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(54) **SYSTEM AND METHOD FOR SAFING AND ARMING A BORE-LAUNCHED PROJECTILE**

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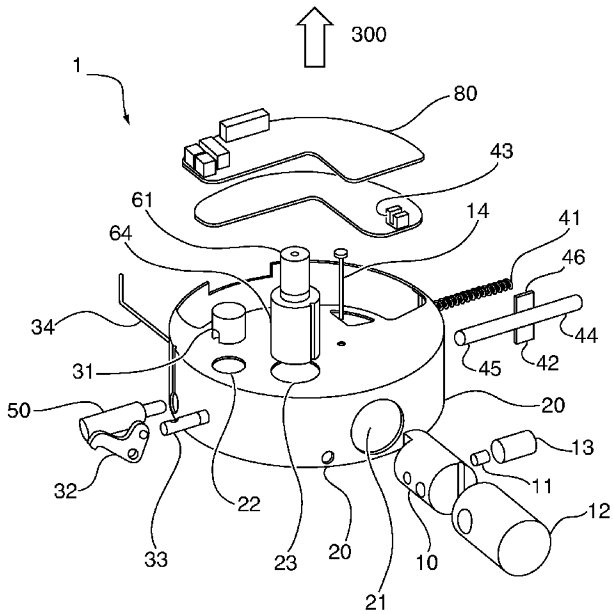
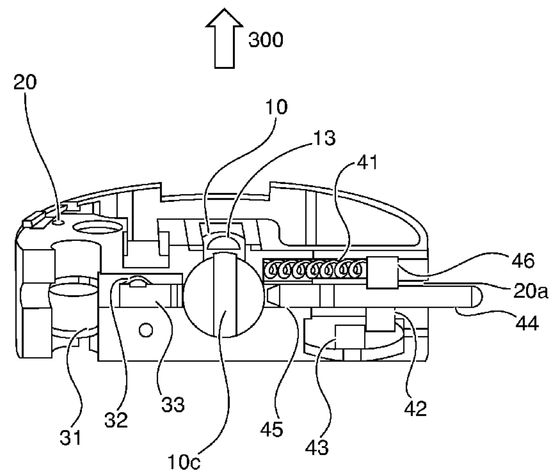
(57) **ABSTRACT**

A safing and arming (SA) system and method for a bore-launched projectile is provided. The SA system includes an arming switch, including a detonator, movable from a first position to a second position. When the arming switch is in the first position, the detonator is separated from an explosive train of the projectile. When the arming switch is in the second position, the detonator is substantially aligned with the explosive train, allowing the projectile to be armed. Safing systems are provided for retaining the arming switch in the first (safe) position. Various embodiments also allow for release of the arming switch so as to allow the arming switch to be moved to the second (armed) position, wherein the release may be triggered by a selected acceleration force exerted on the projectile and/or a determination that the projectile has been launched from the launch bore.





