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United States Patent	12383845
Kind Code	B2
Date of Patent	August 12, 2025
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Inflatable, expanding sword

Abstract

The present disclosure provides an inflatable toy sword device with a blade configured to extend from and retract into the handle. A flexible blade material may be stored in a spooled configuration within the handle and inflated during extension. During retraction, the process is reversed and air is controllably released while the material is spooled. A method of extending and retracting the flexible blade material of an inflatable toy sword is also provided.

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Family ID: **1000008750946**

Appl. No.: **17/852695**

Filed: **June 29, 2022**

Prior Publication Data

Document Identifier	**Publication Date**
US 20220410026 A1	Dec. 29, 2022

Related U.S. Application Data

us-provisional-application US 63216069 20210629

Publication Classification

Int. Cl.: **A63H33/30** (20060101); **A63H33/00** (20060101)

U.S. Cl.:

CPC **A63H33/009** (20130101);

Field of Classification Search

CPC: A63H (33/009)

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION (1) This application claims priority to U.S. provisional application Ser. No. 63/216,069, filed Jun. 29, 2021, the entire contents of which is incorporated by reference

BACKGROUND OF INVENTION

1. Field of the Invention

(1) The present invention relates generally to sabers and more specifically it relates to an inflatable, extending, and retracting sword for novelty use as a toy sword, prop or for simulated combat. A method of using such a device is also provided.

2. Discussion of the Related Art

(2) Simulated weapons, such as swords are frequently used as children's toys, theatrical props and combat training aids. Some such simulated weapons are designed to include specific functional components and ornamental appearances in order to replicate weapons from fictional or non-fictional stories and genres. For example, a toy sword that is intended for use in a theatrical production of an Aurtherian legend may include functional and ornamental aspects that are indicative of the sword Excalibur. Alternatively, if the toy sword was an accessory to a samurai costume, the sword may include functional and ornamental aspects that are indicative of a Japanese katana. In the genre of science fiction, many characters utilize swords that include a retractable blade formed of energy and/or light that selectively extends from the handle. The fictional nature of such devices renders accurate simulation of the functional components and ornamental appearances difficult.

(3) Prior attempts to replicate such devices have included an apparatus of two-piece construction, where the rigid elongated blade is selectively attached to the handle or hilt by the user. Alternatively, some devices have utilized a telescopic blade that reduces, but does not eliminate the visible appearance of a portion of the blade when in the retracted configuration. However, all such devices fail to provide an accurate simulation of the blade extension and retraction.

(4) In an effort to remedy these deficiencies, more recent attempts to replicate such energy swords have included the use of LED strips disposed on a flexible substrate that are mechanically driven between extended and retracted configurations. However, such devices are exceedingly delicate and not well suited for use in simulated combat. As such there remains a need for a device that both accurately simulates the extension and retraction of a science fiction energy sword while also being well suited for use in simulated combat and play.

(5) Accordingly, the present invention addresses this long felt need by providing a toy sword which includes in at least one embodiment a blade chamber, handle or hilt, blade, switch, pump, battery, electric motor or motors, and controller.

SUMMARY OF THE INVENTION

(6) In accordance with a first aspect of the invention, this need is satisfied by providing an adjustable sword apparatus configured for use in simulated combat that includes a housing having a sidewall extending between opposing first and second ends, an inflatable blade having a flexible wall extending between a first connected end affixed within a void defined by the sidewall of the housing and an opposing second end that is movable relative to the connected end. The apparatus includes an extension system disposed within the void that is configured to inflate an interior of the blade such that the second end of the flexible wall extends outwardly from the void in the housing, and a retraction system disposed within the void configured to retract at least a portion of the blade within the void.

(7) A nonlimiting feature of this embodiment is to provide an inflatable expanding sword for novelty use as a toy or prop in simulated combat.

(8) Another aspect of the invention is to provide an apparatus comprising a power source and a controller in electrical communication with the extension system and the retraction system, the power source and controller disposed within the housing void.

(9) A nonlimiting feature of this embodiment is to provide a power source located in the apparatus for activating the blade extension and retraction systems.
(10) Another aspect of the invention is to provide an air pump activated by the controller, the air pump in fluid communication with the interior of the blade and configured to provide positive air pressure to the interior of the blade upon activation.
(11) Another nonlimiting feature of this embodiment is to provide an inflatable, expanding sword that contains significant pressure to hold shape while being swung.
(12) Another aspect of the invention is to provide a motor activated by the controller and a lead extending between the motor and the second end of the flexible wall of the blade, the motor configured to retract the lead and the second end of the flexible wall upon activation.
(13) Another nonlimiting feature of this embodiment is to provide an inflatable, expanding sword that has a blade that returns back into the housing when retracted.
(14) In accordance with a another aspect of the invention, an adjustable saber apparatus configured for use in simulated combat is provided that includes a housing having a sidewall extending between opposing first and second ends, a pressurizable blade having a flexible wall extending between a first connected end affixed within a void defined by the sidewall of the housing and an opposing second end that is movable relative to the connected end. The apparatus includes a control circuit disposed within the housing, including, a power supply, an extension system that is configured to inflate an interior of the blade such that the second end of the flexible wall extends outwardly from the void in the housing, a retraction system configured to retract at least a portion of the blade within the void, and a controller.
(15) In accordance with a another aspect of the invention, an inflatable device is provided that includes a rigid housing affixed to a generally cylindrical inflatable portion formed of a flexible high-tensile strength material configured to move between an expanded configuration and retracted configuration. The inflatable portion is generally contained within a void disposed in the rigid housing when in the retracted configuration and extends outwardly from the void when in the extended configuration.
(16) These and other features and advantages of the invention will become apparent to those skilled in the art from the following detailed description and the accompanying drawings. It should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Preferred exemplary embodiments of the invention are illustrated in the accompanying drawings in which like reference numerals represent like parts throughout, and in which:
(2) FIG. **1** is side plan view of the device according to one embodiment of the present invention in which the blade is in an extended configuration;
(3) FIG. **2** is an isometric view of the device of FIG. **1**, with the blade in an extended configuration;
(4) FIG. **3** is an isometric view of the device of FIG. **1**, with the blade in a retracted configuration;
(5) FIG. **4** is a partially exploded isometric view of the device of FIG. **1**, with the blade in a retracted configuration;
(6) FIG. **5** is a partially exploded isometric view of an alternative embodiment of the device of FIG. **1**, with the blade in a retracted configuration;
(7) FIG. **6** is a schematic view of a handle of the device according to one embodiment of the present invention;

