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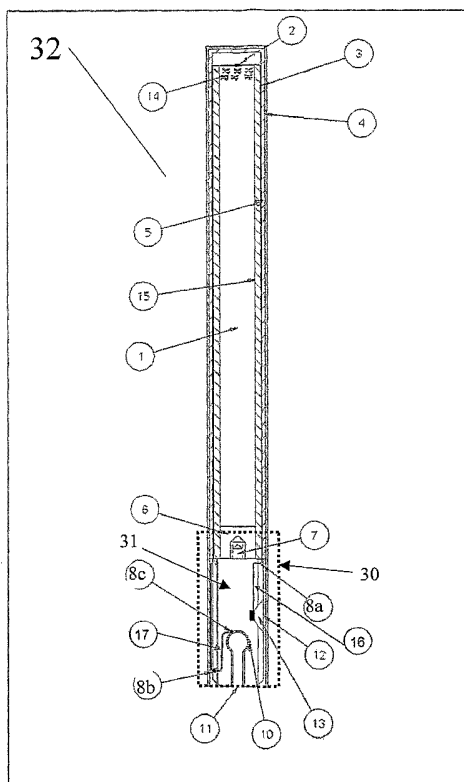
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(54) Title: PYROTECHNIC DEVICE AND PYROTECHNIC DISPLAY COMPRISING THE SAME



(57) Abstract: A pyrotechnic device including an elongated wrapper and a fastening device for fastening the pyrotechnic device to a solid support is provided. Appropriate fastening devices include mechanical and magnetic fastening devices. In exemplary embodiments, the disclosed pyrotechnic device includes an electrical ignition device that receives electrical current delivered from the solid support. The pyrotechnic devices disclosed herein are useful for creating pyrotechnic displays including a plurality of pyrotechnic devices.

PYROTECHNIC DEVICE AND A PYROTECHNIC DISPLAY COMPRISING THE SAME

FIELD OF THE INVENTION

The present invention relates to a pyrotechnic device, a pyrotechnic display and a
5 method of creating a pyrotechnic display.

BACKGROUND OF THE INVENTION

Pyrotechnic displays including a plurality of pyrotechnic devices are well known in the
art. One exemplary pyrotechnic display is disclosed in US Patent 1,976,844, incorporated
herein by reference in its entirety, wherein a display including plurality of lances carried by a
10 support and means for igniting groups of the lances is described.

The aforementioned pyrotechnic displays involve hundreds or even thousands of
individual pyrotechnic devices that are ignited as a group to create an impressive theatrical
effect. Unfortunately, creating these pyrotechnic displays is an extraordinarily tedious
undertaking, as it is necessary to first fasten each individual lance using adhesive tape and the
15 like to the supporting frame, and then to subsequently attach an appropriate fuse to each
individual lance such that a group of lances can be ignited simultaneously. Furthermore, after
the pyrotechnic display is ignited it is difficult to reuse the supporting frame to create another
pyrotechnic display, as removing the used lances from the frame is yet another tedious process.

There is an unmet need for pyrotechnic devices including lances and gerbs configured
20 for easy attachment and removal to support frame in order to create pyrotechnic displays
involving a large number of such devices with a minimal amount of effort. Preferably, the
individual pyrotechnic devices will be configured so that it can be ignited through the

supporting frame, obviating the need for an additional process whereby fuses for igniting a group of devices are attached to each device.

SUMMARY OF THE INVENTION

The aforementioned needs are satisfied by several aspects of the present invention.

5 It is now disclosed for the first time a pyrotechnic device including pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, and a fastening device attached to the elongated wrapper. In exemplary embodiments, the fastening device includes fastener selected the group consisting of a mechanical fastening device and a magnetic fastening device and is useful for attaching the pyrotechnic device to a solid support.

10 In some embodiments, the fastening device includes an electrical ignition device for igniting the pyrotechnic material. In some embodiments, the fastening device includes an electrically conducting material such as a wire embedded therein.

It is noted that the presently disclosed pyrotechnic devices are useful in the creation of pyrotechnic displays, wherein a plurality of pyrotechnic devices are attached or fastened to a solid support such as a support frame. Not wishing to be bound by theory, it is noted that the mechanical and/or magnetic fastener eases the process wherein a pyrotechnic device is attached to the support. For embodiments wherein there is an electrical connection between a location on the fastening device and the electrical ignition device, it is possible to ignite the device by supplying electrical current from the supporting frame, obviating the need to install a separate mechanism for igniting the pyrotechnic device, and allowing the construction of pyrotechnic displays using fewer man hours than was henceforth possible.

In some embodiments, at least a portion of the elongated wrapper is flammable.

In some embodiments, the fastening device is attached to a nonflammable portion of the wrapper.

In some embodiments, the wrapper includes an electrically conducting material attached to the wrapper. The electrically conducting material may be situated on an internal or
5 external surface of the wrapper and attached to the wrapper, or embedded with the wrapper or between constitutive wrapper layers. One example of such an electrically conducting material is an electrically conducting wire.

In some embodiments, the elongated wrapper is of substantially cylindrical shape.

In some embodiments, the electrical ignition device or fuse and the fastening device are
10 located substantially on distal ends of the elongated wrapper.

In some embodiments, the electrical ignition device is located within the elongated wrapper. Not wishing to be bound by theory, it is noted that locating the electrical ignition device within the elongated wrapper protects the ignition device against the precipitation, dew and the like.

