** to swing the retraction/positioning bar **974** to an up or raised position where a trailing end or stop may contact the outer sidewall of housing **104** (as shown). A slot (not shown) may be provided in the sidewall of housing **104** to allow the bar **974** to move through a range of movement between the up/raised position shown in FIG. **9** and the down/retracted position shown in FIG. **10**. The support member **123** for the flame element **125** may be provided as an integral portion of the bar **974**, with the bar **974** being linked to (or formed with) the return/positioning spring **972**.

When the device **900** is turned off, the cover/cap assembly **980** may be used to manually retract the flame element **125** and cover/plug the hole/opening **955** of the casing **950**. The cap assembly **980** includes an elongated cylindrical body **982** formed with a sidewall that may extend only part way about circumference so as to leave an opening for receiving the flame element **125** and/or pendulum member **121** and retraction bar **974** (e.g., similar in shape to many tent/camping stakes or the like). The cap assembly **980** also includes a cap or top portion **984** extending orthogonally out from body **982**, and a wick **986** extending upward or vertically from cap **984**. The cap assembly **980** is manually positionable as shown with arrow **981** in FIG. **9** to be inserted into (or removed from) the casing **950**.

When the cap body **982** is inserted into the hole **955**, its tip or end contacts the retraction bar **974** and pushes the bar **974** downward or into the housing **104**. This causes the spring/hinge **972** to rotate **973** about its axis or mounting locations on housing **104**. As the retraction bar **974** is moved into the housing **104**, the pendulum **121** also is pushed into the housing **104**, which causes the attached flame element **125** to be pulled through the hole **955** (or at least partially as it may be desirable for at least a tip or portion of the flame element **125** to extend out of the hole **955** to avoid binding upon removal of cap assembly **980**). As shown, the cap **984** has its sides or edges abutting the sides of opening **955** to provide relatively tight/press fit into top **954** of casing **950**. In this position, the wick **986** is visible on the top **954** so as to appear as an unlit wick as found in conventional wax candles rather than an unlit flame element **125** (which may diminish the overall candle simulation). The retracting functionality is manual in the device **900** and the cap assembly **980** is removable, but, in other embodiments, the cap assembly **980** is automatically

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positioned upon powering off of the drive **101** and is retained when not used in the casing **950** such as opposite the light assembly **807**.

FIG. **11** illustrates a particular implementation of an upper pendulum member (or single stage pendulum member) **1121** that may be used in the devices **100**, **700**, **800**, and **900**. The body of the member **1121** is hour glass in shape. The member **1121** includes a lower, wider portion **1122** that contains the magnet/ferrous tag **124**, a narrower middle portion **1123**, and an upper wider portion **1124** that may provide the flame silhouette element illuminated by a light engine. The support hole **122** may be provided in the middle portion **1123** or in the end of the lower, wider portion **1122** near the middle portion **1123**. The thickness of the element **1121** may be relatively constant throughout in some embodiments or be varied, e.g., to provide a thicker and heavier lower, wider portion **1122**. In some cases, the upper, wider portion **1124** that provides the flame silhouette element is concave and/or includes a recessed surface **1125** to provide a more desirable light receiving surface (e.g., to provide a curved portion to receive/reflect light from a light engine/source).

In some embodiments, it may be desirable to simulate a scented candle. In such cases, a scent reservoir or solid scent component (not shown) may be positioned within the housing **102** or in casing sidewall **952**. The scent may be released more rapidly when the kinetic flame device such as device **900** is operating as waste heat from the drive mechanism **101** may be used to heat the scent reservoir/component. In other words, the scent component may be positioned on or near the drive mechanism platform or near the coil such that when these components become warmer they also heat the scent component to more rapidly release scented fumes. The scented fumes may also be disseminated by movements of the pendulum members such as lower and upper pendulums **111**, **121** with their kinetic movements, $D1_{Kinetic}$ and $D2_{Kinetic}$, fanning the scented fumes about and upward out of the housing **102**, **104**.

As discussed above, some embodiments of kinetic flame effect devices may utilize two, three, or more light sources to achieve a desired flame animation or simulation. FIG. **12** illustrates one such embodiment of a device **1200** that includes a first light source or engine **807** and a second light source or engine **1207**. The device **1200** may be considered a modification of the devices **800** and/or **900** of FIGS. **8-10** such that similar elements are labeled with like numbers. In other case, the components of device **1200** such as the light engine controller **1250** may be used in the flame effect devices **100**, **300**, and/or **500**. Generally, the device **1200** is useful for providing two or more lighting assemblies **807**, **1207** (such as LEDs) that allow an improved illumination of the flame paper or pendulum member **121** to better or differently simulate a real flame.

For example, the device **1200** may be operated through controller **1250** to vary the intensity (brighter/dimmer) of one or both of the lighting assemblies or engines **807**, **1207** or to turn one or both of the engines **807**, **1207** off (alternating which is on/off, for example) to create a chaotic lighting of the moving flame element **125** of pendulum member **121**. The addition of the second lighting assembly **1207** also achieves a desirable effect by lighting both sides **1233**, **1235** of the body of pendulum **121**. In some cases, one or both of the lighting assemblies **807**, **1207** includes an LED or other light source **808**, **1208** that is capable of changing colors and the controller **1250** may control this color changing to achieve a desired coloring of the flame element **125** or of the light reflected from its surfaces **1233**, **1235**.