(8) FIG. **7** is a cross sectional view of a handle of the device according to one embodiment of the present invention, in which the blade is in the extended configuration;
(9) FIG. **8** is a cross sectional view of a handle of the device of FIG. **7**, in which the blade is in the retracted configuration;
(10) FIG. **9** is a cross sectional view of a handle of the device according to an alternative embodiment of the present invention, in which the blade is in the retracted configuration;
(11) FIG. **10** is side plane view of a blade of the device according to one embodiment of the present invention, wherein the blade is disconnected from the handle and fully extended
(12) FIG. **11** is a side plane view of a blade of the device according to one embodiment of the present invention, wherein the blade is disconnected from the handle of the device and a portion of the blade is disposed internally and shown in broken lines;
(13) FIG. **12** is a isometric view of a blade of FIG. **11**, wherein the blade is disconnected from the handle of the device and a portion of the blade is disposed internally and shown in broken lines; and,
(14) FIG. **13** is an isometric view of an alternative embodiment of the blade of FIG. **11**, wherein the blade is disconnected from the handle of the device and a portion of the blade is disposed internally and shown in broken lines.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(15) Referring now to the drawings, in which similar reference characters denote similar elements throughout the several views, the figures illustrate various components and embodiments of the present invention. In describing the embodiments of the invention which are illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, it is not intended that the invention be limited to the specific terms so selected and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose. For example, the words “connected,” “attached,” or tennis similar thereto are often used. They are not limited to direct connection or attachment, but include connection or attachment to other elements where such connection or attachment is recognized as being equivalent by those skilled in the art.
(16) The various features and advantageous details of the subject matter disclosed herein are explained more fully with reference to the non-limiting embodiments described in detail in the following description.
(17) Referring now to FIG. **1** to **13**, and initially FIG. **1**, a sword or device **1** for simulated combat that has an expanding and retracting blade **30** is shown. During use, the blade **30** automatically expands or extends from the handle or hilt **10** and is then configured to retract back within. Once extended, the blade **30** is monolithic, which is to say fortited of a continuous outer surface that is preferable to a segmented blade. Moreover, the device **1** can be used for simulated combat when the blade **30** is in the extended configuration. Inflating the blade **30** above atmospheric pressure provides rigidity to an otherwise soft and flexible material making it less destructive in simulated combat, than blades formed of rigid plastic.
(18) Generally, the housing **10**, i.e., the handle or hilt, as may be used interchangeably herein, may contain all or most of the electromechanical components of the device **1**. The rigidity of the housing **10** retains the internally housed components protected and firmly situated for use during simulated combat. As shown in FIGS. **7** and **8**, a portion of the interior void **27** of the housing **1** defines a blade chamber **13** that connects to the blade **30** and is designed to hold pressure during operation of the device **1**. In one embodiment of the present invention, the remaining portion of the housing **10**, i.e. the interior void **27** that does not define the blade chamber **13** may not be pressurized above atmospheric pressure. When retracted, the blade **10** is stored or retained in the void **27** defined by the inner surfaces of the one or more walls of the housing **10** disposed within the blade chamber **13**. The blade chamber **13** may be separated from the non-pressurized portion of the housing **10** by an airtight barrier **14**. However, the blade chamber **13** may not define the entirety

of the pressurized section of the housing **10**. That is to say that the blade chamber **13** is configured with at least one opening **26** to receive air flow from the non-pressurized portion of the housing **10** through the airtight barrier **14**. In this manner, the blade chamber **13** plays a role in the extension and retraction of the blade **30** as will be described in further detail below. When retracted, the blade **30** is situated in a void **27** within the blade chamber **13**, such that at least the majority of the blade is recesses within the void **27**.

(19) As shown in FIG. **5**, the blade chamber **13** may be permanently affixed within the pressurized portion of the housing **10**, or it may be releasably affixed. If releasably affixed, the blade chamber **13** may be inserted into a void in the pressurized portion of the housing **10** and affixed such that it will create an airtight seal from the atmosphere as depicted in FIG. **4**. Alternatively, the blade chamber **13** may make up an external portion **48** of the pressurized portion of the housing and may detach from the remaining housing. FIG. **5** shows the two portions of the housing with blade chamber **13** detached from the pressurized portion. When attached, this portion of the housing **10** will form an airtight seal to the blade chamber **13**, and an airtight seal from the atmosphere.

(20) The blade **30**, which will receive the majority of striking force during simulated combat and use of the device **1**, is made to be a resilient inflatable structure. Accordingly, the blade **30** and its connection to the blade chamber **13** are configured to maintain positive air pressure, even when the blade **30** is struck against more rigid structures with generally harder or sharper surfaces such as: walls, furniture, wrist watches and plants. The blade **30** has an outer wall **32** that extends outwardly from the blade chamber **13**. The outer wall **32** is generally cylindrical, but more preferably conical and/or tapered such that its circumference decreases along its length as the blade **30** extends further from the first end that is affixed to the blade chamber **13** until the blade **30** reaches a desired length. At the second end of the extended blade **30**, which is located at a point between the opposed ends of the fully extended blade, as shown in FIG. **10**, the wall **32** of the blade **30** folds inwardly on itself. As a result of this inward fold, as shown in FIG. **13**, at the second end of the blade **30**, the outer diameter of the blade **30** becomes an inner diameter. From the end of the inwardly projecting portion of the blade **30** is a lead **33** or tether, extends from the opposing second end, into the blade chamber **13**. This configuration allows for an axial extension and retraction of the blade **30**. The blade **30** is preferably made of a high tensile strength, highly flexible fabric or material that has a weight of preferably 4 to 310 denier.