15 In some embodiments, pyrotechnic material includes a propellant.

In some embodiments, a thickness of the elongated wrapper is at most 1.5 cm. In some embodiments, a thickness of the elongated wrapper is at most 1 cm. In some embodiments, a thickness of the elongated wrapper is at most 0.5 cm. In some embodiments, a thickness of the elongated wrapper is at most 2 mm. In some embodiments, a thickness of the elongated
20 wrapper is at most 1.5 mm. In some embodiments, a thickness of the elongated wrapper is at most 1.2 mm. In some embodiments, a thickness of the elongated wrapper is at most 1 mm. In some embodiments, a thickness of the elongated wrapper is at most 0.7 mm.

In some embodiments, the wrapper includes a water resistant material such as waxpaper. It will be appreciated that water resistant wrappers can, in some embodiments, be implemented as two separate wrapper layers, wherein an outer layer is water resistant.

In some embodiments, the mechanical fastener includes a screw-threaded device.

5 The presently disclosed pyrotechnic device is useful for construction of pyrotechnic displays such as set pieces. In some embodiments, the presently disclosed pyrotechnic display includes a solid support, and a plurality of presently disclosed pyrotechnic devices attached to the solid support.

10 In some embodiments, the solid support includes an electrically conducting material such as an electric wire attached to or embedded within the solid support.

In some embodiments, the solid support includes a plurality of fastening device ports adapted for the fastening device.

In some embodiments, at least one pyrotechnic device includes an electric ignition device, and each electric ignition device is electrically connected to a fastening device port.

15 In some embodiments, each pyrotechnic device includes an electrical ignition device, and the pyrotechnic display further includes an electrical power source, for supplying electrical current to the pyrotechnic devices. Thus, it is possible to simultaneously or nearly simultaneously ignite a plurality of pyrotechnic devices by supplying electrical current from the power source.

20 It is now disclosed for the first time a method of creating a pyrotechnic display. The presently disclosed method includes providing a plurality of pyrotechnic devices, each pyrotechnic device including an electric ignition device, mechanically or magnetically

fastening the plurality of pyrotechnic devices to a solid support, and igniting the pyrotechnic devices.

In exemplary embodiments, the stage of igniting is carried by providing an electrical current to an electrical ignition device.

5 It is now disclosed for the first time a pyrotechnic device including pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, a fastening device, attached to the elongated wrapper, and an electrical ignition device for igniting the pyrotechnic material, wherein an electrical connection exists between at least one location on the fastening device and the electrical ignition device.

10 It is now disclosed for the first time a pyrotechnic display including a solid support, and a plurality of pyrotechnic devices attached to the solid support. In some embodiments, each attached pyrotechnic device includes pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, a fastening device, attached to the elongated wrapper, and an electrical ignition device for igniting the pyrotechnic material, wherein an electrical connection
15 exists between at least one location on the solid support and the electrical ignition device.

It is now disclosed for the first time a pyrotechnic device including pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, a fastening device, attached to the elongated wrapper, and an electrical ignition device for igniting the pyrotechnic material, wherein an electrical connection exists between at least one location on the fastening
20 device and the electrical ignition device.

It is now disclosed for the first time a pyrotechnic device including pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, a fastening device,

attached to the elongated wrapper, and an electrical ignition device located within the elongated wrapper for igniting the pyrotechnic material.

It is now disclosed for the first time a pyrotechnic device including pyrotechnic material, an elongated wrapper for holding the pyrotechnic material, and a fastening device including an electrically conducting material attached to the elongated wrapper,

These and further embodiments will be apparent from the detailed description and examples that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 provides a schematic of a pyrotechnic device according to some embodiments of the present invention.

FIGS. 2A-2B provides a schematic of a base of an exemplary pyrotechnic device including a fastening device according to some embodiments of the invention.

FIG. 3 provides a schematic of a base of an exemplary pyrotechnic device attached to an exemplary support frame according to some embodiments of the invention.

FIG. 4 provides a schematic of an exemplary pyrotechnic device associated to an exemplary support frame according to some embodiments of the invention.

FIG. 5 provides a schematic circuit diagram for igniting a plurality of mounted pyrotechnic devices in a pyrotechnic display according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present inventor is now disclosing for the first time a pyrotechnic device including a mechanical, electrical or magnetic fastening device which allows the pyrotechnic device to

be attached or fastened to a supporting frame. In some embodiments, the pyrotechnic device can be electrically ignited using electric current delivered from the supporting frame. Exemplary disclosed devices include but are not limited to lances and gerbs. Furthermore, the presently disclosed pyrotechnic devices, allows for the construction and dismantling of pyrotechnic displays including a plurality of such devices using fewer man hours than henceforth was possible. It is noted that these pyrotechnic or fireworks displays are useful as theatrical set pieces.

In some embodiments, the pyrotechnic device has an elongated or tubular shape, and the fastening device is at the base of the pyrotechnic device, distally located from an electrical ignition device. In some embodiments, the disclosed devices include an electric connection between locations on the fastening device and the electrical igniting device, thus allowing for ignition of the device using electrical current delivered from a support frame to which the pyrotechnic device is attached.

FIG. 1 provides a side view of an exemplary pyrotechnic device **32** such as a lance according to some embodiments of the present invention. The disclosed device depicted in FIG. 1 includes pyrotechnic material **1** such as flammable powder, which is provided inside an outer elongated wrapper **5**. The pyrotechnic material **1** can be ignited using an electric ignition device **2** such as a bridge wire, which is supplied with electric current through an axial electrical wire **3** providing an electrical connection from the base **30** and through the electric ignition device **2**. The skilled artisan will appreciate that the electrical wire **3** can either be a single electrical wire with a portion configured as an electrical ignition device **2**, or can be implemented as a plurality of electrical wires.