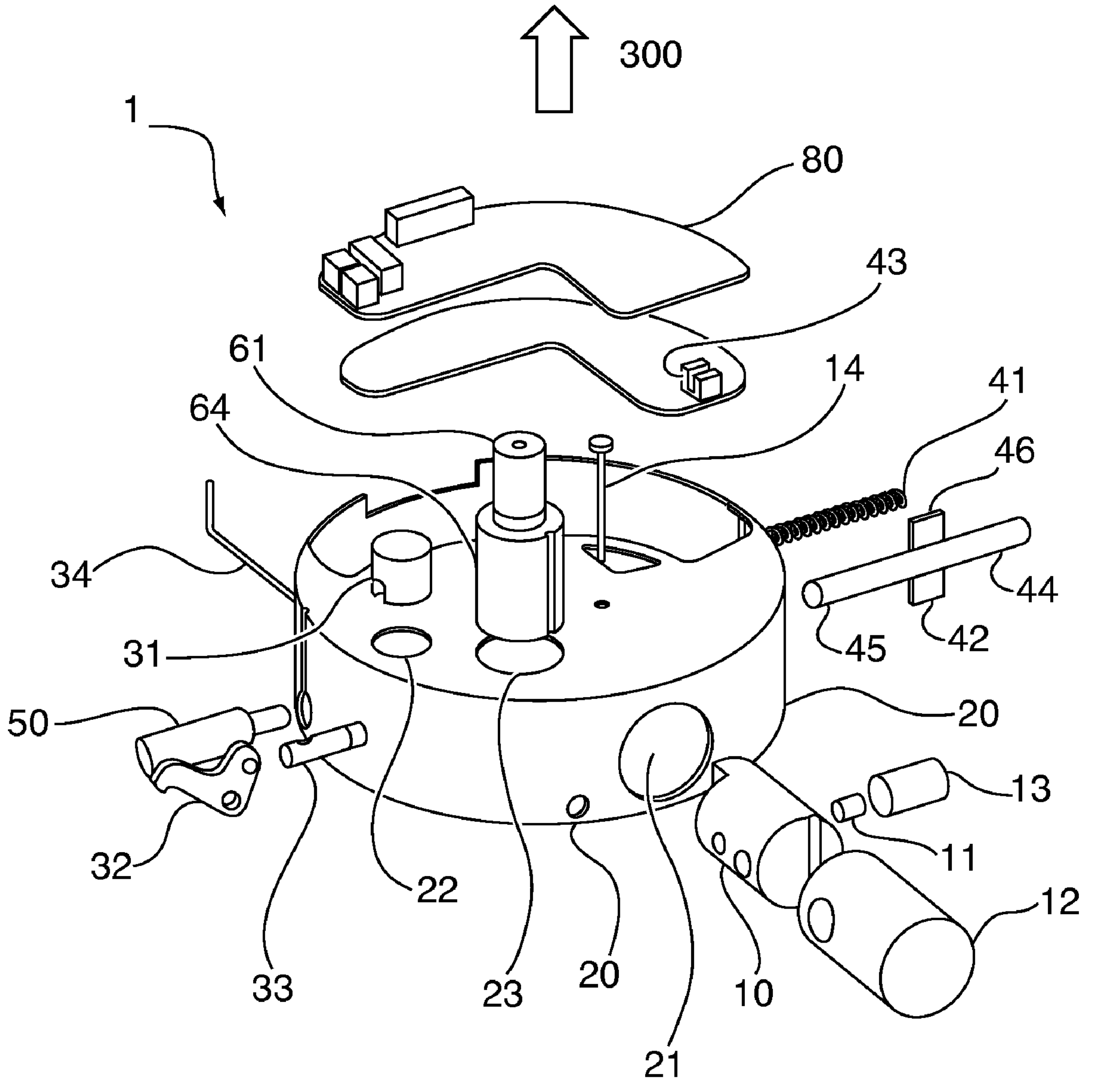

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Fig. 1

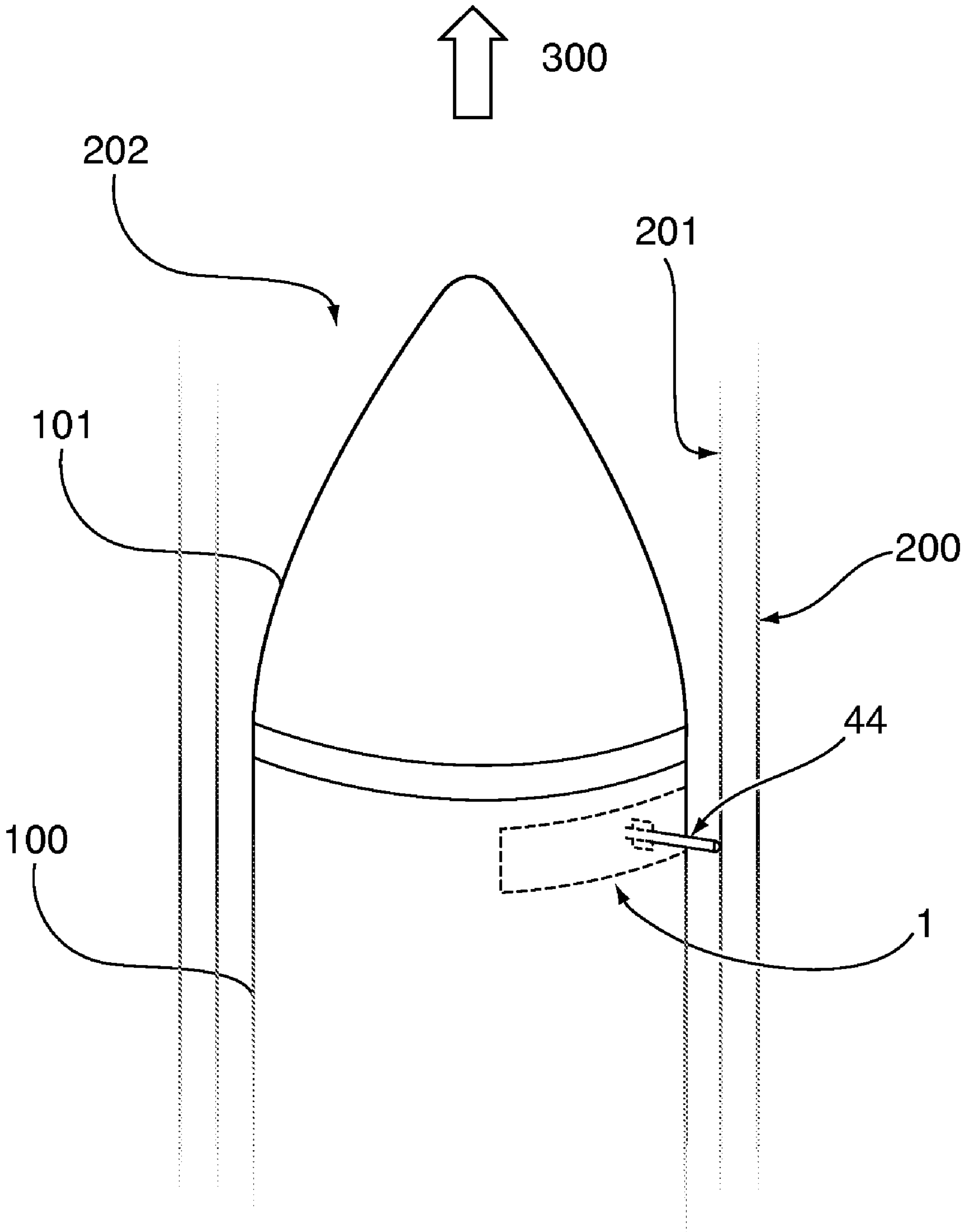

Fig. 2

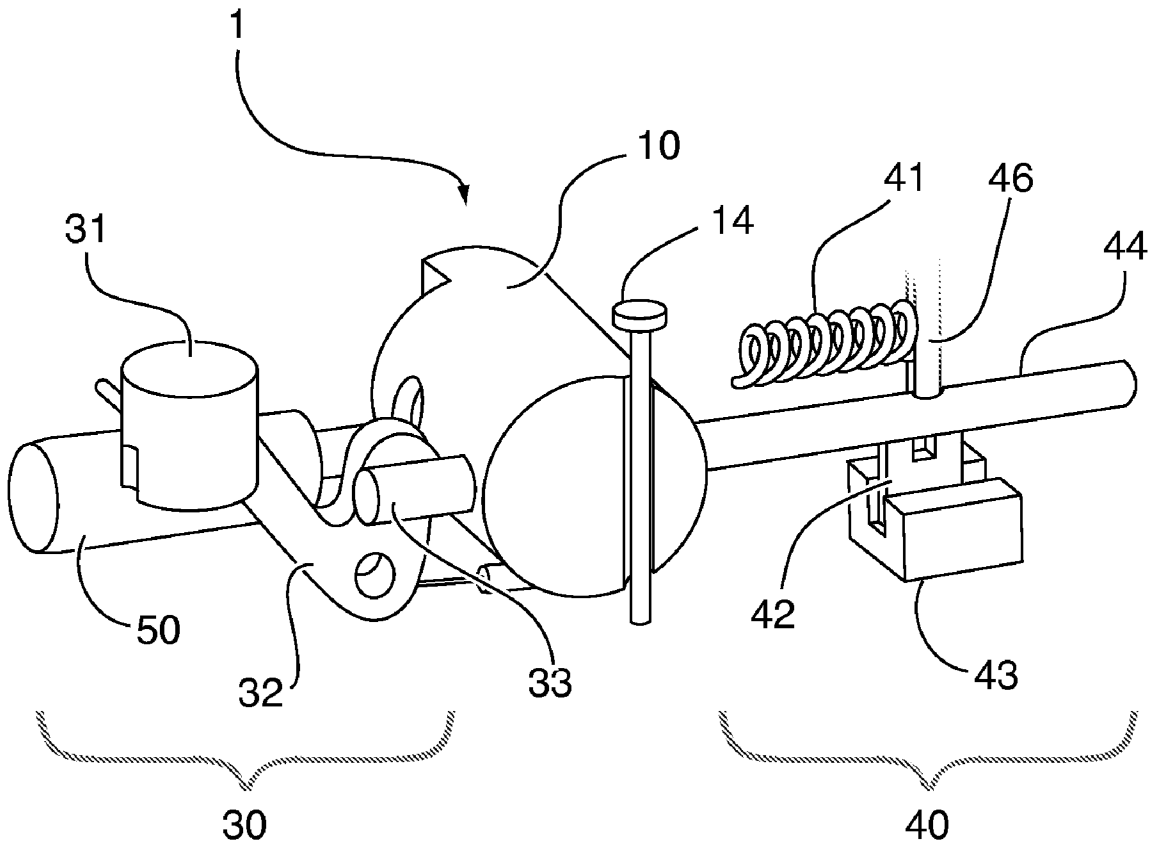

Fig. 3

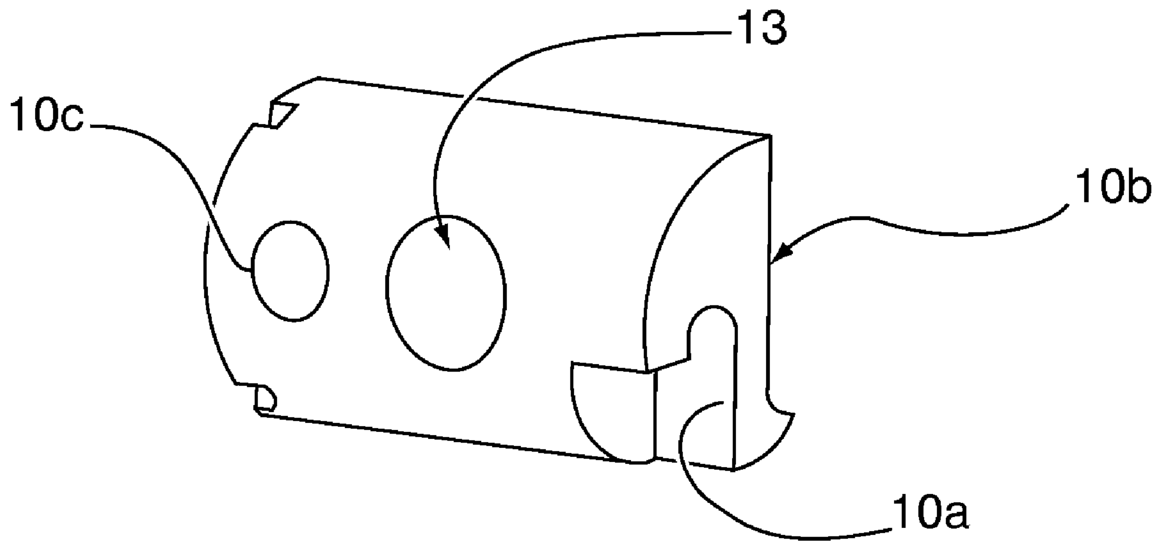

Fig. 4A

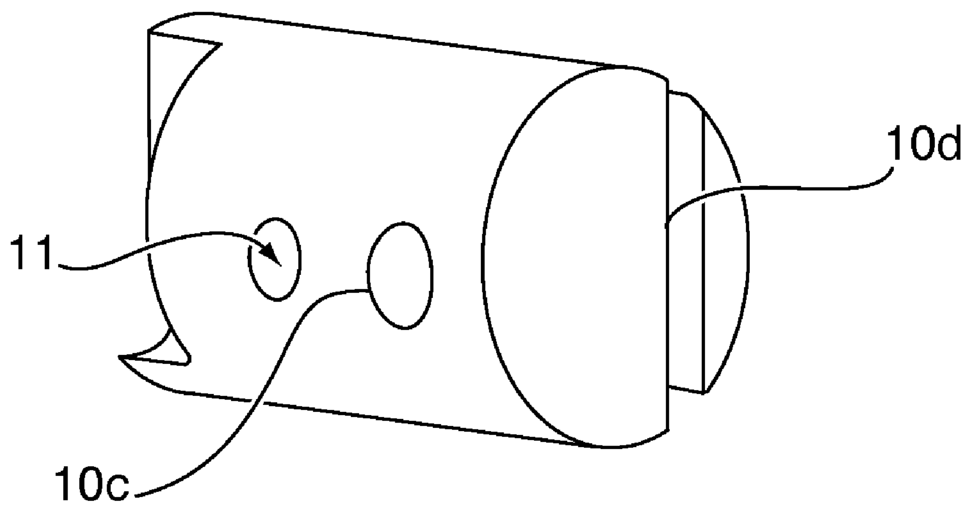

Fig. 4B

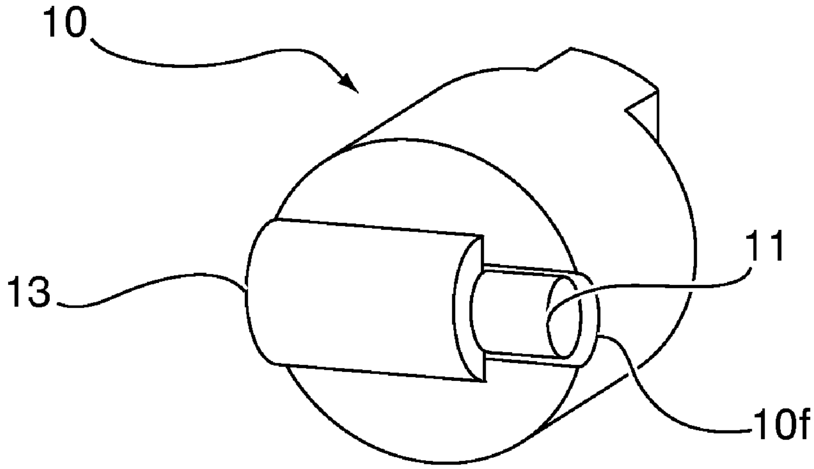

Fig. 4C

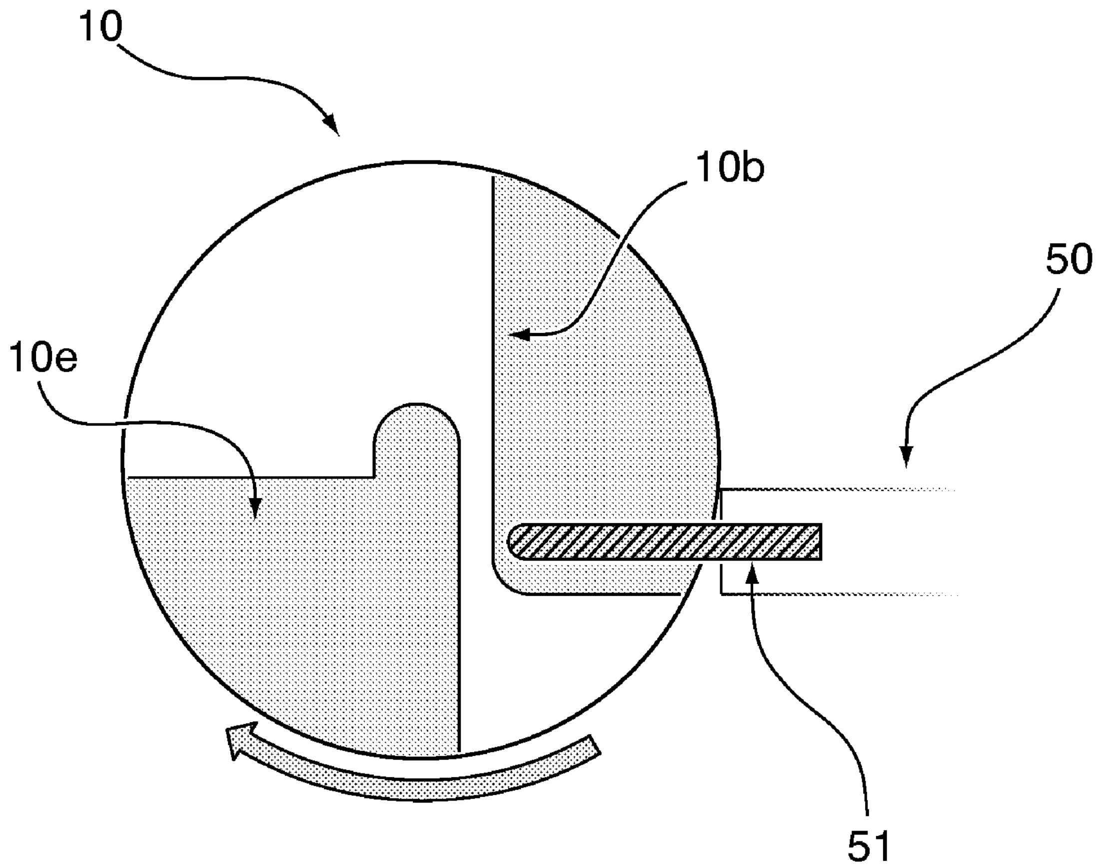

Fig. 4D

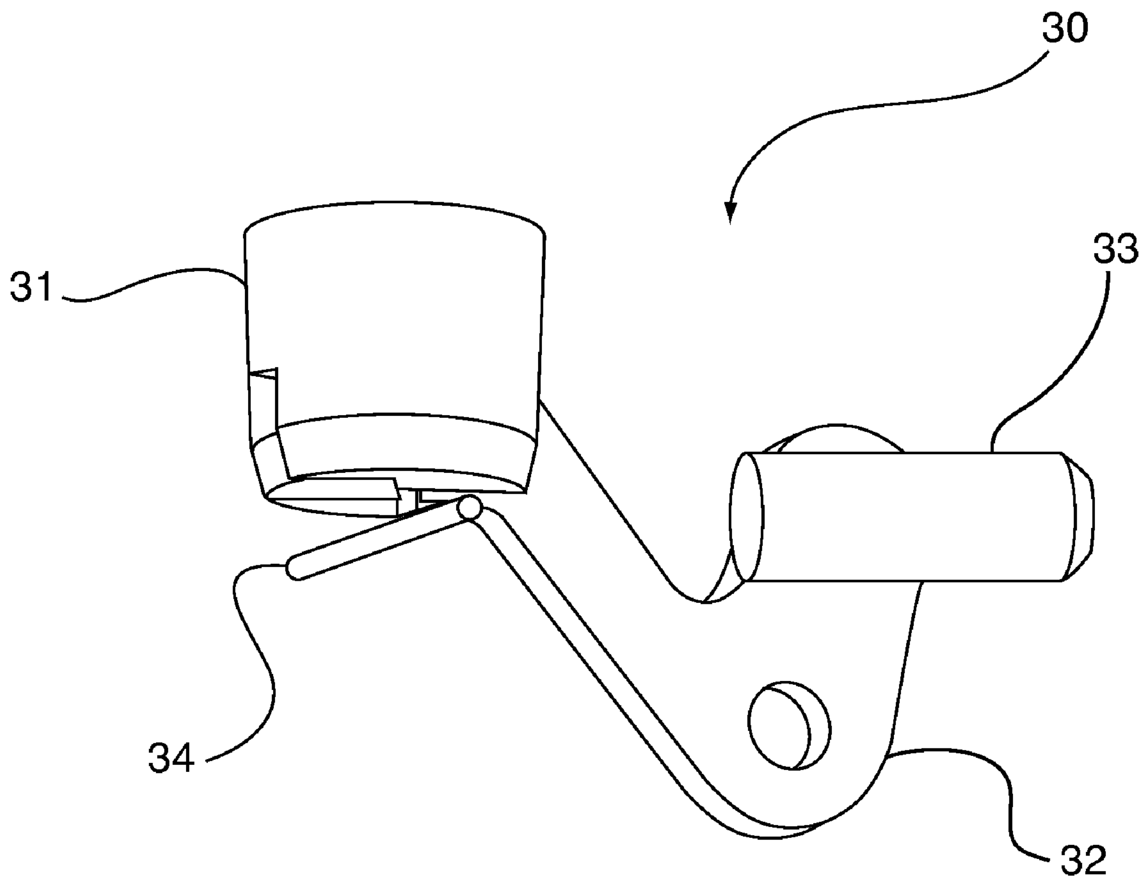

Fig. 5

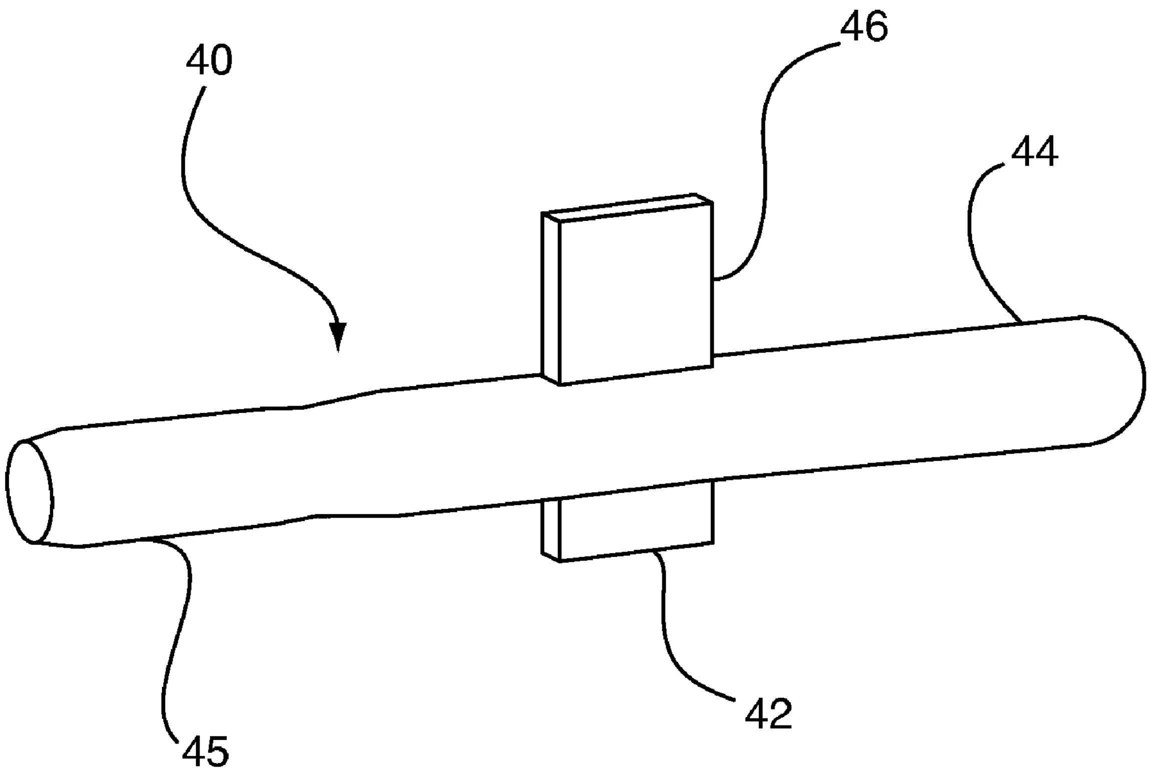

Fig. 6

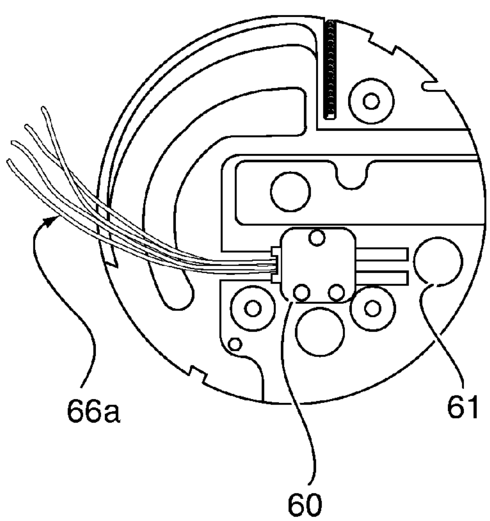

Fig. 7A

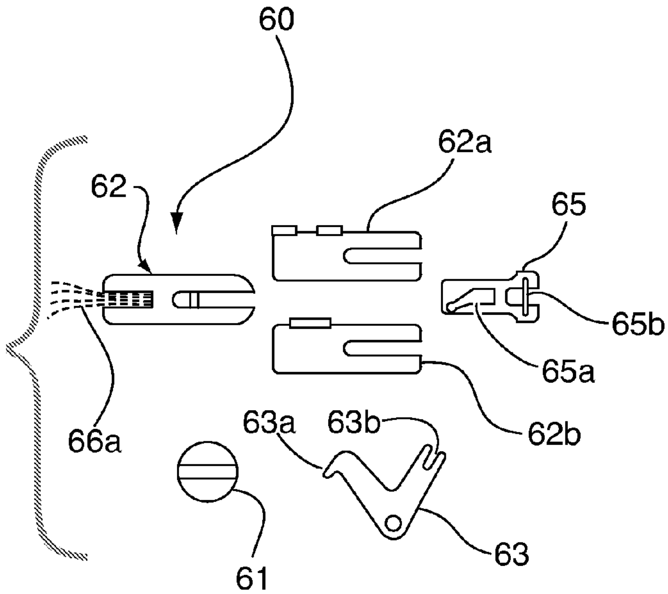

Fig. 7B

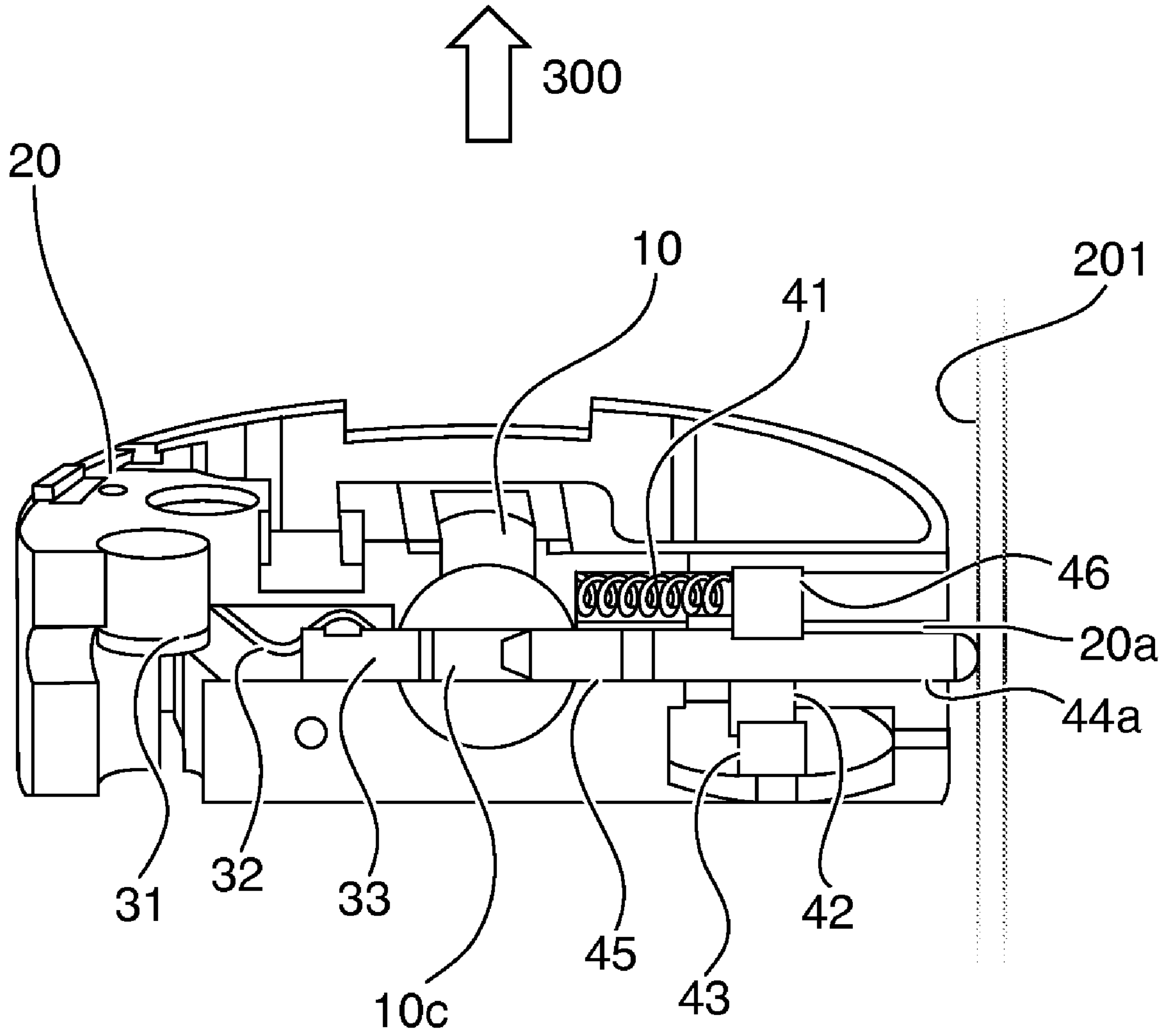

Fig. 8

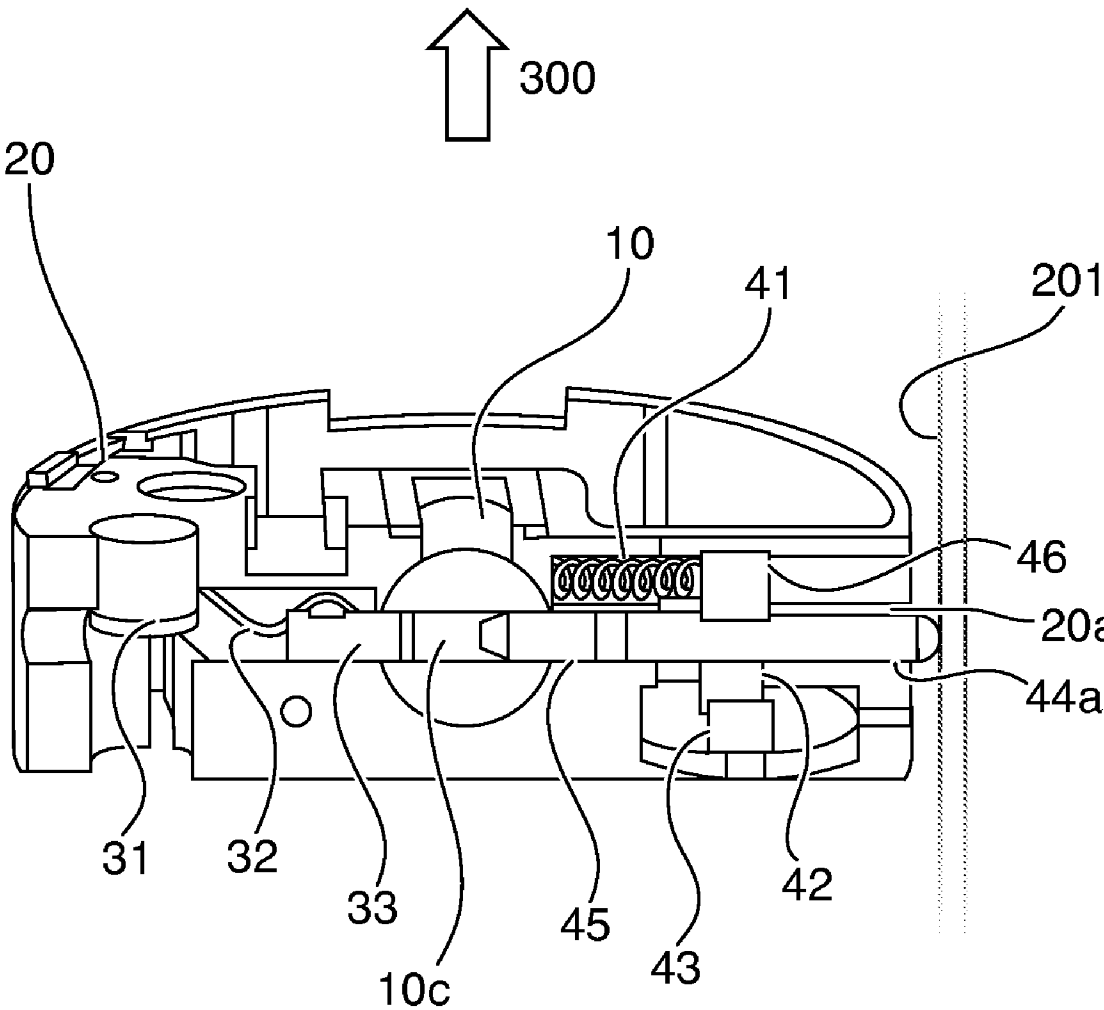

Fig. 9

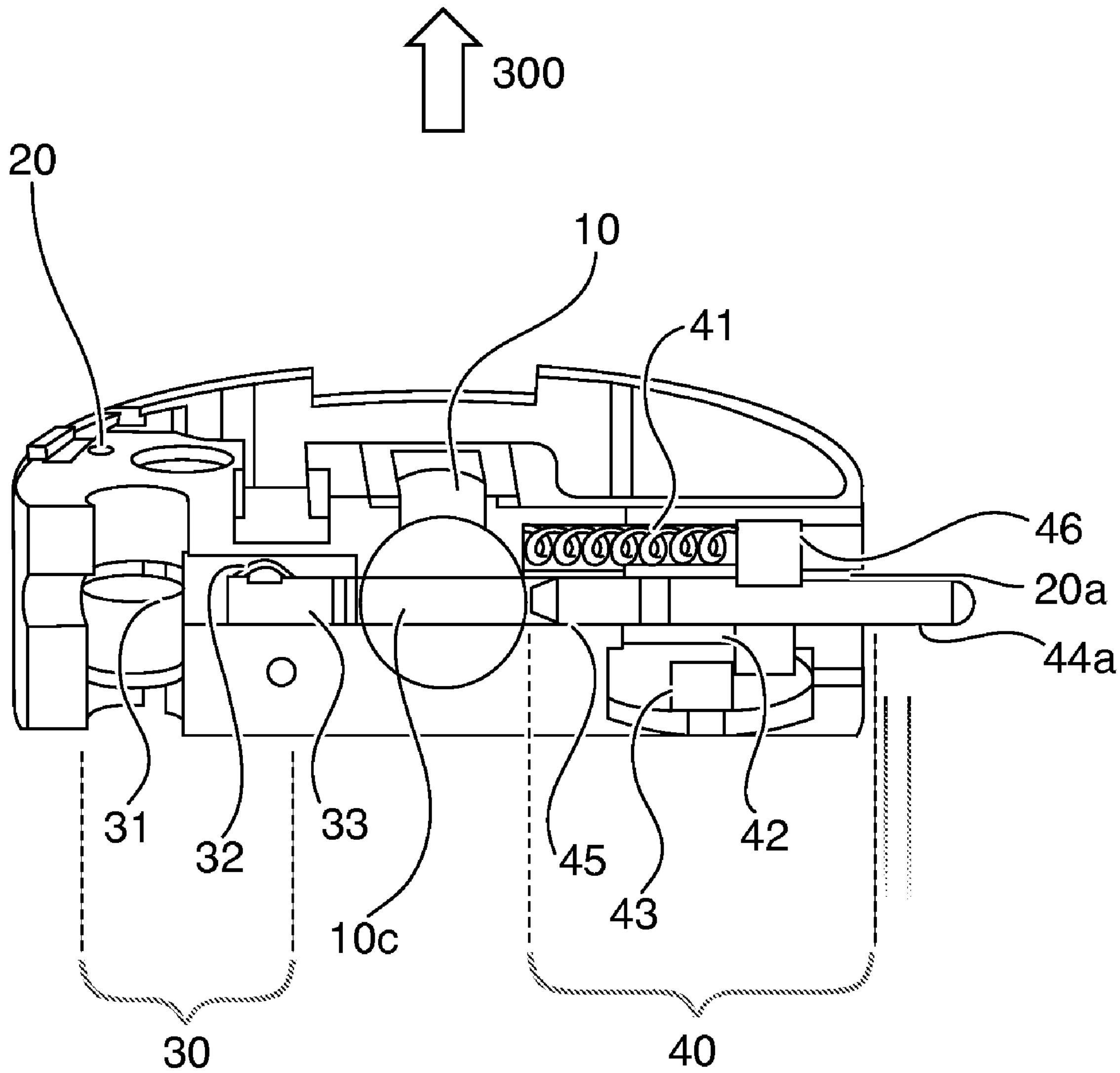

Fig. 10

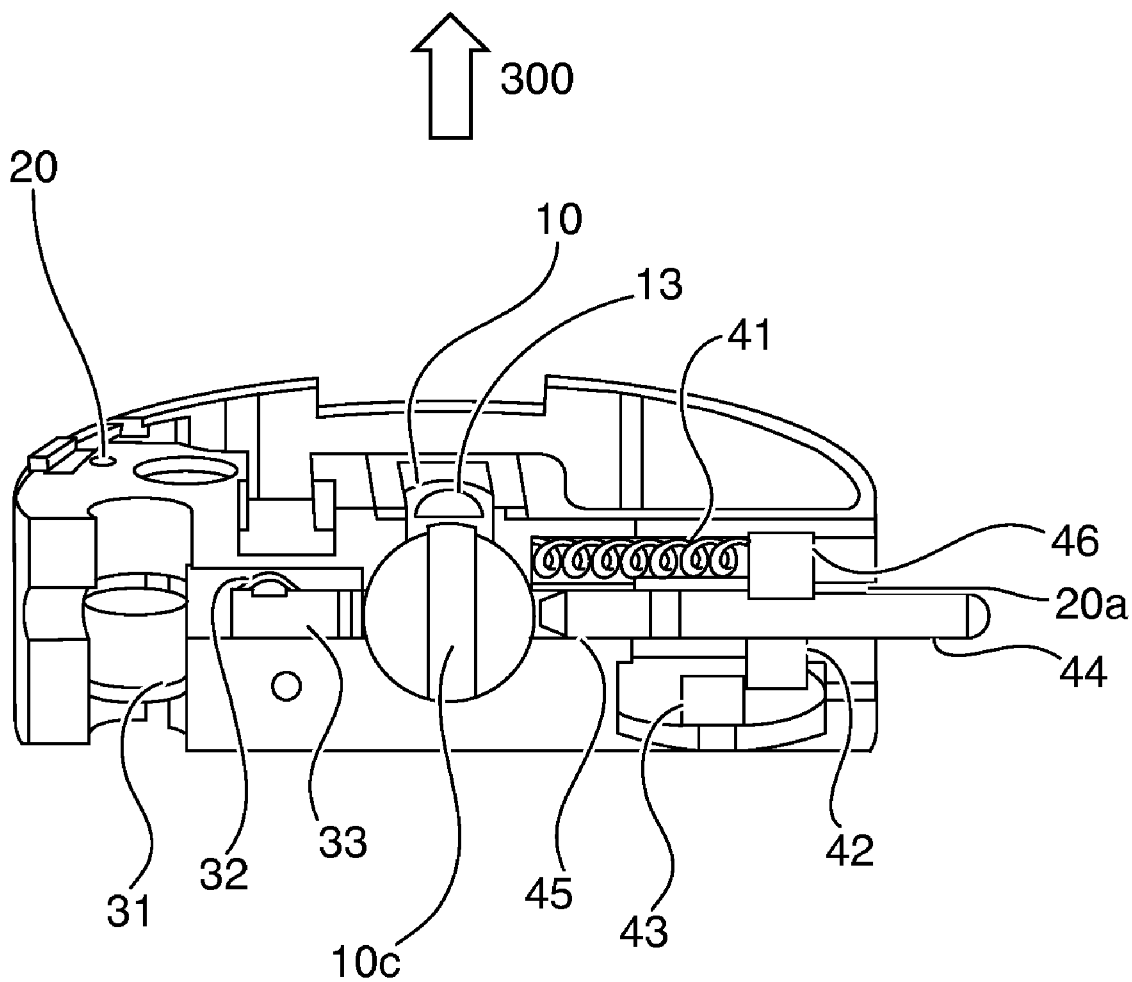

Fig. 11

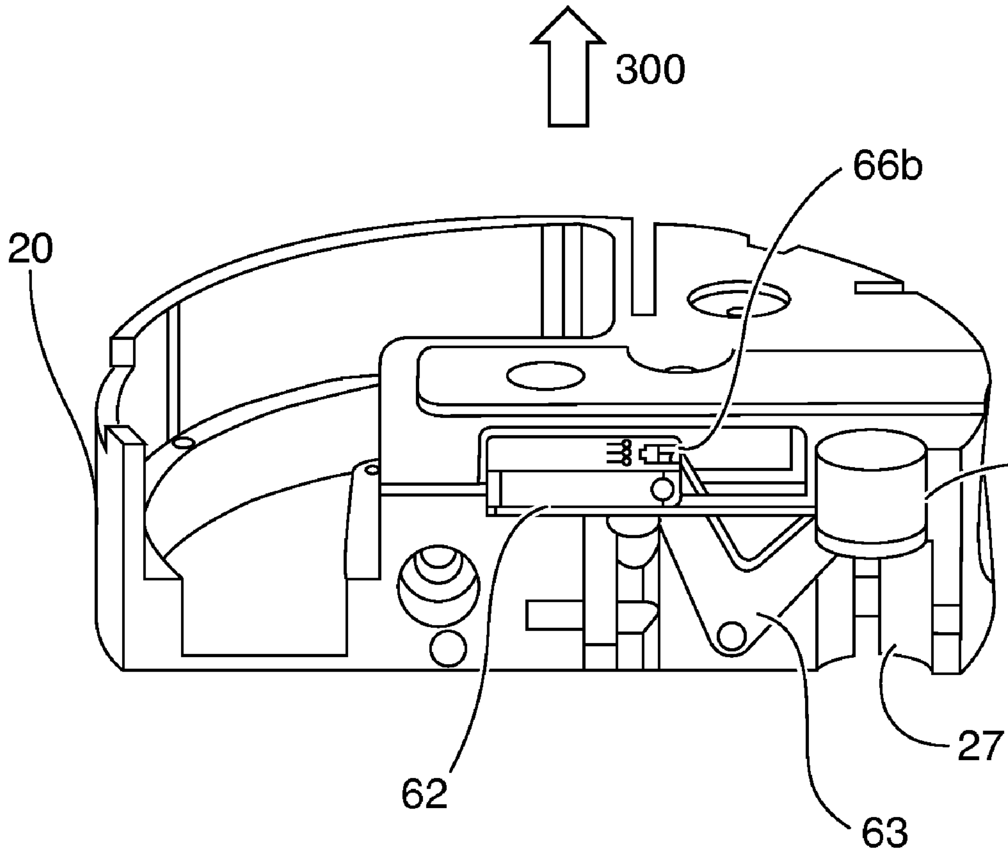

Fig. 12

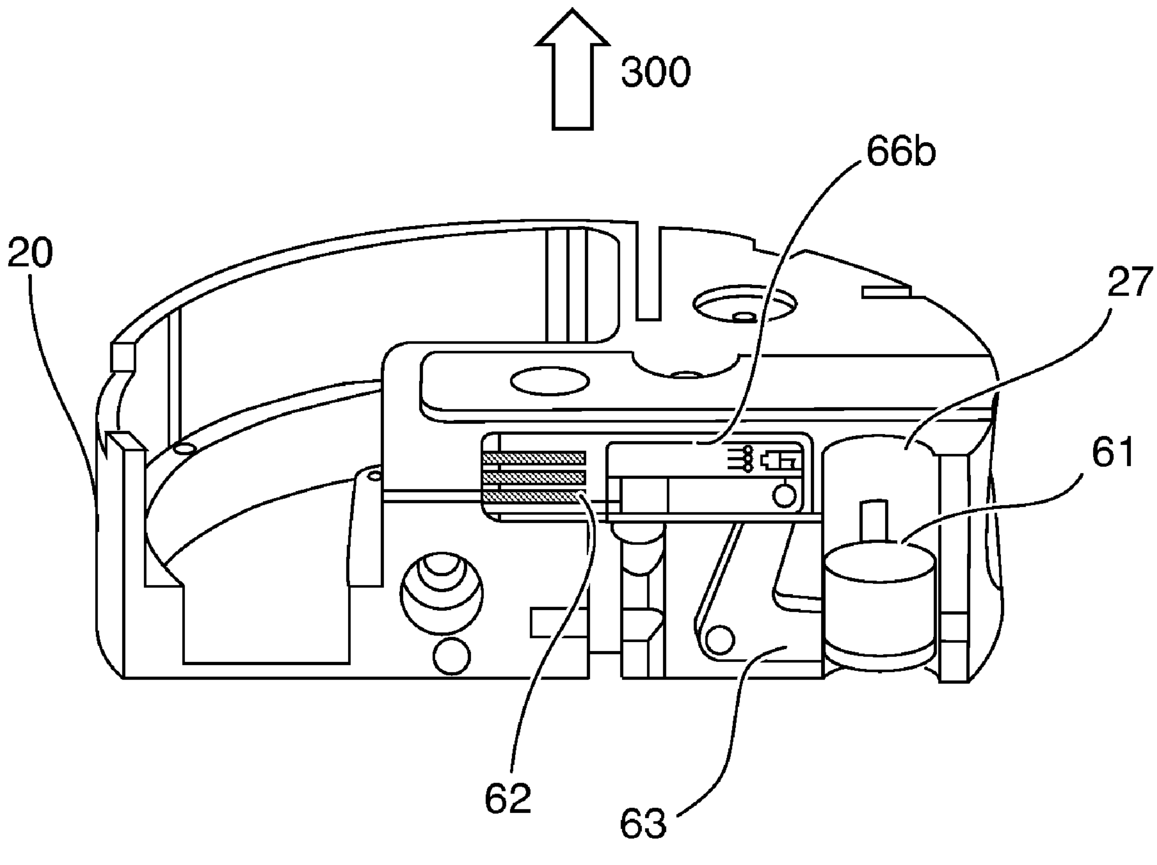

Fig. 13

SYSTEM AND METHOD FOR SAFING AND ARMING A BORE-LAUNCHED PROJECTILE

FIELD OF THE INVENTION

[0001] Various embodiments of the present invention relate generally to a system and method for safing and arming a bore-launched projectile so as to prevent unintended arming of the projectile.

BACKGROUND OF THE INVENTION

[0002] Munitions (such as explosive projectiles) are often provided with a safing and arming ("SA") device that is designed to allow the projectile to arm its explosive train (and consequently, in some cases, the warhead carried by the projectile) only after the projectile has undergone an intentional launch event. For example, all munitions qualified by the United States government must comply with the requirements of U.S. Department of Defense ("DOD") MIL-STD-1316, entitled "Safety Criteria for Fuze Design," which sets forth specific guidelines and requirements for the design of an acceptable SA device. For example, MIL-STD-1316 specifies that an acceptable SA device must sense two independent arming environments prior to arming.

[0003] Conventional SA devices carried by bore-launched explosive projectiles utilize simultaneous acceleration and spin imparted by a gun launch as the two independent arming environments to indicate an intentional launch event. However, there exists a growing class of munitions that do not produce spin upon gun launch and that experience relatively low acceleration forces (i.e. low-g acceleration) during launch. Such no-spin, low-g munitions present problems for conventional SA devices since the magnitude of a launch acceleration force is typically lower than that resulting from an accidental drop of the projectile (i.e. when loading and/or handling the projectile prior to launch). Furthermore, conventional SA devices do not utilize electronic safety back-up systems that are capable of reliably identifying an intentional launch event and/or positively preventing the arming of an explosive projectile (via hard-wired and/or switched short circuits) during non-launch events (such as an accidental drop). Therefore, conventional SA devices may have some shortcomings, especially when applied to newer no-spin and/or low-g bore-launched munitions.