(21) While the first end of the lead **33** extends from the blade **30**, the opposing second end of the lead **33** is affixed, and more preferably movably affixed, within the blade chamber **13**. During extension, air pressure created by the pump **20** increases within the interior cavity of blade **30**. This increased pressure forced the blade **30** to expand from within itself, unraveling away from the blade chamber **13**. The outward extension from the housing **10** of the device **1** will stop as the lead **33** reaches its full length and is placed under tension. During use, in one embodiment the pump **20** may be activated at a lower flow rate to maintain desired positive pressure in the blade **30**. Conversely, for retraction from the pressurized and extended shape shown in FIG. **2**, the blade **30** is controllably depressurized as it is simultaneously retracted, e.g., rolled by the motor **16** into the blade chamber **13** by rolling or spooling of the lead **33** from its spool end **37**. In one embodiment, the motor **16** is an electric DC motor that creates preferably between 100 and 500 kg-cm of torque and spools the lead **33** at a rate of 100-500 rpm, such that the retraction of the blade **30** occurs in preferably under 10 seconds. The top of the internal cone **35**, referred to as the folding point **34** will begin to move down the length of the outer wall **32**, towards the housing **10**, as the spooling begins. Eventually, the entirety or majority of the blade **30** will be inverted and rolled into the blade chamber **13**.

(22) Extension and retraction of the blade **30** are controlled by a system of components that may work in tandem. By way of nonlimiting example, during extension of the blade **30**, increased air pressure is created by a pump **20**, as shown in FIGS. **6** through **9**, to inflate and extend the blade **30**. Extension of the blade **30** may also incorporate activation of the motor **16** to unspool or

otherwise physically move the blade **30** out of the blade chamber **13**. In another embodiment, the motor **16** may be placed in a neutral position during blade extension as to minimize drag on the blade **30** while it is extended, in the event that the motor is not reversed to apply active assistance in extension. Conversely, the retraction system may utilize the motor **16** to spool or roll the lead **33** and blade **30** into the blade chamber **13**. Simultaneously, the blade **30** and blade chamber **13** may be controllably depressurized by a pressure relief mechanism **15**. Alternatively, the retraction system may also incorporate use of the pump **20** if the pressure falls below the desired value for retraction, which is to say a set threshold of air pressure maybe maintained in the blade **30** during retraction such that the blade **30** does not undesirably wilt during retraction, but rather maintains its general cylindrical shape while retracting. Both systems may also incorporate a switch **25**, power source **21**, controller **22**, sensors, fluid pathways **23**, and check valve **19**, as shown in FIGS. **6** through **9**.

(23) In addition to extension and retraction functions, the device **1** may also incorporate components that enhance the audio-visual experience during use of the device **1**. By way of non limiting examples, these components may include lights, such as one or more LEDs, speakers, and sensors to detect motion and impact, some or all of which may be incorporated as part of the controller **22**.

(24) Still referring to FIGS. **6** through **9**, the housing **10** or as it's more commonly known, the hilt or handle, will now be described in greater detail. The housing **10** houses the blade chamber **13**, retracted blade **30**, and electromechanical components of the device **1**. The housing **10** preferably defines a plastic shell, likely of PC or ABS material that keeps the internal components firmly situated within. Alternatively, the housing **10** may also be constructed entirely or partially of metal, likely steel or aluminum if desired for higher durability or a specific aesthetic appearance. In most cases, the housing **10** will be generally cylindrical for ergonomics but may be many shapes and sizes that fit within a user's hand or hands. The housing **10** will preferably be 6 inches to 14 inches long and 1 inch to 3 inches wide, however it may be longer or wider in some embodiments such as a double bladed or staff saber. Furthermore, it should be understood that the shape of the housing **10** does not need to be cylindrical, can be curved or a multitude of other shapes. Multiple hilts can connect to one another at the bottom or sides of the housing **10** to form a staff or multiple blade saber. Other accessories may be designed to connect to the housing **10**. It is also possible that the functional components of the devices are separated into two housings that are linked by a flexible connection, likely containing fluid pathways and/or electrical wiring. Such an embodiment may be preferable to reduce the size of the housing **10** that is held in the user's hands.

(25) Within the housing **10**, the power source **21**, charging port **24** and controller **22** are preferably disposed at a second end opposite the blade **30**. In such an embodiment, their location is within the non-pressurized portion of the housing **10**. In one preferred embodiment, pump **20** is preferably situated between the power source **21** with its outlet directed towards the airtight barrier **14**. The outlet of pump **20** is connected to a fluid pathway **23** which may be connected to check valve **19**. In one embodiment, the pump **20** has a flow rate of approximately 5-50 liters of air per minute. Check valve **19** passively maintains the pressure built by the pump **20** from flowing back into the pump **20**. The pressurized portion of housing **10** is configured to hold significant pressure until that pressure is released by the actuation of relief mechanism **15**. Air intake **18** is preferably located near the inlet of pump **20** and the outlet and/or relief mechanism **15**. Air intake **18** may be a perforated opening in the housing **10** that allows free flow of air inside and out of the housing **10**. It is preferably large enough that pump **20** will not be starved for air while at peak function and as to not restrict the desired flow of relief mechanism **15**. In one embodiment, as shown in FIG. **5**, the housing **10** may define a set of two injection molded halves that screw or clip together. Disposed upon the outer surface of the housing **10** is a switch **25**. Switch **25** can be placed anywhere along the housing **10**, and is configured to activate extension and retraction of the blade **30** via the extension and retraction systems as described above.

(26) Alternatively, the housing **10** connection to the blade chamber **13** may include an embodiment wherein the electric motor **16** is not separated by an airtight barrier from the non-pressurized portion of the housing **10**, but rather has a connection through an airtight barrier with an airtight shaft configuration which attaches the motor driveshaft. Another embodiment may include the pressure sensor **17** connected directly to a fluid pathway between the check valve **19** and the airtight barrier **14**. The blade chamber **13** may include other mechanical or electrical components, such as gears **45** or additional sensors.

(27) Referring now to the blade chamber **13**, which defines a portion of the housing **10** that connects to the blade **30** and is designed to hold pressure during extended blade operation of the device **1**. In contrast, the remaining portion of the housing **10** is preferably not pressurized above atmospheric pressure. When retracted, the blade **30** is stored within a void **27** in the blade chamber **13**. The airtight barrier **14** divides the housing **10** into a pressurized portion **11** on one side of the barrier and non-pressurized portion **12** on the opposing side of the barrier. The blade chamber **13** is positioned on the pressurized portion **12** of the housing **10**. Various components will be disposed within the pressurized side of the airtight barrier **14**. Most or all of the retraction mechanism will preferably be positioned within the pressurized portion **12** of the housing **10** since the blade **30** is both attached to the blade chamber **13** and stored in a void **27** within. The motor **16** is preferably positioned on the pressurized side of the airtight barrier **14**, as it is easier to pass electrical current through the airtight barrier **14** than mechanical motion. However, it should be understood that the present invention is not so limited, and that location of the motor **16** within the nonpressurized portion of the housing **10** is well within the scope of the present invention. The motor **16** may also connect to other mechanical elements of the retraction system within the blade chamber **13**, such as gears **45**, belts, chains, a driveshaft, spool **46**, or roller **47** to the extent present