In some embodiments, there is a separate inner elongate wrapper **15** which separates between the electrical wire **3** and the pyrotechnic material **1**. In proximity of the electrical ignition device **2** is optional pyrotechnic primer **14** for facilitating ignition of the pyrotechnic material **1**.

5 Optionally, the outer elongated wrapper **5** includes a layer of waxpaper or other water resistant material. It is noted that for embodiments wherein the electrical ignition device **2** is located within the device, rather than externally, and wherein the outer elongated wrapper **5** includes a layer of water resistant material **4**, the device itself is water resistant, reducing the risk of ruination in outdoor conditions.

10 In exemplary embodiments, the outer elongated wrapper **5** as well as the inner elongated wrapper **15** are constructed of a flammable material. Appropriate materials include but are not limited to bond, poster paper, and cardboard. In a typical embodiment wherein the pyrotechnic device **32** is a lance, 0.004 bond may be used. While there is no specific limitation on a material or an aggregate thickness of the inner **15** and outer elongated wrapper **5**, it is
15 noted that some embodiments, including embodiments wherein the disclosed pyrotechnic device **32** is a lance, the aggregated thickness is at most 1.5 mm. It is noted that some embodiments, including embodiments wherein the disclosed pyrotechnic device **32** is a gerb, the aggregated thickness is at most 1.5 cm.

20 As shown in FIG. 1, base **30** is attached to the rest of the device by means of a screw-threaded engagement including a rigid connector **6** and screw head **7**, both of which are contained within the outer elongated wrapper **5**. In some embodiments, the rigid connector **6** and screw head **7** are constructed from inflammable material, reducing the risk that the ignited device could fall away from a support frame. Also, it is noted that the screw-thread

engagement of FIG. 1 reflects one exemplary embodiment, and should not be construed as a limitation. Alternatively or additionally, the base 30 may be connected to the elongated or substantially cylindrical portion of the pyrotechnic device 32 by welding, with a mechanical fastener, bonding or adhering.

5 It is noted that the base 30 includes mechanical fasteners and thus functions as a mechanical fastening device.

Referring to FIGS. 2A-2B, the base 30 is arranged so as to allow electrical current to flow between an electrical outlet 12, the electrical ignition device 2, and an electrically conducting external surface of the base 10. In some embodiments, the electrical outlet 12 is
10 simply a hole or recess within an electrically conducting element 13.

Optionally, the base 30 has a rigid structure, which is optionally imparted by a rigid base support 31 internal to the base 30. In exemplary embodiments, the rigid base support 31 is constructed from a rigid plastic material or glass, though this should not be construed as a limitation and any material known to the skilled practitioner for imparting rigid structure is
15 appropriate. In some embodiments, the material that contributes to imparting rigid structure is an electrical insulator. Alternately or additionally, the base 30 is contained within some sort of external support or rigid shell (not shown) in order to imbue the base with a rigid structure.

As depicted in FIGS. 2A-2B, the electrically conducting element 13 is connected to a first base electrical wire 16, which connects the electrically conducting element 13 and *inter*
20 *alia* the electrical outlet 12 to the axial wire 3 through a first electrical connection point 8a. Furthermore, a second base electrical wire 17 connects the electrically conducting external surface 10 to the axial electrical wire 3 through a second electrical connection point 8b. The second base electrical wire 17 is connected to the electrically conducting external surface 10 at

a third connection point **8c**. The skilled artisan will appreciate that the particular geometric layout of the wires in FIGS. 2A-2B is provided only as an illustrative example, and that any arrangement of wires whereby electrical current may flow from the base **30** and through electrical ignition device **20** is appropriate for the present invention.

5 Furthermore, the base **30** as depicted in FIGS. 1, 2A-2B also functions as a mechanical fastener allowing the pyrotechnic device **32** to be fastened to a support **31** such as a supporting frame. Thus, both the electrical outlet **12** as well as the female connector **11** are configured to function as fasteners. Nonetheless, the skilled artisan will appreciate that other mechanical or magnetic or electrical fasteners that include an electrically conducting material are appropriate
10 for fastening the pyrotechnic device **32** to a support. In some embodiments, the disclosed base **30** includes a screw assembly for screwing the disclosed pyrotechnic device **32** into an outlet provided on the support frame. In some embodiments, the disclosed based **30** includes a snap fastening device or any other mechanical fastening device known in the art.

As shown in FIGS. 3, the support frame has a male connector **25** connects to the female
15 connector **11** of the base of the pyrotechnic device **32**. It is noted that the male connector **25** of the support frame **31** has a first frame electrically conducting surface **26** which contacts the electrically conducting second external surface of the base **10**. The male connector **25** includes an first electric wire embedded therein **27** which provides an electrical connection between the first frame electrically conducting surface **26** and a first support frame wire **21** for conveying
20 electrical current from a power supply (not shown).

It is noted that as depicted in FIG. 3, the support frame is also attached to the first external surface of the base **12** which contains electrically conductive element **13**. Thus, the frame includes a hook **23** or similar device with a second frame electrically conducting surface

11

24 that contacts the electrically conducting element 13 within the electrical outlet 12. In some embodiments, this hook is an integral part of the frame, and includes a second electric wire embedded therein 29 which provides an electrical connection between the second frame electrically conducting surface 24 and a second support frame wire 22 for conveying electrical
5 current from a power supply (not shown).