[0004] Thus, there exists a need for SA devices capable of distinguishing between an intentional launch and an accidental drop of a projectile equipped with such an SA device. Furthermore, there exists a need for SA devices capable of sensing arming environments other than projectile spin, so as to be compatible with no-spin bore-launched projectiles, while still providing an independent safeguard against an accidental arming and/or detonation. There also exists a need for SA devices that provide parallel electronic safeguards against accidental and/or unintentional arming of an explosive projectile that may be coupled to one or more of the arming environments sensed by the SA device.

BRIEF SUMMARY OF THE INVENTION

[0005] Various embodiments presented herein provide technical solutions to many of the problems inherent in conventional SA devices while providing robust and, in some cases, multiple independent safeguards against accidental arming of a projectile. According to various embodiments of the present invention, a safing and arming system is provided to be operably engaged with a projectile adapted to be launched from a launch bore.

[0006] In one embodiment, the system comprises an arming switch configured to be movable from a first position to a second position. The arming switch is further configured to operably engage a detonator, such that when the arming switch is in the first position, the detonator is substantially out of alignment with the explosive train. Furthermore, the arming switch is further configured such that when the arming switch is in the second position, the detonator is substantially aligned with the explosive train such that the explosive train is capable of being armed. In some embodiments, the arming switch comprises a rotatable cylinder having a central axis and defining an arming channel extending radially outward from the central axis. Furthermore, in such embodiments, the arming channel is configured to receive the detonator such that as the rotatable cylinder is rotated from the first position to the second position, the detonator is substantially aligned with the explosive train such that the explosive train is capable of being armed. In some embodiments, the system further comprises an actuator device operably engaged with the arming switch. In such embodiments, the actuator device is configured to be capable of moving the arming switch from the first position to the second position in response to a signal.

[0007] According to some system embodiments, the system further comprises a first acceleration safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position. Furthermore, the first acceleration safety device is configured to disengage the arming switch so as to allow the arming switch to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration. For example, the acceleration force may be imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile.