(28) The pressure relief mechanism **15** can be placed on either side of the airtight barrier **14** with appropriate connections to a fluid pathway **23** passing through the airtight barrier **14**. Likewise, the check valve **19** can also be placed on either side of the airtight barrier **14** with appropriate connections to a fluid pathway **23** passing through the airtight barrier **14**. The pump **20** is preferably positioned within the housing on the non-pressurized side of the airtight barrier **14** so that it can intake air from the atmosphere. The pump **9** is connected to a fluid pathway **23** to the blade chamber **13** to create air pressure in the blade chamber **13** and blade **30**. However, it is possible to place the pump **20** within the pressurized side of the airtight barrier **14** if there is a fluid pathway **23** connection through the airtight barrier **14** that opens to atmosphere.

(29) The blade chamber **13** may be permanently affixed within the pressurized portion **12** of the housing **10**, or more preferably it may be releasably affixed. Having a releasably affixed blade chamber **13** allows for replacement of a damaged blade **30** while retaining the comparably more mechanically complex, and theoretically undamaged, components within the housing **10**.

(30) If releasably affixed, the blade chamber **13** may be inserted into a void in the housing **10** and affixed in a manner that the connection will create an airtight seal from the atmosphere as depicted in FIG. **4**. For example, the blade chamber **13** can be seated internally within the pressurized portion **12** of the housing and affixed therein by a threaded or locking collar **41** disposed at the first end of the housing **10**, as shown in FIG. **4**. Such an embodiment provides the additional benefit of maintaining the entirety or majority of the external surface of the housing **10** independent from the replaceable blade chamber **13**. Therefore, a common replaceable blade chamber **13** may be used in multiple different housing **10** designs. The airtight barrier **14** that separates the pressurized portion **12** of the housing **10** from the non-pressurized portion **11** of the housing **10** may be affixed to the pressurized portion **12** or the blade chamber **13**. When the blade chamber **13** is inserted, it will form a mechanical linkage with the housing **10**. This linkage may be formed with an external threaded lock collar, screws, or other similar retaining structure. The blade chamber **13** itself may have integral threads or a quick connect design to easily attach to the main housing. Air seals, such as O-rings or an alternative resilient structure, may be present so that when affixed, the blade

chamber **13** is pressurized with the pressurized portion **12** of the housing **10**. The blade chamber **13** may be keyed to ensure proper orientation when inserted into the housing **10**. The retraction system, such as gears **45**, will need to mate properly when the blade chamber **13** is installed.

(31) In an alternative embodiment, rather than the blade chamber **13** inserting into the housing **10** as shown in FIG. **4** and described above, a detachable blade chamber **13** may incorporate and define an external portion **48** of the housing **10** as depicted in FIG. **5**. This embodiment provides the additional benefit of providing a blade chamber **13** that may be more durable as it is formed integrally with the outer surface of a portion of the housing **10**, and/or provides an opportunity for the ornamental design of the housing **10** to be altered with a replacement blade chamber **13**. When attached, the blade chamber **13** will form an airtight seal, closing the pressurized portion **12** of the housing and allowing for appropriate mating of the fluid pathways **23**, electrical connections, and mechanical components of the retraction system to be made. The blade chamber **13** may be keyed or indexed to ensure proper orientation when attached to the housing **10**. When the blade chamber **13** is attached, it will form a mechanical connection with the non-pressurized portion **12** of the housing **10**. This connection may be formed with an external threaded lock collar, screws, or other similar retaining features. The blade chamber **13** itself may have integral threads or a quick connect design to easily attach to the housing **10**. Air seals, such as O-rings, will be used so that when affixed, pressure can be raised and held to the desired value.

(32) Turning now to FIGS. **10** thorough **13**, the blade **30** will be described in further detail. The blade **30**, which will receive the greatest about of wear and tear from receiving striking blows, is made to be a resilient inflatable structure. The blade **30** is preferably made of a high tensile strength, highly flexible fabric or material that is air impermeable, for example a nylon or polyester material. Air impermeability is preferably achieved with a thermoplastic polyurethane (TPU) coating disposed on or more sides of the flexible fabric or material. The TPU coating also allows for bonding or sealing to itself during the construction of the blade **30**. The blade **30** is designed to maintain air pressure, even when hit against other inflatable blades or comparably harder and sharper objects. The blade **30** is preferably sealed at its connecting end **36** to the blade chamber **13** and in fluid communication with the pressurized portion **12** of the housing **10**. The blade **30** is generally cylindrical, but more preferably conical. The blade **30** preferably has a length of approximately between 10 and 40 inches in length between the connected end **36** and the folding point **34** when fully extended, and a cross-sectional width of approximately 1 to 5 inches, and more preferably approximately 2 inches. As used herein the term approximately is understood to mean plus or minus 10%. The sidewall of the blade may be inclined at an angle of between 0.1° and 20° relative to a central longitudinal axis of the blade. Furthermore, the degree of taper may vary along the length of the blade **30**. The blade **30** may have a conical outer wall **32** that extends from the outer diameter of the blade chamber **13**. The outer wall **32** is preferably conical and has an outer circumference that decreases along the length of the blade as it travels further from the connecting end **36**. The opposing end of the blade **34** when fully or partially extended defines a fold point **34**, where the blade **30** folds inwardly, toward the center of the blade **30**, causing the outer wall **32** to become an internal surface. At this opposing exposed end defined by the folding point **34** of the blade **30**, the outer diameter is tensioned inward for a small section that forms a short conical inlet in the center. This portion is called the inner cone **35**. The point at which the material bends at the second end and is redirected is defines the folding point **34**. From the center of the inner cone **35** there is a lead **33** that extends down into the internal center of the blade chamber **13**. The lead **33** may be a thin band of the same material the blade **30** is constructed of, or a different material such as a string or wire which engages the handle **10** as described above.