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As shown, the device **1200** lights flame silhouette element **2** from below (or from an interior space defined by a housing such as housings **102**, **104** or **950**) using a first lighting assembly **807** and also a second lighting assembly **1207**. These assemblies **807**, **1207** may both be mounted within the interior spaces of a housing on opposite sides of the housing's interior walls or in other positions to light opposite sides **1233**, **1235** of the flame silhouette **125** of pendulum member **121**. In some embodiments, though, one or both of the assemblies **807**, **1207** is positioned to light the silhouette **125** from above and/or to cause light **811**, **1211** to strike a same side **1233** or **1235** (which may be flat/planar or concave).

The light assemblies **807**, **1207** each are shown to include a lighting source **808**, **1208** that projects light **809**, **1209** that is focused or diffused by lens **810**, **1210** to provide light **811**, **1211** that is projected upon opposite surfaces **1233**, **1235** of flame silhouette **125**. Each of the light sources **808**, **1208** may be LEDs. The LEDs **808**, **1208** may be of the same color, e.g., a monochromatic LED, or may be different in color, which may be useful in cases where the body of flame element/silhouette **125** is at least partially translucent (e.g., up to about half (or more) of the light **811**, **1211** is transmitted through the material of the element **125**) to mix the colors of the two light streams **811**, **1211**.

In other cases, one or both of the light sources **808**, **1208** is a bi-color or multi-color source such as an LED capable of providing light **809**, **1209** of two or more colors. In these cases, the sources **808**, **1208** may be controlled or operated to switch between the colors to vary the color of the illumination of surface **1233**, **1235** over time. For example, the source **808** and/or **1208** may be a bi-color LED that has any two of yellow, orange, or red (or other colors that may even include blue, green, white, purple, turquoise, or the like, which may be flickered more briefly to achieve a particular coloring/lighting effect) LEDs housed near the lens **810**, **1210**, and each of these colored LEDs may be selectively used to provide light **809**, **1209**. In other cases, one or both light sources **808**, **1208** may be a multi-color LED light bulb that can transition in response to control/driver signals **1266**, **1267** through a plurality of color (and brightness) combinations (e.g., the controller **1250** can select an individual color or brightness for light **809**, **1210** (which may be the same or different at any particular operating time of device **1200**)).

Further, it is typically preferable that the brightness or intensity of the light **809**, **1209** may be controlled by the controller **1250** over time to vary the lighting of the surfaces **1233**, **1235**. For example, one or both of sources **808**, **1208** may be switched between on and off (e.g., to flicker or flash or pop). Also, the sources **808**, **1208** may be selectively operated to have other brightness transition effects such as strobing, fading in and out in a smooth manner from a minimum (or first) intensity to a maximum (or second) intensity, and the like.

To provide these varying lighting effects, the device **1200** is further shown to include a light engine controller **1250** that is connected to the sources **808**, **1208** to provide driving or control signals **1266**, **1267** (or may be connected to LED drivers or the like to affect such control over assemblies **807**, **1207**). The controller **1250** is shown to include a processor **1252** (e.g., a microchip or the like) and a power supply **1254** (which may be the same or different from that used to drive sources **808**, **1208**). The processor **1252** manages memory **1256** of the controller **1250**, which may contain a flame lighting program **1260**. The controller **1250** typically is contained within the housing with the lighting assemblies **807**, **1207** (such as within the base of a housing proximate to a power source such as a battery).

The program **1260** may take the form of code or software in nearly any programming language that is executed by the processor **1252** to cause it to selectively transmit control signals **1266**, **1267** to drive or operate the light sources **808**, **1208**. For example, the program **1260** may include a simulation algorithm(s) **1264** that is useful for simulating or emulating a real flame with light **809**, **1209** by causing the controller **1250** to issue signals **1266**, **1267**. In some embodiments, the controller **1250** may be replaced with or include manual controls that allow an operator to manually tune the color and/or intensity of the light sources **808**, **1208** or to select among algorithms **1264** (e.g., a rapidly flickering candle, a dim and slowly moving flame, a bright and larger flame effect, and so on).

In one embodiment, the pendulum member **121** and its flame element **125** take the form of a sheet of Mylar (e.g., BoPET) or the like that is colored (e.g., plum or the like). Such a metalized film provides reflective surfaces **1233**, **1235** that reflect received light **811**, **1211** to a viewer or observer of the kinetic flame effect device **1200** in a desirable manner. In this or other embodiments, the simulation algorithm **1264** acts to randomly (or seemingly randomly) transition at least the intensity/brightness of one and, more preferably, both sources **808**, **1208** over time.