[0008] In some system embodiments, the first acceleration safety device comprises: a first setback weight slidably disposed in a first setback weight chamber; a second pin configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position; and a first linkage arm operably engaged between the first setback weight and the second pin. Thus, in such embodiments, in response to the acceleration force, the first setback weight slides within the first setback weight chamber and the first linkage arm is configured to disengage the pin from the arming switch so as to allow the arming switch to be moved to the second position. In some embodiments, the first setback weight is configured to slide within the first setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

[0009] The system may also further comprise a proximity safety device configured to operably engage the arming switch so as to normally retain the arming switch in the first position. The proximity safety device is further configured to sense an inner wall of the launch bore. The proximity safety device is further configured to allow the arming switch to be moved to the second position such that the explosive train is capable of being armed when the projectile is launched from the launch bore. In some embodiments, the proximity safety device comprises a first pin slidably disposed in a first pin channel, wherein the first pin includes a first end configured to contact an inner wall of the launch bore, and a second end configured to engage the arming switch so as to normally retain the arming switch in the first position when the projectile is disposed within the launch bore. In such embodiments, the proximity safety device further comprises a biasing element operably engaged with the first pin for biasing the first pin towards the inner wall of the launch bore such that when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed.

[0010] According to some system embodiments, the proximity safety device further comprises a tab configured to normally cover an optical sensor in communication with the detonator. In such embodiments, the optical sensor is configured to be capable of transmitting the signal to the actuator device when the tab is moved to uncover the optical sensor. The tab of the proximity safety device is further configured to uncover the optical sensor when the projectile is launched from the launch bore such that the optical sensor is capable of transmitting the signal to the actuator device. Thus, in such embodiments, the actuator device may be rendered capable of moving the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

[0011] Some system embodiments of the present invention further comprise a wiring assembly configured to short circuit the signal to prevent the signal from being transmitted to the actuator device. In some such system embodiments, the wiring assembly may comprise electrical connections including, but not limited to: a short circuit connection to a ground for the signal; a short circuit connection to a ground for a detonator arming signal; a short circuit connection to a