It is noted that both the hook 23 and the male connector 25 function as device ports of the supporting frame, configured to make a mechanical connection with the mechanical fastener of the base 30 of the pyrotechnic device 32.

In some embodiments, the present invention provides conveniently stackable frames.

10 FIG. 4 provides a diagram of an exemplary pyrotechnic device associated to an exemplary support frame according to alternate embodiments of the invention. According to embodiments illustrated in FIG. 4, the base 30 does not necessarily include any electrically conducting material, unlike the embodiment illustrated in FIG. 3. Thus, as illustrated in FIG. 4 male connector 25B which serves to mechanically fasten the pyrotechnic device to the
15 supportive frame is not necessarily electrically conductive. Furthermore, as illustrated in FIG. 4 the base 30 contains no wires or electrically conductive material embedded therein.

As illustrated in FIG. 4, the electric ignition device 2 receives electrical current delivered from electrically conductive first and second support frame wires 21 and 22. This electrical current is delivered through two external supply wires 44A and 44B which receives
20 the electrical current from electrically conductive first and second support frame wires 21 and 22 via an electrical adapter 41 that is part of the frame or mechanically attached thereto. It is noted that electrical adapter 41 includes connection electrical connection points 43A and 44B

which connect to wires 44, and provide an electrical connection between the external supply wires 44A and 44B and the first and second support frame wires 21 and 22.

Also, it is noted that in embodiments depicted in FIG. 4 there is no need for electrical wire 3 embedded within the wrapper, as the electric ignition device 2 receives electrical current via the two external supply wires 44A and 44B.

Electrical Circuit Including a Plurality of Pyrotechnic Devices Receiving Electric Current from A Supporting Frame

In some embodiments, more than one pyrotechnic device is electrically connected to the first support frame wire 21 and/or the second support frame wire 22. Thus, by supplying electrical current it is possible to ignite several pyrotechnic devices by providing current through the first support frame wire 21 to the second support frame wire 22 or vice versa. Optionally, each individual electric circuit between the first support frame wire 21 and the second support frame wire 22 includes a resistor each of whose value is individually determined.

FIG. 5 provides a diagram of an exemplary electrical circuit, including a power source 35, an optional switch 36, a plurality of pyrotechnic devices 32, and a plurality of resistors 33.

Composition of the Pyrotechnic Material

The present invention imposes no particular limitations on the particular pyrotechnic material 1. In some embodiments, the pyrotechnic material includes particulate matter or powder. In some embodiments, the pyrotechnic material includes any particulate matter or powder typically used in creating pyrotechnic displays. In particular embodiments, the pyrotechnic material includes only particulate matter or powder typically used in creating pyrotechnic displays.

In some embodiments, the pyrotechnic composition includes a fuel, an oxidizing agent, and at least one of a metal salt and metal powder. Appropriate pyrotechnic materials for embodiments where the pyrotechnic device is a lance include but are not limited to potassium perchlorate, barium chlorate, barium nitrate, strontium carbonate, cryolite, copper carbonate, ammonium perchlorate, paris green, red gum, lactose, copal gum, potassium nitrate, sulfure, antimony metal powder, mealed gunpowder. In some embodiments, the pyrotechnic material includes a mixture of potassium nitrate and accaroid resin.

In some embodiments, the disclosed pyrotechnic device is a gerb. The skilled artisan is directed to U.S. Patent 6,530,327, for a description of gerbs known in the art. Among typical compositions for gerbs or fountains have been: (1) potassium nitrate, charcoal, sulfur, steel powder; or (2) potassium nitrate, strontium nitrate, potassium benzoate and titanium metal powder. Typical formulations for gerbs generally include a fast-burning fuel/oxidizer mix that contains metallic filings or powder. The metal filings or powder burns to produce various colored sparks depending on the type of metal used. Typically, the gerbs include some sort or propellant or pyrotechnic material that emits sparks upon combustions.

There is no particular limitation of the luminous intensity of the presently disclosed pyrotechnic device. Nevertheless, it is recognized that in some embodiments a plurality of pyrotechnic devices are deployed in a pyrotechnic display including at least 2 at least 10, at least 100, at least 500, or at least 1000 such pyrotechnic devices, such as a theatrical set piece. For certain embodiments wherein a multiplicity of pyrotechnic devices are attached to a supporting frame to comprise a pyrotechnic display, it is recognized that it is not desirable for any individual pyrotechnic device to burn with too great an intensity. Thus, in certain

embodiments, an individual disclosed pyrotechnic device burns with an intensity of at most 300 candela, at most 750 candela, at most 1000 candela, at most 1300 candela, at most 1600 candela, at most 2000 candela, at most 5000 candela, and at most 10000 candela.

The present invention imposes no particular limitation on the size of the pyrotechnic device, and it is noted that the principles of the present invention are applicable to any previously disclosed pyrotechnic device such as a lance or gerbs or fountain. Thus, in specific embodiments the presently disclosed pyrotechnic device has dimensions similar to those typical for lances and gerbs. In some embodiments, the disclosed pyrotechnic device is substantially cylindrical, and the inner diameter of the device is at most 2 inches or 50.8 mm, at most 50 mm, 38.1 mm or 1 ½ inches, at most 40 mm, at most 25.4 mm or 1 inch, at most 25 mm, at most 15 mm, at most 12.7 mm or ½ inch, at most 10 mm, and at most 8 mm. In some embodiments, the disclosed pyrotechnic device is substantially cylindrical and the length of the device is at least about 5 cm, and at most about 35 cm.