(33) FIG. **10** illustrates an embodiment of the blade **30** fully extended and before it is inverted to attached to the blade chamber **13**. Once the blade **30** is inverted over itself, sealed edge **31** will be internal to the outer wall **32**. The specified length of the lead **33**, from the spool end **37** to the inner cone **35**, determines the length to which the blade **30** can expand. Air pressure will build within the

blade **30**, forcing it to extend from within itself, unraveling away from the blade chamber **13**. The expansion outward from the device **1** will stop as the lead **33** reaches its full length and is placed under tension. From there, the inverted cone **35** extends to the folding point **34** where the material folds and becomes the outer wall **32**, as is shown in FIG. **11**. FIG. **11** also illustrates the connecting end **36** and spool end **37**. The connecting end **36** is the location at which the outer wall **32** connects with the blade chamber **13** to create an airtight seal. FIG. **11** shows an isometric view of the second end of blade **30** in its expanded form, which depicts the lead **33** centered within the outer wall **32**. It's preferable that the length of the outer wall **32** is drafted. The smaller end being at the folding point **34** and the larger at the connecting end **36**. Such a tapered configuration provides ease of retraction into itself, ease of expansion from within itself, as well as increased line of sight for light emitted from internal LEDs to the internal surface of the blade **30**'s outer wall **32**.
(34) In an alternative embodiment, the inner cone **35** may extend fully or most of the way to the spool end **37** and define the lead **33**. FIG. **13** shows this alternative embodiment. Such an embodiment may give the blade **30** increased rigidity and reduce the volume that is pressurized within the blade **30**. Such a reduced in interior volume of the blade **30** would correspondingly reduce the time to full expansion and pressurization of the blade **30**.
(35) Turning now to FIG. **8**, one system and method of retraction of the blade **30** within the blade chamber **13** is illustrated. That is to say, from its pressurized/extended shape in FIG. **2**, the blade **30** is controllably depressurized as it is rolled into the blade chamber **13** by rolling of the lead **33** from its spool end **37**. The top of the inner cone **35**, referred to as the folding point **34**, will begin to move down the length of the outer wall **32**, towards the connected end **36**, as the spooling begins. Eventually, the entire blade **30** will be inverted and the majority of its length rolled into the blade chamber **13**.
(36) In another system and method of retraction, the lead **33** is rolled as previously described but the outer portion of the blade **30** collapses down as it retracts in the manner consistent with a compression spring. The compressed outer blade fits down into a void **27** within the blade chamber **13** or housing **10**. In this embodiment, a spring or lattice like structure could be coupled to the blade to aid in guiding the retraction so the blade **30** collapses desirably, or to add rigidity when extended. A lattice structure (not shown) could be configured similar to an isokinetic expanding hinged sphere, i.e., Hoberman sphere, arranged instead in a cylindrical shape. In another embodiment, the lead **33** may be comprised of a spring metal or spring plastic that rolls flat but when extended has shape memory to form a rigid member, much like a tape measure. In another embodiment, the lead **33** may be comprised of a coil spring, flat spring, or shape memory alloy that extends upon extension of the blade **30**. One end of the spring would be affixed in the blade chamber **13**, while the other end is affixed or positioned at the second end of the blade **30**. The spring may be configured to maintain an opposing return force applied to the folding point **34** of the blade **30** to aid in retraction of the blade **30**. The spring may alternatively be configured to maintain opposing expanding force while the blade **30** is retracted to aid in extension of the blade. In another embodiment, the lead **33** may be spooled and coupled to a torsion spring that maintains a return force while the lead is fully extended to aid in retraction when air pressure is removed. The lead **33** can be a string or different thicknesses for weight or size reduction or even increased tensile strength. The lead **33** could potentially be elastic for increased recovery to its desired shape when the blade **30** shape is deformed from impact.
(37) Other embodiments include of the blade **30** as described above may include or incorporate different colors, lengths and blade shapes. Such variable colors may include translucency. The blade **30** could be colored instead of white to help with color visualization. This may be necessary for use in brightly lit areas or to make a lower cost device that is not able to use LEDs of sufficient brightness as to fully illuminate the blade **30** when fully extended. It is also considered within the scope of the present invention to have printed patterns, textures, layers or multiple types of materials on the blade **30** to further improve the visual effect of device **1**

(38) As indicated above, while blade **30** with a conical shape aids in expansion and retraction, other shapes are considered well within the scope of the present invention in order to achieve a specific visual look, including cylindrical, curved, square, or flat blades **30** which can be made using internal structures that connect to opposing inner blade walls to hold a flatter shape while staying out of the way of the retraction system. Alternatively, a flat blade could be formed using two pressurized tubes with additional material spanned between them. The device may incorporate a multitude of blades. One embodiment incorporating multiple blades would be a dual bladed device with blades extending from opposite ends of the housing **10**. This embodiment may require additional internal components, such as a second pump and additional sensors, retraction motors, etc. Another multiple blade embodiment would include small blades extending out perpendicular to the main blade **30** forming a hilt guard. These smaller blades may have retraction components similar to the main blade **30**, a retraction shaft coupled to a motor, a retraction shaft that is spring loaded, or may function more simply using elastic center leads or tensile springs to retract when air pressure is released. The housing of a multi-blade device may be separable, joinable, foldable, or otherwise assembled in a way to match a desired style and configuration.
(39) As indicated above, blade retraction is performed by an interworking system of components. One embodiment of the system includes a spool **46** which is attached to the lead **33** of the blade **30**. FIG. **8** illustrates such an embodiment, in which the blade **30** is rolled around the spool **46**. The opposite end of the blade **30**, i.e., end **36** is connected to the top of the blade chamber **13** and creates an airtight seal. Retraction of the blade in such a system may utilize both the release of pressure and the mechanical movement of the spool **46** by means of the motor **16**.
(40) In another system and method of retraction, one or more rollers **47** are positioned such that they pinch and then pull the lead **33** and then blade **30** into an internal void **27** when they are bunched. The rollers **47**, which may include one or more actively driven rollers and/or one or more passive following rollers may exert sufficient force onto the blade **30** to grip the blade **30** and are sufficiently compliant as to adapt to the changing thickness as retraction progresses from the lead **33** to the outer wall **32**. The rollers **47** may be round in shape as shown in FIG. **9** or have a gear or other shape to aid in gripping the blade **30**.
(41) The motor **16** of the device **1** is in a mechanical connection to the retraction components, which may take the form of either the spool **46** or the rollers **47**. One embodiment of transmitting mechanical power is a set of gears **45**, with the first gear on the output shaft of the motor **16**, the final gear on the spool **46** or rollers **47**, and any necessary gears **45** between to achieve the desired orientation, distance, and rotation speed. FIGS. **7** through **9** illustrate the span of these gears **45**. Other methods of connection, such as a driveshaft, pulley and belt, chain and sprocket, or a combination of a multitude of the aforementioned structures are also considered within the scope of the present invention.
(42) Within the blade chamber **13**, there may also be a structure or structures referred to herein as the shaper or blade guide **44**. The purpose of the blade guide **44** is to orient the blade during retraction. There may also be a multitude of blade guides **44**. The blade guide **44** could be for merely centering the blade **30** relative to the interior of the housing **10** during retraction. Alternatively, the blade guide **44** may fold the edges of the blade **30** before rolled or fold the entire blade **30** in half. Such shaping of the blade prior to retraction may reduce the width and allow the blade **30** to be rolled within a smaller diameter blade chamber **13**.
(43) During retraction of the blade **30**, it is desirable to maintain some air pressure in the blade **30** during retraction to keep the blade **30** straight, and prevent wilting. Therefore the pump **20** may also be engaged at a controlled rate during retraction. The controller **22** may determine when the blade **30** is fully retracted in a multitude of ways as to trigger deactivation of the retraction system. The controller may monitor current to the retraction electric motor **16** to detect a stall. Alternatively, a sensor on the blade **30** or a trigger that pairs with a sensor in the blade chamber **13**, such as a hall effect or optical sensor, that will signal full retraction, or a sensor in the housing **10**,