ground for an electronic controller configured to control the detonator; and combinations of such electrical connections. In some embodiments, the system further comprises a second acceleration safety device configured to be capable of disabling the wiring assembly in response to the acceleration force such that the signal is capable of being transmitted to the actuator device. The second acceleration safety device may comprise: a second setback weight slidably disposed in a second setback weight chamber; a cutting device slidably disposed in a cutting channel; and a second linkage arm operably engaged between the second setback weight and the cutting device such that as the second setback weight slides within the second setback weight chamber in response to the acceleration force, the second linkage arm is configured to move the cutting device within the cutting channel such that the cutting device cuts at least one wire within the wiring assembly such that the signal is capable of being transmitted to the actuator device. As described herein with respect to the first acceleration safety device, the second setback weight provided in some system embodiments may also be configured to slide within the second setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

[0012] Various embodiments of the present invention also provide a method for safing and arming a projectile including an explosive train, using a safing and arming system. As described herein, the projectile is adapted to be launched from a launch bore. In some embodiments, the method first comprises securing an arming switch in a first position so as to normally retain the arming switch in the first position wherein the arming switch is configured to be movable from the first position to a second position. The arming switch is further configured to operably engage a detonator, such that when the arming switch is in the first position, the detonator is substantially out of alignment with the explosive train and such that when the arming switch is in the second position, the detonator is substantially aligned with the explosive train such that the explosive train is capable of being armed. The method further comprises a step for releasing the arming switch so as to allow the arming switch to be moved to the second position. According to some method embodiments, the arming switch may be released by: an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile; and a determination that the projectile has been launched from the launch bore.

[0013] According to some method embodiments, the securing step described herein further comprises securing the arming switch in the first position with a first acceleration safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position. Furthermore, the securing step may also further comprise securing the arming switch in the first position with a proximity safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, wherein the proximity safety device is further configured to sense an inner wall defining the launch bore.