The present invention imposes no limitation upon the duration for which a disclosed pyrotechnic device may be ignited. In some embodiments, the device is configured to burn for at most 3 minutes, at most 2 minutes, at most 90 seconds, at most 60 seconds, or at most 30 seconds.

While the present invention has been particularly described, persons skilled in the art will appreciate that many variations and modifications can be made. Therefore, the invention is not to be construed as restricted to the particularly described embodiments, rather the scope, spirit and concept of the invention will be more readily understood by reference to the claims which follow.

WHAT IS CLAIMED IS:

- 1) A pyrotechnic device comprising
 - a) pyrotechnic material;
 - b) an elongated wrapper, for holding said pyrotechnic material; and
 - c) a fastening device selected from the group consisting of a mechanical fastening device and a magnetic fastening device, attached to said elongated wrapper.
- 2) The pyrotechnic device of claim 1 wherein said fastening device includes an electrically conducting material.
- 3) The pyrotechnic device of claim 1 wherein said wrapper includes an electrically conducting material.
- 4) The pyrotechnic device of claim 1 further comprising:
 - d) an electrically conducting wire, attached to said wrapper.
- 5) The pyrotechnic device of claim 1 further comprising:
 - d) an electrical ignition device, for igniting said pyrotechnic material.
- 6) The pyrotechnic device of claim 5, wherein an electric connection exists between said electrical ignition device and a location on said fastening device.
- 7) The pyrotechnic device of claim 1 wherein said wrapper includes waxpaper.
- 8) The pyrotechnic device of claim 1 wherein said pyrotechnic device is configured to burn with an luminous intensity of at most 2000 candela.
- 9) The pyrotechnic device of claim 1 wherein said pyrotechnic material includes particular matter.

- 10) The pyrotechnic device of claim 1 wherein said pyrotechnic material includes a material that emits sparks upon combustion.
- 11) The pyrotechnic device of claim 1 wherein a thickness of said elongated wrapper is at most 1 mm.
- 12) The pyrotechnic device of claim 1 wherein a diameter of the device is at most 12.7 mm.
- 13) A pyrotechnic display comprising:
 - a) a solid support; and
 - b) a plurality of pyrotechnic devices according to claim 1 attached to said solid support.
- 14) The pyrotechnic display of claim 13 wherein said solid support includes an electrically conducting material.
- 15) The pyrotechnic display of claim 13 wherein said solid support includes a plurality of fastening device ports adapted for said fastening device.
- 16) The pyrotechnic display of claim 14 wherein at least one said pyrotechnic device includes an electric ignition device, and each said electric ignition device is electrically connected to said electrically conducting material.
- 17) A method of creating a pyrotechnic display comprising:
 - a) providing a plurality of pyrotechnic devices, each pyrotechnic device including an electric ignition device;
 - b) mechanically fastening said plurality of pyrotechnic devices to a solid support;
 - c) igniting said pyrotechnic devices.
- 18) A pyrotechnic device comprising:

- a) pyrotechnic material;
- b) an elongated wrapper, for holding said pyrotechnic material;
- c) a fastening device, attached to said elongated wrapper; and
- d) an electrical ignition device for igniting said pyrotechnic material, wherein an electrical connection exists between at least one location on said fastening device and said electrical ignition device.

19) A pyrotechnic device comprising:

- a) pyrotechnic material;
- b) an elongated wrapper, for holding said pyrotechnic material;
- c) a fastening device, attached to said elongated wrapper; and
- d) an electrical ignition device located within said elongated wrapper for igniting said pyrotechnic material.

20) A pyrotechnic device comprising:

- a) pyrotechnic material;
- b) an elongated wrapper, for holding said pyrotechnic material; and
- c) a fastening device including an electrically conducting material attached to said elongated wrapper.