such as optical or IR proximity, can determine when the blade **30** is fully retracted, and single the controller **22** accordingly.

(44) During use, extension of the blade **30** is primarily driven by the pump **20** increasing air pressure in the blade chamber **13** and blade **30**. As air pressure fills blade chamber **13**, the rolled blade **30** being a highly flexible material will innately conform to exert internal pressure outward toward lower atmospheric pressure. Since there is only one direction that the blade **30** it can expand, i.e. through the open first end of the housing **10**, the blade **30** will begin to unravel from within, extending the folding point **34** from the pressure chamber **13** to its full length opposite the connecting end **36**. The motor **16** may also be engaged in the reverse direction to help unspool or otherwise actively move the blade **30** out of the blade chamber **13**. If the motor **16** has sufficiently low resistance, it may spin freely to allow the blade **30** to extend without electrically engaging the motor **16**. Alternatively, the motor **16** may be mechanically decoupled from the retraction mechanisms to remove any resistance during extension. Extension will continue until the device **1** determines that the blade **30** is fully extended and the desired air pressure is achieved within the interior of the blade. Desired pressure is preferably in the range 3-30 and more preferably 3-20 psi, and can be determined with a pressure sensor **17** or switch. It may also be possible to measure the current of the pump **20** to determine when the pump **20** has reached the maximum pressure it can achieve, or by using a timer knowing that the pump will max out at the correct pressure. Complete blade **30** extension can be determined by a sensor on the blade **30** or a trigger that pairs with a sensor in the housing **10**, such as a hall effect or optical, that will signal when fully extended, or a sensor in the housing **10**, such as optical or IR proximity.

(45) Turning now to FIGS. **6** through **9**, the power source **21**, is configured to fit within the housing **10**. The power source **21** is directly connected to the controller **22** which is in electrical communication with the remaining electrical components of the device **1**. The power source **21** is preferably a rechargeable (secondary) lithium ion battery, composed of either a cylindrical cell or cells or a polymer pack. The battery size and chemistry selected is configured to provide sufficient current to satisfy the electrical current draw of the pump and the electric motor. The battery may be comprised of one or more cells to achieve the required voltage and capacity for operation. The battery may be removable from the hilt for charging or replacement. Alternatively, other battery types may be used including nickel-metal hydride (Ni-MH) or nickel cadmium (NiCad), however these are no longer as popular due to lower performance compared to lithium ion. Charging of the power source may be achieved by connecting a power supply via a cable to an external charging port **24** on the hilt, a charging base or connector that connects via contacts externally mounted on the hilt, or a charging base or connector that wirelessly charges via induction. Alternatively, non-rechargeable primary cells can also be used to power the device to allow replacement instead of recharging. Alternatively, the power source may be comprised of a non-traditional battery type, such as a supercapacitor, or any emerging battery technologies.

(46) As previously indicated, device **1** include an activation switch **25**. The function of the device **1** relies on the user to turn it on and off. A main element of this activation/deactivation, i.e., extension and retraction of the blade **20** is the switch **25**. The switch **25** is preferably embedded within the clamshell of the housing **10** and is preferably located just above the grip portion of the housing **10**, where someone comfortably holding the device **1** could easily access it but will avoid incidental contact during simulated combat. The switch **25** location may change based on ornamental design of the housing **10**. The switch is configured to power the device on and off, which coincides with the expansion and retraction of the blade **30**. The switch **25** will be directly connected to the controller **22** to interface with its operation. The switch **25**, attached to the outside of the hilt or within, is preferably activated from the outside of the housing **10** by the user.

(47) The switch **25** may be an electronic switch that signals all functions to be performed by the circuitry. The electronic switch may be but is not limited to a push button, toggle switch, slider, rotary switch, capacitive switch, or pressure switch. The electronic switch may be momentary or