[0014] Furthermore, the releasing step may further comprise disengaging a first acceleration safety device from the arming switch so as to allow the arming switch to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration. As described herein, the acceleration force may be imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile. Furthermore, the releasing step may also further comprise steps including, but not limited to: sensing the inner wall of the launch bore with a proximity safety device; determining when the inner wall is no longer sensed by the proximity safety device, after disengaging the first acceleration safety device from the arming switch; and disengaging the proximity safety device from the arming switch after the determining step so as to allow the arming switch to be moved to the second position such that the explosive train is capable of being armed when the projectile is launched from the launch bore. According to some such method embodiments, the proximity safety device comprises a first pin slidably disposed in a first pin channel. In such embodiments, the method may further comprise steps including, but not limited to: contacting an inner wall of the launch bore with a first end of the first pin when the projectile is disposed within the bore; engaging a second end of the first pin with the arming switch so as to normally retain the arming switch in the first position when the projectile is disposed within the bore; and biasing the first pin towards the inner wall of the launch bore. The biasing step may be accomplished in some embodiments with a biasing element operably engaged with the first pin. Thus, when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed.

[0015] Additional method embodiments of the present invention may further comprise steps for moving the arming switch from the first position to the second position with an actuator device operably engaged therewith, in response to a signal received by the actuator device. In such embodiments, the method may comprise normally short-circuiting the signal with a wiring assembly to prevent the signal from being transmitted to the actuator device. The method may also further comprise disabling the wiring assembly in response to the acceleration force with a second acceleration safety device such that the signal is capable of being transmitted to the actuator device. The method may also further comprise transmitting the signal to the actuator device such that the actuator device is capable of moving the arming switch from the first position to the second position. Furthermore, in some method embodiments, the proximity safety device comprises a tab configured to normally cover an optical sensor in communication with the detonator. Such method embodiments may further comprise steps for: moving the tab so as to uncover the optical sensor when the projectile is launched from the launch bore such that the optical sensor is capable of transmitting the signal to the actuator device; and transmitting a signal from the optical sensor to the actuator device such that the actuator device is capable of moving the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

[0016] Thus, various embodiments of a safing and arming system and associated method according to the present invention may provide one or more advantages that may include, for example: providing a robust mechanical safing system that allows a projectile to arm only after an intentional launch event; providing a safing system that is capable of discerning between acceleration loads resulting from a launch event and a shock load resulting from rough handling and/or an accidental drop; providing a parallel optical and/or electronic safing system that is capable of activating an electronic arming system; providing a safing and arming system that is compatible with "no-spin" bore-launched projectiles having relatively low launch acceleration rates; and providing a readily-adjustable mechanical safing mechanism that may be adjusted to function under a wide range of launch acceleration conditions.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0017] Having thus described various embodiments in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0018] FIG. **1** shows an exemplary exploded schematic depiction of a safing and arming system according to one embodiment of the present invention;

[0019] FIG. **2** shows an exemplary cross-sectional schematic view of a safing and arming system installed in a bore-launched projectile according to one embodiment of the present invention;

[0020] FIG. **3** shows an exemplary schematic of a safing and arming system according to one embodiment of the present invention, including a first acceleration safety device and a proximity safety device operably engaged with a rotatable arming switch;

[0021] FIG. **4**A shows a schematic view of a first side of a rotatable arming switch defining a bearing surface configured to be operably engaged with a piston actuator for operating a safing and arming system according to one embodiment of the present invention;

[0022] FIG. **4**B shows a schematic view of a second side of a rotatable arming switch defining a shear pin channel configured to be operably engaged with a shear pin for operating a safing and arming system according to one embodiment of the present invention;

[0023] FIG. **4**C shows a schematic cut-away view of a rotatable arming switch defining a detonator channel configured to carry a detonator as part of a safing and arming system according to one embodiment of the present invention;

[0024] FIG. **4**D shows a schematic end view of a rotatable arming switch including a bearing surface operably engaged with a piston actuator for operating a safing and arming system according to one embodiment of the present invention;

[0025] FIG. **5** shows a schematic view of a first acceleration safety device forming a part of a safing and arming system according to one embodiment of the present invention;

[0026] FIG. **6** shows a schematic view of a proximity safety device forming a part of a safing and arming system according to one embodiment of the present invention;

[0027] FIG. **7** shows a schematic view of a second acceleration safety device forming a part of a safing and arming system according to one embodiment of the present invention;

[0028] FIG. **8** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, wherein the arming switch is in a safe position and a first acceleration safety device and a proximity safety device are engaged with the arming switch to retain the arming switch in the safe position;

[0029] FIG. **9** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, wherein the arming switch is in a safe position and a first acceleration safety device is disengaged from the arming switch in response to an acceleration force;

[0030] FIG. **10** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, wherein the arming switch is in a safe position, a first acceleration safety device is disengaged from the arming switch in response to an acceleration force, and a proximity safety device is disengaged from the arming switch;

[0031] FIG. **11** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, wherein the arming switch is in an armed position;

[0032] FIG. **12** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, including a second acceleration safety device, wherein the second acceleration safety device is positioned so as to complete a short circuit; and

[0033] FIG. **13** shows a cross-sectional schematic of a safing and arming system according to one embodiment of the present invention, including a second acceleration safety device, wherein the second acceleration safety device is positioned so as to disable a wiring assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0034] Various embodiments of a system and associated method for safing and arming a bore-launched projectile now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments are shown. Indeed, system and method may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

[0035] While the various system **1** and method embodiments of the present invention are described in the context of a safing and arming system **1** having a rotatable arming switch **10** (see FIGS. **4A-4D**, for example), it should be understood that the various SA system **1** and method embodiments described herein may also be applied to a linearly slidable arming switch (not shown) wherein at least one of the first acceleration safety device **30**, the second acceleration safety device **60**, and the proximity safety device **40**, otherwise described herein, may be configured to retain the linearly slidable arming switch (and a detonator **11** carried thereby) normally out of alignment with an explosive train. Furthermore, while various safing and arming systems **1** and methods are described herein in the context of a "no-spin" bore-launched projectile (adapted to be launched from a smooth bore tube, for example), it should be understood that the various embodiments described herein may also be used in conjunction with projectiles imparted with a spin upon launch (such as explosive projectiles launched from a barrel or launch tube having a rifled bore, for example). In addition, it should be understood that the various system and method embodiments disclosed herein may be used in conjunction with any number of projectile types having an explosive train configured to detonate an explosive warhead (such as a high explosive anti-tank (HEAT) round, for example) and/or configured to initiate the launch of a kinetic energy penetrator device from a sabot, for example.

[0036] Embodiments of the present invention include a safing and arming (SA) system **1** (see FIG. **1**, for example) adapted to be operably engaged with a projectile **100** including an explosive train (such as a series of explosive charges carried by the projectile **100** for exploding a warhead **101**, for example, as shown in FIG. **2**). As shown generally in FIG. **2**, the SA system **1** may be disposed substantially adjacent to the explosive train as part of a projectile **100** that is adapted to be launched from a launcher **200** defining a launch bore **202**.

[0037] In some embodiments, such as that shown generally in FIG. **1**, the SA system **1** comprises an arming switch **10** that may be carried by a system housing **20**. As shown generally in the cross-sectional schematics of FIGS. **10** and **11**, the arming switch **10** may be configured to be movable from a first position (see FIG. **10**, for example) to a second position (see FIG. **11**, for example). Furthermore, as shown generally in FIG. **4C**, the arming switch **10** may be further configured to operably engage a detonator **11** (such as an M55 detonator device, for example), such that when the arming switch **10** is in the first position, the detonator **11** is substantially out of alignment with the explosive train (see FIG. **10**, for example), and such that, when the arming switch **10** is in the second position, the detonator **11** is substantially aligned with the explosive train such that the explosive train is capable of being armed (see FIG. **11**, for example).

[0038] According to some embodiments, as shown generally in FIGS. **4A-4D**, the arming switch **10** may comprise a rotatable cylinder having a central axis and defining an arming channel **10**F extending radially outward from the central axis. As shown in FIG. **4**C, the arming channel **10**F defined by the arming switch **10** may be configured to receive the detonator **11** such that, as the rotatable cylinder is rotated from the first position to the second position, the detonator **11** is substantially aligned with the explosive train of the projectile **100** such that the explosive train is capable of being armed. According to some such embodiments, the arming channel **10**F defined by the arming switch **10** may be further configured to receive an explosive lead element **13** such that the explosive lead element **13** is disposed substantially between the detonator **11** and a primary explosive charge (and/or warhead) carried by the projectile **100**. Thus, when the arming switch **10** is in the second (armed) position (see FIG. **11**), the explosive lead element **13** may, in some embodiments, act as a transfer charge between the detonator **11** and the primary explosive charge (and/or warhead) carried by the projectile **100**. For example, in some embodiments, the detonator **11** may comprise an M55 "stab" detonator configured to initiate the explosive lead element **13** which, in turn, may be configured to produce a sufficient explosive output to initiate the detonation of the primary explosive charge (and/or warhead) carried by the projectile **100**. Thus, the explosive lead element **13** may increase the reliability of the arming and detonation mechanism of the projectile **100**.

[0039] Furthermore, the arming switch **10** may comprise, for example, a metal and/or metallic alloy exhibiting relatively robust dimensional stability and corrosion resistance so as to further improve the reliability of the arming switch **10**. For example, in some embodiments, the arming switch **10** may comprise a stainless steel material (such as **303** stainless steel) machined as shown generally in FIGS. **4A-4C** and as described further herein so as to be compatible with various types of acceleration safety devices (see generally, element **30**, FIG. **3**) and proximity safety devices (see generally, element **40**, FIG. **3**). According to some SA system **1** embodiments (as shown in FIG. **8**, for example), the arming switch **10** may define a locking channel **10**C configured to be capable of receiving a pin **33** of a first acceleration safety device **30** (FIG. **5**) and/or a second end **45** of a bore rider pin **44** (FIG. **6**) included as part of a proximity safety device **40**.

[0040] As shown in FIG. **3**, the SA system **1** may further comprise a first acceleration safety device **30** carried by the system housing **20** (see FIG. **1**, showing an exploded view of the SA device **1** including the system housing **20** depicted relative to the arming switch **10**). The first acceleration safety device **30** is configured to be capable of operably engaging the arming switch **10** (via a pin **33**, for example, as shown in FIG. **3**) so as to normally retain the arming switch **10** in the first position (see FIG. **10**, showing the arming switch **10** substantially out of alignment with an explosive train of a projectile). The first acceleration safety device **30** may be further configured to disengage the arming switch **10**

(as shown in FIG. **9**, for example) so as to allow the arming switch **10** to be moved to the second position in response to an acceleration force having a selected magnitude and a selected duration. As shown in FIG. **2**, the acceleration force may be imparted on the first acceleration safety device **30** (carried by the system housing **20** of the SA system **1**) by an acceleration of the projectile **100** with respect to the launcher **200** during a launch of the projectile in the launch direction **300**.