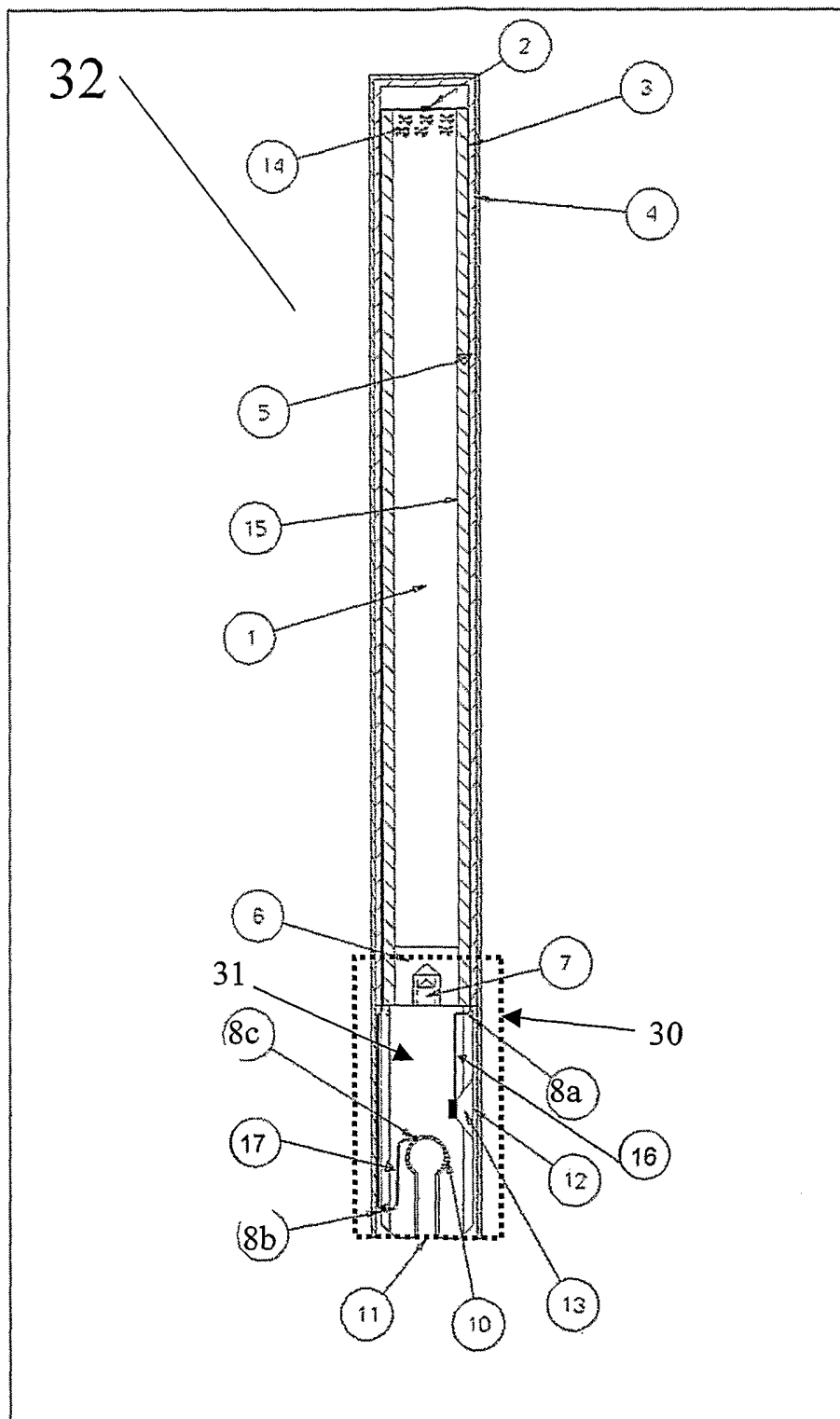


FIG. 1

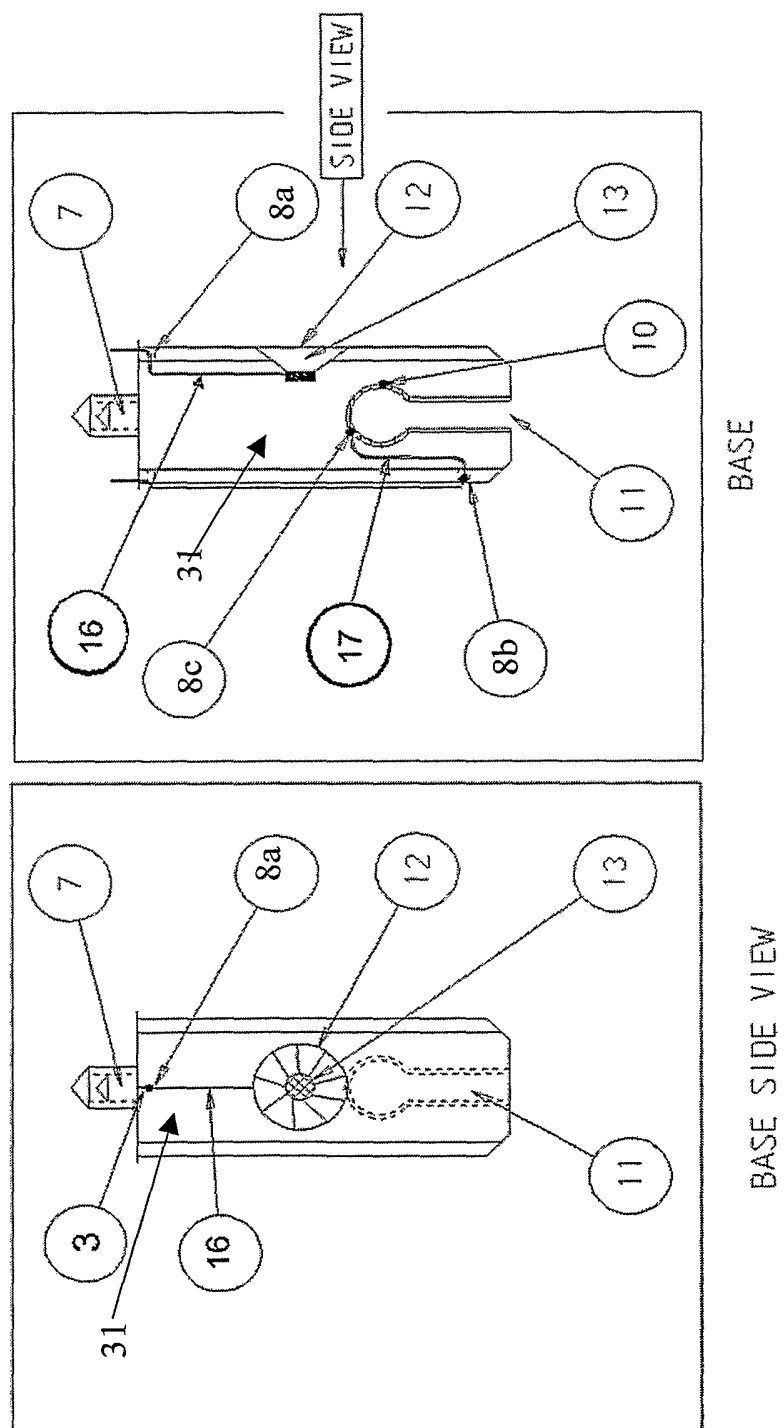