hold an on-off position. The movement of the switch **25** may also be mechanically linked to perform a function within the housing **10**. For example, movement of a slider switch may mechanically open or close an air release valve or move the motor into position to couple or decouple with the retraction components.
(48) At least a second switch, dial, or similar user interface may also be added to make other adjustments to the function of the device, such as adjusting the LEDs activation, LED color, air pressure, or blade length, speaker volume, etc.
(49) The motor **16**, firmly affixed within the housing **10**, is used in the extension and retraction of the blade **30**. The motor **16**, likely of cylindrical shape, is preferably located within the pressurized portion **12** of the housing **10** as previously indicated. The motor **16** will be controlled by the controller **22** and powered by the power source **21**. The motor **16** will preferably be coupled to gears **45** to reduce the speed and increase the torque. The motor could be of brushed or brushless design. Alternatively, if the motor can be mechanically decoupled, or has sufficiently low free-spinning resistance, it may not be used during extension of the blade **20**.
(50) The controller **22** connects all the electrical components and runs basic firmware so the device **1** can operate as indicated herein. Located within the housing **10**, the controller **22** will be firmly affixed as to avoid damage during simulated combat.
(51) The controller **22** will feature numerous electrical parts common to operation of motors, LEDs, power source, speakers, and all other components included in the device **1**. These parts may include, but are not limited to, some or all of the following: a voltage regulator, voltage step up (boost) circuit, battery monitoring and charging circuit, motor driver or drivers, LED driver or circuitry to control current and voltage supplied to LEDs, speaker controller, vibrator, motion sensing including accelerometer or gyroscope, circuit to read or communicate with the air pressure sensor, Bluetooth receiver/transmitter, NFC or RFID reader, and various electrical connectors. The speaker may be mounted on the controller **22** or mounted off board and connected with wires. The controller **22** will respond to user input via the switch **25** and motion and impact of the blade **30**. The controller **22** may be interfaced by the user to change the color of the blade **30**. Programming may be done by adjusting an internally or externally mounted switch or dial or buttons, wirelessly with Bluetooth and a connected app, memory card, or changed by the physical or wireless connection of different parts that the user will be able to swap within the housing **1**. The blade **30** could be made of a conductive fabric that is connected electrically to the controller **22** so that it functions as a sensor to detect when it makes contact with another blade, which could be distinguished from contact with another object.
(52) Programming of the controller **22** will account for all envisioned scenarios during use so that the device remains functional. For example, if the power source **21** is depleted during use the device **1** will be able to extend or retract a partially extended blade **30** when recharged. For another example, if a blade **30** is obstructed during expansion or retraction, it will stop inflating once it reaches set pressure even if partially extended, or will stop retraction if the controller **22** senses a motor stall. Constant monitoring of the state of the blade **30** could allow the controller **22** to resume extension or retraction once able, or the user could trigger extension or retraction to resume as desired. Error codes could be given to the user through LED indication, audio indication, or wireless communication with another device such as a cellphone.
(53) There are several possible embodiments of the pressure relief mechanism **15**. One possible embodiment is that the motor **16** used for retraction is also configured to move a pressure valve open and closed. This can be done with a cammed or toothed element operation when spinning in one direction. After the valve is open, the element could de-clutch as it spins to prevent damage. The valve could be spring loaded so that when the motor **16** stops spinning it closes. This operation of the air valve could also be controlled by a second electric motor that is not also being used for retraction.
(54) One embodiment of the present invention includes an electric solenoid that directly opens and

closes an air valve in fluid communication with atmospheric pressure. Other electric possibilities include an electric motor or electric stepper motor that opens a valve through turning motion (i.e. a ball valve, stop-cock or screw valve), or a linear stepper or actuator that slides a valve open and closed.

(55) Another possible embodiment may include user actuation of the switch **25**, which physically opens and closes an air valve. In such an embodiment, the switch **25** would further include adequate air seals to prevent leaking.

(56) One system and method of lighting the blade **30** is an LED ring or array **43** that is situated at the base of the blade **30** within the blade chamber **13**. The LEDs may be positioned circumferentially around the base of the blade **30** for even illumination, for example around locking collar **41**. However, a smaller number of LEDs may be used so it may not resemble a ring. If the blade **30** is shaped differently from a cylinder or cone, the LEDs may not necessarily be arranged in a ring as to provide even illumination. A light diffuser may also be disposed adjacent the LEDs to achieve desired light distribution. Alternatively, it is possible to light the blade **30** with at least one centrally located LED behind the spool. The central location of the LEDs may be desirable to interact with optical or luminescent elements down the center lead **33** of the blade. The LEDs may be directed to emit light in line with the blade or directed at optical elements located therein. Optical elements, such as fiber optics may be included to further direct the light for full and even illumination of the blade. Optics could include lenses, collimators, filters, mirrors, diffraction elements, or fiber optics. Fiber optics may be incorporated into the construction of the blade **30** or lead **33** to improve light transmission. An additional light emitter may be affixed to the second end of the blade and oriented to emit light back down the blade to aid in full blade illumination.

(57) Alternatively, the LEDs may be incorporated into the construction of the blade **30**. LEDs may be mounted on the lead **33** and distributed down the length of the blade **30**. The associated circuitry and wiring connecting the LEDs will be made flexible so that the blade **30** can still be rolled up or otherwise stored when retracted.

(58) If the blade **30** is constructed of a translucent white or gray colored material, the LED color can dictate the illuminated color of the blade. LEDs may be of a single color or multiple colors that allow for adjustment of the output hue, i.e. RGB LEDs. Alternatively, the blade may be constructed of a translucent colored material which can be lit by colored or white LEDs. Blades may be constructed of a multitude of colored materials to achieve the desired visual effect.

(59) The blade **30** material may also be constructed containing a photoluminescent material that reacts with the emitted light to enhance the lighting effect of the blade, or an electroluminescent material that emits light when an electrical current is applied. The blade may be constructed of varying densities, layers, or woven patterns that vary the light output for the desired visual effect.

(60) A laser diode or diodes could also be used with the proper optical components. The beam would need to be split a multitude of times and projected in an even spread throughout the length of the blade for an even lighting effect. There may also be the addition of an o-ring lens or lenses above the LED's that have movements for optical effects.

(61) Although the best mode contemplated for carrying out the present invention is disclosed above, practice of the above invention is not limited thereto. It should be understood that the invention is not limited in its application to the details of construction and arrangements of the components set forth herein. The invention is capable of other embodiments and of being practiced or carried out in various ways. Variations and modifications of the foregoing are within the scope of the present invention. It is also understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text and/or drawings. All of these different combinations constitute various alternative aspects of the present invention. The embodiments described herein explain the best modes known for practicing the invention and will enable others skilled in the art to utilize the invention.