[0041] For example, in some embodiments, as shown in FIG. **5**, the first acceleration safety device **30** comprises a first setback weight **31** slidably disposed in a first setback weight chamber **22** defined by the system housing **20** (see FIG. **1**). In addition, the first acceleration safety device **30** comprises a pin **33** configured to be capable of operably engaging the arming switch **10** (by extending into the locking channel **10**C defined by the arming switch **10**, for example) so as to normally retain the arming switch **10** in the first position (see FIG. **8**, elements **33** and **10**C). In order to link the release of the pin **33** from the locking channel **10**C with the movement of the first setback weight **31** within the first setback weight chamber **22**, the first acceleration safety device **30** further comprises a first linkage arm **32** operably engaged between the first setback weight **31** and the pin **33** such that, as the first setback weight **31** slides within the first setback weight chamber **22** (in response to the acceleration force, for example), the first linkage arm **32** is configured to disengage the pin **33** from the arming switch **10** (or, more particularly, the locking channel **10**C that may be defined thereby) so as to allow the arming switch **10** to be moved to the second position (see, for example, FIG. **11**, showing the first acceleration device **30** and the proximity device **40** (described further herein) disengaged from the arming switch **10** such that the arming switch **10** is movable to the second "armed" position). As will be appreciated by one skilled in the art, in some embodiments, various characteristics of the first setback weight **31** (and other components of the first acceleration safety device **30**) may be selected such that the first setback weight **31** is configured to slide within the first setback weight chamber **22**, defined by the system housing **20**, in response to an acceleration force having a selected magnitude and a selected duration. Furthermore, as shown generally in FIG. **5**, the first acceleration device **30** may further comprise a cantilever spring **34** operably engaged between the first setback weight **31** and the system housing **20** so as to provide a selected amount of resistance to sliding movement of the first setback weight **31** within the first setback weight chamber **22** defined by the system housing **20**. Thus, in such embodiments, the characteristics (such as, for example, spring rate, stiffness, and/or other mechanical properties) of the cantilever spring **34** may be selected such that the cantilever spring **34**, in conjunction with the mechanical properties of the first setback weight **31**, allows the first setback weight **31** to slide within the first setback weight chamber **22** only in response to an acceleration force having a selected magnitude and a selected duration. Thus, the first acceleration safety device **30** may be configured only to allow arming of the explosive train (by disengaging the arming switch **10**, for example, as shown generally in FIG. **9**) in response to acceleration force intensity and/or duration that is indicative of an intentional launch of the projectile **100** (as opposed to relatively short-duration acceleration forces resulting from accidental drops and/or rough handling of the projectile **100**). Furthermore, in order to increase the likelihood that the first acceleration safety device **30** remains operable and robust for the projected storage life of the projectile **100**, the components thereof may be comprised of particularly selected materials for corrosion resistance and enhanced mechanical properties. For example, in some embodiments, the first setback weight **31** and the pin **33** may be formed of **303** stainless steel. Furthermore, in some embodiments, the first linkage arm **32** may be formed of aluminum or an aluminum alloy (such as, for example, 6061-T651 aluminum). By selecting the particular characteristics of the first setback weight **31**, cantilever spring **34**, the pin **33**, and/or the first linkage arm **32**, the embodiments of the SA system **1** may be configured such that projectiles having relatively low-g loads during launch may still be reliably armed without compromising the safing capabilities of an SA system **1** according to embodiments of the present invention. In other embodiments, the mass, weight, and or geometry of the first setback weight **31** may be customized for the specific launch conditions of the particular projectile **100** that is configured to carry the SA system **1** such that the first setback weight **31** is configured to initiate the disengagement of the pin **33** from the arming switch **10** (see FIG. **9**, for example) only in response to acceleration conditions that are indicative of an intentional launch of the projectile **100**.

[0042] As shown in FIG. **3**, the SA system **1** may further comprise a proximity safety device **40** carried by the system housing **20** (see FIG. **1**, showing an exploded view of the components of the proximity safety device **40** relative to the system housing **20**). As shown in FIG. **3**, the proximity safety device **40** (and/or a bore rider pin **44** thereof) is configured to be capable of operably engaging the arming switch **10** so as to normally retain the arming switch **10** in the first position. Furthermore, as shown generally in FIG. **2**, the proximity safety device **40** (and/or a bore rider pin **44** thereof) is further configured to sense an inner wall **201** of the launch bore **202** so as to allow the arming switch **10** to be moved to the second position (see FIG. **11**, for example) such that the explosive train is capable of being armed when the projectile **100** is launched from the launch bore **202**. The proximity safety device **40** may comprise, in some embodiments, a bore rider pin **44** biased radially outward from the system housing **20** so as to contact and therefore sense or detect the inner wall **201** defining the launch bore **202** when the projectile **100** is positioned within the launch bore **202**.

[0043] For example, as shown in FIGS. **3** and **5**, the proximity safety device **40** may comprise a bore rider pin **44** slidably disposed in a pin channel **20**A defined by the system housing **20** (see also, the cross-sectional schematics of the SA system **1** shown in FIGS. **8-11**). The bore rider pin **44** includes a first end **44**A configured to contact the inner wall **201** of the launch bore **202** and a second end **45** configured to engage the arming switch **10** (i.e. to extend into a locking channel **10**C defined therein) so as to normally retain the arming switch **10** in the first position (see FIG. **9**, for example) when the projectile **100** is disposed within the bore **202**. As shown in FIGS. **1** and **3**, the proximity safety device **40** may comprise a biasing element **41** (such as a coil spring, for example) operably engaged between the system housing **20** and the bore rider pin **44** (and/or a spring tab **46** extending outward from the bore rider pin **44**) so as to bias the bore rider pin **44** towards the inner wall **201** of the launch bore **202** such that, when the projectile **100** is launched from the launch bore **202**, the first (wall-sensing) end **44**A of the bore-rider pin **44** becomes unconstrained, and the second end **45** of the bore rider pin **44** disengages the arming switch **10** (as shown generally in FIG. **10**, for example) and such that the arming switch **10** is capable of being moved to the second position (as shown, for example, in FIG. **11**). According to some SA system **1** embodiments, the bore rider pin **44** (and the tab **42** and spring tab **46** extending therefrom) may be formed of corrosion-resistant and reliably-machined material so as to increase the reliability of the proximity safety device **40**. For example, in some embodiments, the bore rider pin **44** may be formed of 6061-T651 aluminum.

[0044] In other embodiments, the proximity safety device **40** may comprise one or more non-contact sensors configured to be capable of sensing the inner wall **201** of the launch bore **202**. For example, the proximity safety device **40** may comprise one or more optical sensors, magnetic sensors, piezoelectric elements, and/or other sensors or transducer devices configured to sense the inner wall **201** defining the launch bore **202**. Furthermore, the proximity safety device **40** (and/or one or more sensors thereof) may be in communication with an actuator device **50** configured to disengage the pin **44** from the locking channel **10**C defined by the arming switch **10** so as to allow the arming switch **10** to be moved to the second position when the proximity safety device **40** has determined that the projectile **100** has exited the launch bore **202**. As described further herein, various control elements may be in communication with an actuator device **50** in some embodiments of the SA system **1** to ensure that the arming switch **10** is not moved to the second (armed) position (see FIG. **11**, for example) until a selected time after the proximity safety device **40** has determined that the projectile **100** has exited the launch bore **202** (so as to ensure that the projectile **100** and/or an explosive train carried thereby will not be armed until the projectile **100** has reached a pre-determined "safe" distance from the launch bore **202**).

[0045] Thus, once the first acceleration safety device **30** and the proximity safety device **40** have been disengaged from the arming switch **10** (see FIGS. **9** and **10**, respectively); the arming switch **10** may be capable of being moved to the second position (as shown, for example, in FIG. **11**). In order to facilitate the movement of the arming switch **10** to the second (armed) position, the SA system **1**, as shown in FIGS. **1** and **3**, may further comprise an actuator device **50** operably engaged between the system housing **20** and the arming switch **10** and configured to be capable of moving the arming switch **10** from the first position to the second position in response to a signal, wherein the signal may be, for example, an electrical or other suitable signal. For example, as shown in FIG. **4**D, in some embodiments, the actuator device **50** may comprise one or more electromechanical piston actuators capable of extending a piston **51** to engage a bearing surface **10**A defined by a rotatable cylindrical arming switch **10** such that as the piston **51** extends, the arming switch **10** is moved from the first (safe) position (see FIG. **10**, for example) to the second (armed) position (see FIG. **11**, for example). In case of an accidental extension of the piston **51** while the first acceleration safety device **30** and the proximity safety device **40** are still engaged with the locking channel **10**C of the arming switch **10** (as shown, for example, in FIG. **8**), some embodiments of the SA system **1** may comprise an arming switch **10** defining a cutaway section **10**E behind the bearing surface **10**A such that the piston **51** may shear and/or penetrate the bearing surface **10**A if the actuator device **50** is initiated when at least one of the first acceleration safety device **30** and the proximity safety device **40** are still engaged with the locking channel **10**C of the arming switch **10**.

[0046] According to some additional embodiments, the arming switch **10** may be provided with additional safety features to reduce the risk of unintentional and/or accidental movement and/or rotation of the arming switch **10** from the first (safe) position to the second (armed) position. For example, cylindrical embodiments of the arming switch **10** (see FIGS. **4**A-**4**D, for example) may define a shear pin slot **10**D (defined off-center from the axis of the cylindrical arming switch **10**) for receiving a shear pin **14** (see FIGS. **1** and **3**). According to some SA system **1** embodiments, the shear pin **14** may extend through one or more apertures defined by the system housing **20** (and through the shear pin slot **10**D) for preventing the rotation of cylindrical arming switch **10** embodiments relative to the system housing **20** of the SA system **1**. Furthermore, the shear pin **14** may be configured to predictably fail in response to a torque generated by the action of the piston **51** (and/or other actuator device **50** component) on a bearing surface **10**A defined by the arming switch **10**.

[0047] According to various embodiments, the actuator device **50**, which is configured to move the arming switch **10** from the first position to the second (armed) position as shown in the sequential views of FIGS. **10** and **11**, may be in communication with one or more control devices configured to generate a signal that may be required to initiate movement of the actuator device **50**. The control devices may be disposed on a circuit board **80** that is operably engaged with the system housing **20** of the SA system **1** (see FIG. **1**). In addition (and as described further herein), the actuator **50** may comprise, for example, an electromechanical device or other suitable device configured to be in communication with one or more of the control devices via a wiring assembly **62** (see FIG. **7**, for example) configured to maintain a short circuit around the actuator device **50** so as to reduce the risk of the actuator device **50** unintentionally initiating the movement of the arming switch **10** to the second (armed) position. In other embodiments, as described herein, the actuator device **50** may be in communication with an optical sensor **43** (see FIGS. **1** and **3**) configured to be capable of generating the initiating signal in response to a change in detected ambient optical conditions. As described further herein, the optical sensor **43** may be included as part of and/or be coupled with the proximity safety device **40** such that the optical sensor **43** generates the initiating signal for the actuator device **50** only after a selected time has elapsed since the proximity safety device **40** no longer senses the inner wall **201** defining the launch bore **202**. Thus, the combination of the optical sensor **43** (and/or other control devices and/or wiring assemblies **62**, as described further herein), may provide secondary safeguards (to supplement, for example, the first acceleration safety device **30** and proximity safety device **40** described herein) against the accidental, premature, and/or unintentional arming of the explosive train carried by the projectile **100**. In addition, some SA system **1** embodiments, may further comprise one or more logic circuits carried by the circuit board **80** and configured to be in communication with the actuator device **50** and/or one or more of the first acceleration safety device **30** and the proximity safety device **40** to ensure that the mechanical disengagement of these devices from the arming switch **10** occurs according to a timing schedule and in an order that is indicative of an intentional launch event.

[0048] As shown, in FIGS. **3** and **6**, the proximity safety device **40** (and/or the bore rider pin **44** that may be included as part of the proximity safety device **40**) may further comprise a tab **42** configured to normally cover an optical sensor **43** in communication with the actuator device **50**. As described generally herein, and as shown, for example in FIGS. **8-11**, the optical sensor **43** may be operably engaged with the system housing **20** (and/or a circuit board **80** operably engaged therewith). Further, the tab **42** may be configured to uncover the optical sensor **43** when the projectile **100** is launched from the launch bore **202** such that the optical sensor **43** becomes capable of transmitting the signal to the actuator device **50** so that the actuator device **50** is capable of moving the arming switch **10** from the first position (see FIG. **10**, for example) to the second (armed) position (see FIG. **11**, for example) at a selected time after the projectile **100** is launched from the launch bore **202**. For example, as shown generally in FIGS. **8-11**, the tab **42** may be operably engaged with and/or integrated with the bore rider pin **44** of the proximity safety device **40**. Therefore, according to such embodiments, when the bore rider pin **44** loses contact with the inner wall **201** defining the launch bore **202**, the biasing element **41** urges the bore rider pin **44** outward from the system housing **20** (see FIG. **10**, for example) such that the tab **42** uncovers and/or removes a substantially opaque barrier between a light source (not shown) and a light detection device (not shown) that may be included as part of the optical sensor **43**. In response to the removal of the tab **42**, one skilled in the art will appreciate that the optical sensor **43** may transmit the signal to the actuator device **50** so as to initiate the movement of the arming switch **10** to the second (armed) position (as shown generally in FIG. **11**).