FIG. 2

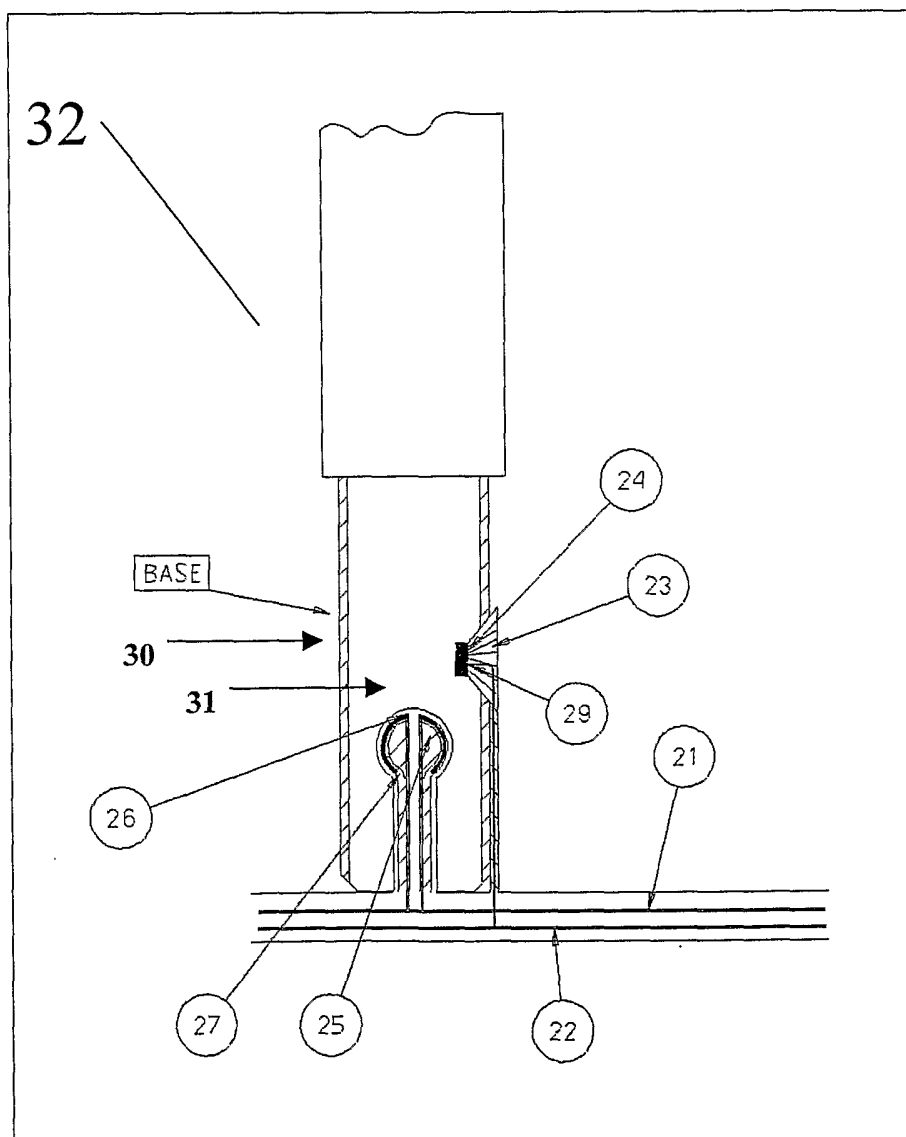


FIG. 3