Typically, one or both sources **808**, **1208** provides light **809**, **1209** of two or more colors and the control signals **1266**, **1267** are generated by controller **1250** to switch the color of light **809**, **1209** over time, too, such as transition between orange and white over time. The transitions of sources **808**, **1208** may occur concurrently or these transitions may differ over time. For example, the source **1208** may be providing a light **1209** of a first color varying based on a first transition pattern (e.g., rapid flickering white or light blue light) while the source **808** is operated with signals **1266** to provide a light **809** of second and third colors that vary based on a second transition pattern (e.g., a slow fade in and out between yellow and red).

We claim:

1. An apparatus for simulating a flame, comprising:
 - a housing including an interior space;
 - a drive mechanism generating a time varying electromagnetic field that extends into the interior space;
 - a pendulum member pivotally mounted within the interior space of the housing, the pendulum member including a magnetic coupling member on a first end positioned proximate to the drive mechanism, wherein the magnetic coupling member interacts with the time varying electromagnetic field and wherein the pendulum member includes a flame silhouette element extending from a second end of the pendulum member opposite the first end;
 - a first light source adapted to selectively project a first light stream onto the flame silhouette element; and
 - a second light source adapted to selectively project a second light stream onto the flame silhouette element.
2. The apparatus of claim 1, wherein at least one of the first and second light sources comprises at least a bi-color light source whereby at least one of the first and second light streams is a first color during a first operating period of the apparatus and is a second color during a second operating period of the apparatus.
3. The apparatus of claim 2, wherein the first light stream comprises light of a color differing from a color of the second light stream at least periodically during operation of the apparatus.
4. The apparatus of claim 1, wherein the flame silhouette element has a first surface and a second surface and wherein

the first light stream is directed onto the first surface and the second light stream is directed onto the second surface.

5. The apparatus of claim 4, wherein the flame silhouette element has a body formed of a material that is at least partially translucent.

6. The apparatus of claim 1, further including a light engine controller with a processor running a flame lighting program that defines a first set of control signals for operating the first light source and a second set of control signals for operating the second light source, wherein the first and second light streams transition according to first and second transition patterns.

7. The apparatus of claim 6, wherein the first and second sets of control signals differ over an operating period of the apparatus such that at least one of brightness and color of the first and second light streams differs during the operating period.

8. A kinetic flame device, comprising:

a housing with a sidewall defining an interior space with a first stage and a second stage;

an elongated, first pendulum member with a first magnetic coupling member positioned near a first end and second magnetic coupling member positioned near a second end, wherein the first pendulum member is pivotally mounted within the first stage;

an elongated, second pendulum member with a third magnetic coupling member positioned near a first end and a flame silhouette element extending from a second end, wherein the second pendulum member is pivotally mounted within the second stage of the housing with the first end of the second pendulum member spaced apart and proximate to the second end of the first pendulum member;

during an operating time period, a coil providing a time-varying magnetic field within a portion of the first stage containing the first end of the first pendulum member; and

a lighting assembly at least partially concurrently directing a first stream of light onto a first surface of the flame silhouette element and a second stream of light onto a second surface of the flame silhouette element.

9. The kinetic flame device of claim 8, wherein the lighting assembly includes a first LED providing the first stream and a second LED providing the second stream and a controller selectively driving the first and second LEDs based on a lighting program.

10. The kinetic flame device of claim 9, wherein the lighting program defines a first light transition pattern for the first LED that differs over time from a second light transition pattern for the second LED.

11. The kinetic flame device of claim 10, wherein at least one of the first and second streams vary in color according to the first and second light transition patterns.

12. The kinetic flame device of claim 10, wherein at least one of the first and second streams vary in brightness according to the first and second light transition patterns.

13. A flame simulator, comprising:

a drive mechanism generating a time-varying electromagnetic field;

a first stage pendulum member pivotally supported proximate to the drive mechanism, the first stage pendulum member including a first magnetic coupling member on a first end and a second magnetic coupling member on a second end distal from the drive mechanism, whereby the first magnetic coupling member interacts with the time-varying electromagnetic field;

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a second stage pendulum member pivotally supported with a first end containing a magnetic coupling member proximate to the second end of the first stage pendulum member, wherein the second stage pendulum member further includes a flame silhouette element extending from a second end of the second stage pendulum member;

a first light source selectively transmitting light onto the flame silhouette element; and

a second light source selectively transmitting light onto the flame silhouette element.

14. The flame simulator of claim 13, wherein the first light source is adapted for projecting the light in a first color and a second color differing from the first color.

15. The flame simulator of claim 14, wherein the second light source is adapted for projecting the light in a third color and a fourth color differing from the third color.

16. The flame simulator of claim 13, wherein the first light source is adapted for projecting the light over a brightness range.

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17. The flame simulator of claim 16, wherein the second light source is adapted for projecting the light over a brightness range, whereby the brightness of the light provided by the first and second light sources differs at least periodically during operation of the flame simulator.

18. The flame simulator of claim 13, further including a light engine controller with providing control signals to the first and second light sources to cause the light from at least one of the first and second light sources to transition according to a predefined light transition pattern.

19. The flame simulator of claim 18, wherein the light transition pattern causes the first or second light source to switch between on and off to selectively provide the light.

20. The flame simulator of claim 18, wherein the light transition pattern causes both the first and second light sources to vary in both color and brightness during operation of the flame simulator.

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