Claims

1. An adjustable sword apparatus configured for use in simulated combat, the apparatus, comprising: a housing having a sidewall extending between opposing first and second ends, at least a portion of an outer surface of the sidewall configured to be grasped by a user; an inflatable blade having a flexible monolithic wall extending between a first end affixed within a void defined by the sidewall of the housing and an opposing movable second end, an extension system disposed within the void of the housing configured to inflate an interior of the blade defined by the flexible monolithic wall such that the second end of the flexible monolithic wall extends outwardly from the void; and, a retraction system disposed within the void configured to retract at least a portion of the inflatable blade within the void.
2. The apparatus of claim 1, further comprising a power source and a controller in electrical communication with the extension system and the retraction system, the power source and controller disposed within the void.
3. The apparatus of claim 2, wherein the extension system comprises an air pump activated by the controller, the air pump in fluid communication with the interior of the blade and configured to provide a positive air pressure to the interior of the blade upon activation of the extension system.
4. The apparatus of claim 2, wherein the retraction system comprises a motor activated by the controller and a lead extending between the motor and the second end of the flexible monolithic wall of the blade, the motor configured to retract the lead and second end upon activation of the retraction system.
5. The apparatus of claim 1, wherein upon activation of the retraction system, a portion of the flexible monolithic wall proximal the second end is initially retracted into the void prior to a portion of the flexible monolithic wall proximal the first end.
6. The apparatus of claim 1, wherein upon activation of the retraction system, a portion of the flexible wall proximal the first end is initially retracted into the void prior to a portion of the flexible wall proximal the second end.
7. The apparatus of claim 1, wherein at least a portion of the blade is constructed of a flexible material having a cylindrical shape.
8. The apparatus of claim 1, further comprising one or more light emitters disposed within one or more of the void of the housing and the interior of the blade, the one or more light emitters in electrical communication with the controller.
9. The apparatus of claim 1, further comprising one or more speakers disposed within the void of the housing, the one or more speakers in electrical communication with the controller.
10. The apparatus of claim 1, further comprising a motor in electrical communication with the controller, wherein the motor is selectively operable to activate the extension system and retraction system.
11. An adjustable saber apparatus configured for use in simulated combat, the apparatus, comprising: a housing having a sidewall extending between opposing first and second ends, at least a portion of an outer surface of the sidewall configured to be grasped by a user; a pressurizable blade having a flexible monolithic wall extending between a first end affixed within a void defined by the sidewall of the housing and an opposing movable second end, a control circuit at least partially disposed within the void of the housing, the control circuit comprising: a power supply; an extension system configured to inflate an interior of the blade defined by the flexible monolithic wall such that the second end of flexible monolithic wall extends outwardly from the void; a retraction system disposed within the void configured to retract the second end of the flexible monolithic wall within the void; and, a controller configured to selectively activate and deactivate the extension system and retraction system.
12. The apparatus of claim 11, wherein the blade is constructed of a flexible material a portion of

which defines a cylindrical shape.
13. The apparatus of claim 11, further comprising a lead extending between the retraction system and the second end of the flexible monolithic wall of the blade, the retraction system configured to retract at least the lead and second end upon activation of the retraction system.
14. The apparatus of claim 13, wherein upon activation of the retraction system, a portion of the flexible monolithic wall proximal the second end is initially retracted into the void prior to a portion of the flexible monolithic wall proximal the first end.
15. The apparatus of claim 11, wherein upon activation of the retraction system, a portion of the flexible wall proximal the first end is initially retracted into the void prior to a portion of the flexible wall proximal the second end.
16. The apparatus of claim 11, wherein the control circuit further comprises one or more light emitters disposed within one or more of the void of the housing and the interior of the blade.
17. The apparatus of claim 16, wherein the flexible monolithic wall further comprises at least a portion of an outer surface that is configured to create a visible interaction with light generated from the one or more light emitters.
18. The apparatus of claim 16, wherein the control circuit further comprises one or more speakers disposed within the void of the housing.
19. The apparatus of claim 18, wherein the control circuit further comprises one or more motion sensors configured to generate a signal indicative of movement, and wherein upon receipt of the signal the controller activates one or more of the speakers and light emitters to generate an output therefrom.
20. The apparatus of claim 18, wherein the control circuit further comprises one or more contact sensors configured to generate a signal indicative of the pressurizable blade contacting an external structure, and wherein upon receipt of the signal the controller activates one or more of the speakers and light emitters to generate an output therefrom.
21. The apparatus of claim 11, wherein the retraction system is configured to pass the flexible wall between a pair of rollers.
22. The apparatus of claim 11, further comprising a guide disposed within the void between the retraction system and the second end of the sidewall that is configured to orient the flexible monolithic wall for retraction by the retraction system.
23. The apparatus of claim 11, further comprising releasable coupling disposed adjacent the first end of the pressurizable blade, wherein the coupling is configured to relesably affix the pressurizable blade to the housing.
24. The apparatus of claim 11, further comprising a pressure release mechanism in fluid communication with the interior of the flexible monolithic wall.
25. The apparatus of claim 11, wherein the extension system comprises an air pump in fluid communication with the interior of the blade and a check valve disposed between the air pump and the interior of the blade, the air pump configured to provide a positive air pressure to the interior of the blade upon activation of the extension system.
26. The apparatus of claim 11, wherein the control circuit further comprises a pressure sensor in fluid communication with the interior of the flexible monolithic wall.
27. The apparatus of claim 11, wherein the control circuit further comprises a blade position sensor.
28. The apparatus of claim 11, wherein the controller is configured to disengage the retraction system during activation of the extension system.
29. The apparatus of claim 11, wherein the housing further defines a first and second housing chamber, and a first portion of the control circuit disposed within the first housing chamber and a second portion of the control circuit disposed within the second housing chamber.
30. The apparatus of claim 29, further comprising an attachment mechanism disposed between the first and second housing chambers such that the first and second housing chambers are releasably coupled.

31. The apparatus of claim 11, further comprising a secondary housing coupled to the housing, wherein a first portion of the control circuit is disposed within the void in the housing and a second portion of the control circuit is disposed within the secondary housing.
32. The apparatus of claim 11, wherein the pressuraziable blade is one of a plurality of pressurizable blades.
33. The apparatus of claim 11, wherein a first portion of the void defines a pressure chamber in fluid communication with the interior of the flexible monolithic wall.
34. An adjustable saber apparatus configured for use in simulated combat, the apparatus, comprising: a housing having a sidewall extending between opposing first and second ends, at least a portion of an outer surface of the sidewall configured to be grasped by a user; a pressurizable blade having a flexible wall extending between a first end affixed within a void defined by the sidewall of the housing and an opposing movable second end, a control circuit at least partially disposed within the void of the housing, the control circuit comprising: a power supply; an extension system configured to inflate an interior of the blade defined by the flexible wall such that the second end of the flexible wall extends outwardly from the void; a retraction system disposed within the void configured to retract the second end of the flexible wall within the void; and, a controller configured to selectively activate and deactivate the extension system and retraction system; wherein the retraction system comprises a motor that is configured to spool the flexible wall about a rotatable shaft upon activation of the retraction system.