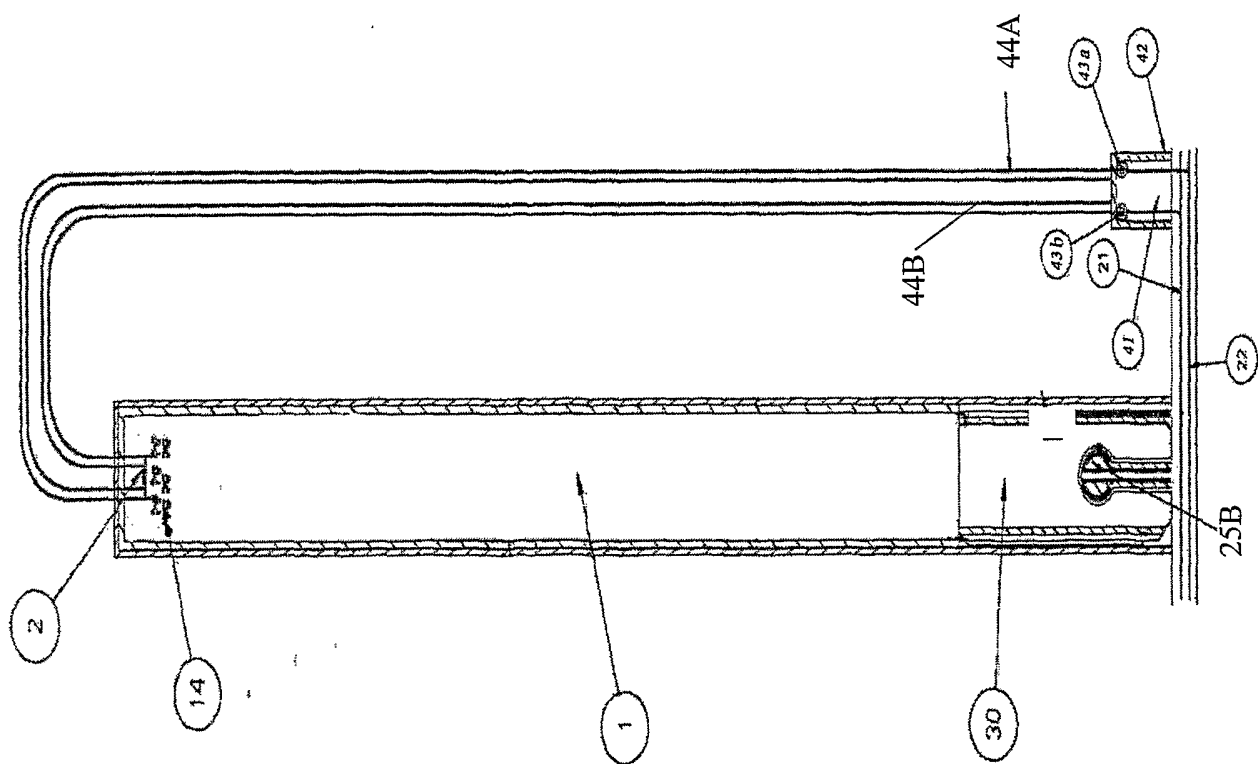


FIG. 4

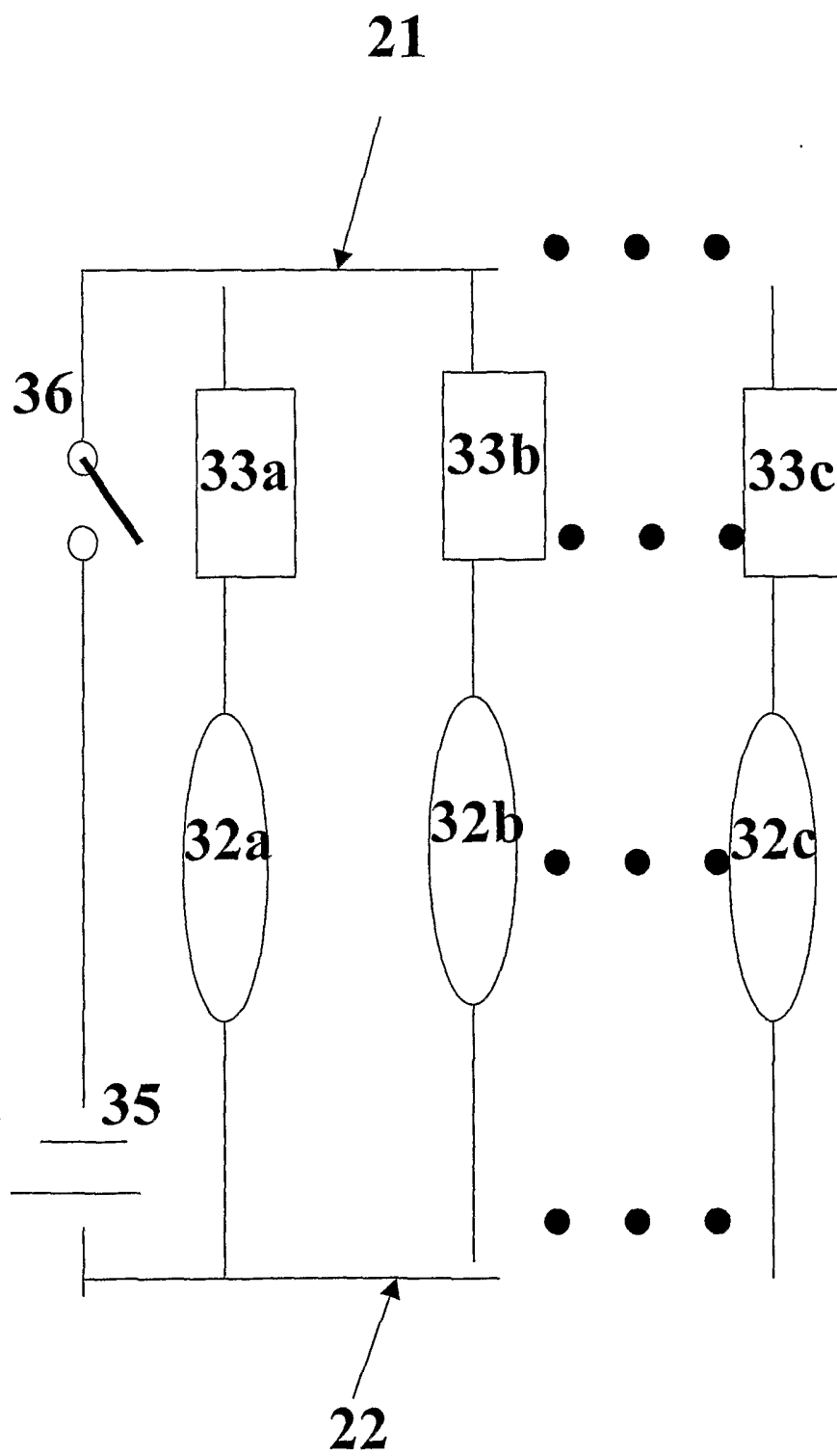


FIG. 5