[0049] According to some additional embodiments, as shown generally in FIGS. **7**, **12** and **13**, the SA system **1** may further comprise a wiring assembly **62** disposed between the optical sensor **43** (and/or one or more of the control devices carried by the circuit board **80** of the SA system **1**) and the actuator device **50**. Furthermore, in some embodiments, the wiring assembly **62** may be disposed between an energy source (carried, for example, by the circuit board **80**) and a device configured to be capable of initiating the detonation of the explosive train (such as, for example, the detonator **11** carried by the arming switch **10**, as shown in FIGS. **4A-4C**). Thus, the wiring assembly **62** may be configured to normally provide and maintain a short circuit around the actuator device **50** so as to reduce the risk of the actuator device **50** unintentionally initiating movement of the arming switch **10** to the second (armed) position. In some embodiments, the wiring assembly **62** may be configured to normally provide and maintain a short circuit around the detonator **11** (or other explosive component of an explosive train carried by the projectile **100**) so as to reduce the risk of unintentionally actuating the explosive train (even if the arming switch **10** (and the detonator **11**, carried thereby) are substantially aligned with the explosive train of the projectile **100**). The wiring assembly **62** may comprise, in various SA system **1** embodiments, a normally closed switch (as shown, for example in FIG. **12**, showing a slider switch **66** normally in electrical contact with one or more contacts carried by the wiring assembly **62**). According to other SA system **1** embodiments, the wiring assembly **62** may comprise a substantially continuous set of electrical connections (established by wires, for example, as shown in FIG. **7**). According to various SA system **1** embodiments, the electrical connections (established by wires (see element **66**A) and/or contacts **66**B disposed on the slider switch **66**) may include, but are not limited to: a short circuit connection to ground for the signal transmitted between the optical sensor **43** and the actuator device **50**; a short circuit connection to ground for a detonator **11** arming signal; a short circuit connection to ground for a controller device (such as a chip and/or other controller carried by the circuit board **80**) configured to control the detonator **11**; and combinations of such electrical connections.

[0050] The wiring assembly **62** may thus serve as at least one component of a second acceleration safety device **60** (see exploded components of a second acceleration safety device **60** as shown, for example, in FIG. **7**). The various components of the second acceleration safety device **60** (including, for example, a second setback weight **61** and a second linkage arm **63**) may thus be configured to be capable disabling the wiring assembly **62** in response to the acceleration force of the projectile **100** such that a signal is capable of being transmitted to the actuator device **50** and/or detonator **11** in order to align the explosive train and/or actuate the explosive train only after the projectile **100** has experienced an acceleration force having a selected magnitude and duration. As described above with respect to the first acceleration safety device **30**, the second setback weight **61** of the second acceleration safety device **60** may comprise materials having a selected mass and/or density such that the second acceleration safety device **60** only disables the short circuit of the explosive train and/or actuator device **50** in response to acceleration force (produced by movement of the SA system **1** in the launch direction **300**, for example) having an intensity and/or duration that is indicative of an intentional launch of the projectile **100** (as opposed to relatively short-duration acceleration forces resulting from accidental drops and/or rough handling of the projectile **100**).

[0051] In some embodiments, as shown in FIG. **7** for example, the second acceleration safety device **60** may comprise a second setback weight **61** slidably disposed in a second setback weight chamber **27** defined by the system housing **20**. The second acceleration safety device **60** may, in some embodiments, further comprise a cutting device **65** configured to be capable of cutting one or more wires **66**A in the wiring assembly **62**. Furthermore, the cutting device **65** may be slidably disposed in a cutting channel (not shown) defined by the system housing **20** (and/or a cutting channel defined between two halves **62**A, **62**B of the wiring assembly **62**). In addition, the second acceleration safety device **60** may further comprise a second linkage arm **63** operably engaged between the second setback weight **61** and the cutting device **65** such that, as the second setback weight **61** slides within the second setback weight chamber **27** in response to the acceleration force, the second linkage arm **63** is configured to move the cutting device **65** within the cutting channel (via the interaction of a second linkage arm slot **63**B and a cutting device bearing element **65**B, for example) such that the cutting device **65** (and/or a cutting edge **65**A defined thereby) cuts at least one wire **66**A within the wiring assembly **62** so that a signal is capable of being transmitted to the actuator device **50** and/or the detonator **11**. As described herein with respect to the first setback weight **31** (provided as a component in some embodiments including a first acceleration safety device **30**), the second setback weight **61** may be configured to slide within the second setback weight chamber **27** in response to the acceleration force having a selected magnitude and a selected duration.

[0052] According to some additional embodiments, as shown in FIGS. **12-13**, the second setback weight **61** of the second acceleration safety device **60** may be configured to slide within the second setback weight chamber **27** in response to an acceleration force imparted on the SA system **1** such that the second setback weight **61** initiates the disconnection of a contact between a slider switch **66** and the wiring assembly **62**, via the second linkage arm **63**.

[0053] A method for safing and arming a projectile **100** including an explosive train, using an SA system **1** that may be disposed substantially adjacent to the explosive train, is further provided in additional embodiments described herein. As described herein with respect to FIG. **2**, the projectile **100** may be adapted to be launched from a launch bore **202**. According to one embodiment, the method comprises providing an arming switch **10** carried by a system housing **20**, wherein the arming switch **10** is configured to be capable of moving from a first position to a second position. The arming switch **10** is further configured to operably engage a detonator **11** (and/or carry a detonator **11**, as shown generally in FIG. **4**C, for example). Thus, when the arming switch **10** is in the first position (see FIG. **10**), the detonator **11** is substantially out of alignment with the explosive train, and when the arming switch **10** is in the second (armed) position (see FIG. **11**, for example), the detonator **11** is substantially aligned with the explosive train such that the explosive train is capable of being armed.

[0054] Such a method may further comprise securing the arming switch **10** in the first position so as to normally retain the arming switch **10** in the first position (see, for example, FIG. **8**), and then selectively releasing the arming switch **10** (see, for example, FIG. **10**) so as to allow the arming switch **10** to be moved to the second position (see, for example FIG. **11**). As described herein with respect to the various SA system **1** embodiments, the releasing step may be triggered by various intentional launch indicators that may include, but are not limited to: an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the projectile **100** by an acceleration of the projectile **100** with respect to the launch bore **202** during a launch of the projectile **100**; and a determination that the projectile **100** has been launched from the launch bore **202** (see FIG. **2**, for example).

[0055] As described herein with respect to the SA system **1** embodiments, the securing step described herein may be accomplished by two or more safety devices (which may be, in some embodiments, mechanically independent). For example, in some method embodiments, the securing step may comprise securing the arming switch **10** in the first position using a first acceleration safety device **30** carried by the system housing **20** and configured to be capable of operably engaging the arming switch **10** (and/or a locking channel **10**C defined therein, as shown in FIGS. **8-11**) so as to normally retain the arming switch **10** in the first (safe) position. The securing step may also further comprise securing the arming switch **10** in the first position using a proximity safety device **40** (which may comprise a bore rider pin **44**, as described in the SA system **1** embodiments) configured to be capable of operably engaging the arming switch **10** (and/or a locking channel **10**C defined therein, as shown in FIGS. **8-11**) so as to normally retain the arming switch **10** in the first (safe) position. As described further herein, the proximity safety device **40** may be configured to sense the inner wall **201** of the launch bore **202** such that the proximity safety device **40** disengages the arming switch **10** only at some selected time after the projectile **100** has exited the launch bore **202**.

[0056] As shown generally in FIG. **9**, the releasing step may further comprise disengaging a first acceleration safety device **30** from the arming switch **10** so as to allow the arming switch **10** to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration, with the acceleration force being imparted on the first acceleration safety device **30** (and/or the first setback weight **31** thereof) by an acceleration of the projectile **100** with respect to the launch bore **202** during a launch of the projectile **100**. In addition, the releasing step may also comprise, as shown in FIG. **9**, sensing the inner wall **201** of the launch bore **202** with a proximity safety device **40** (and/or the bore rider pin **44** included as part of the proximity safety device **40**, in some embodiments). According to such method embodiments, the releasing step may further comprise determining that the inner wall **201** is no longer sensed by the proximity safety device **40**, after disengaging the first acceleration device **30** from the arming switch **10** (see FIG. **9**); and disengaging the proximity safety device **40** (as shown in FIG. **10**, for example) from the arming switch **10** after the determining step so as to allow the arming switch **10** to be moved to the second position such that the explosive train is capable of being armed when the projectile **100** is launched from the launch bore **202**. As described herein with respect to some SA system **1** embodiments of the present invention, the proximity safety device **40** may comprise a bore rider pin **44** slidably disposed in a first pin channel **20**A defined by the system housing **20**. According to such embodiments, the method may further comprise (as shown in FIG. **9**): contacting the inner wall **201** of the launch bore **202** with a first end **44**A of the bore rider pin **44** when the projectile **100** is disposed within the launch bore **202**; and engaging a second end **45** of the bore rider pin **44** with the arming switch **10** (and/or a locking channel **10**C defined therein) so as to normally retain the arming switch **10** in the first position, when the projectile **100** is disposed within the launch bore **202**. In such method embodiments, the method may further comprise biasing the bore rider pin **44** towards the inner wall **201** of the launch bore **202** using a biasing element **41** (such as a coil spring, for example) operably engaged between the system housing **20** and the bore rider pin **44** (and/or a spring tab **46** extending outward from the bore rider pin **44**), such that when the projectile **100** is launched from the launch bore **202** (see FIG. **2**, for example), the first end **44**A of the bore rider pin **44** (see FIG. **10**, for example) becomes unconstrained, such that the second end **45** of the bore rider pin **44** disengages the arming switch **10** (and/or a locking channel **10**C defined therein) such that the arming switch **10** is capable of being moved to the second position and consequently such that the explosive train is capable of being armed.

[0057] As described herein with respect to some SA system **1** embodiments of the present invention, the proximity safety device **40** and the operation thereof may be coupled with an optical sensor **43** configured to be capable of transmitting a signal to initiate an arming sequence of the projectile **100** (i.e. by initiating the movement of an actuator device **50** to actuate the arming switch **10** (see FIG. **4**D, for example), and/or by initiating the generation of arming signals that may be transmitted to the detonator **11** carried by the arming switch **10**). According to such embodiments, as shown generally in FIG. **3**, the proximity safety device **40** (and/or a bore rider pin **44** included as a component of the proximity safety device **40**) may comprise a tab **42** configured to normally cover an optical sensor **43** in communication with the detonator **11** and/or the actuator device **50** (as described further herein). The optical sensor **43** may be operably engaged with the system housing **20** (and/or a circuit board **80** disposed therein). Thus, in such embodiments, the method may further comprise steps for moving the tab **42** so as to uncover the optical sensor **43** (and/or remove a substantially opaque barrier between a light source and a light detection device that may be included as part of the optical sensor **43**) when the projectile **100** is launched from the launch bore **202** (see FIGS. **9** and **10**, sequentially showing the movement of the tab **42** relative to the optical sensor **43** as the projectile **100** exits the launch bore **202**). Thus, once the tab **42** is removed, the optical sensor **43** is capable of transmitting the signal to the actuator device **50** and/or the detonator **11** for initiating the arming and/or actuation of the explosive train carried by the projectile **100**. Furthermore, the method may further comprise transmitting the signal from the optical sensor **43** to the actuator device **50** and/or detonator **11** such that the actuator device **50** is capable of moving the arming switch **10** from the first position (see, for example, FIG. **10**) to the second (armed) position (see FIG. **11**) at a selected time after the projectile **100** is launched from the launch bore **202**. Furthermore, the method embodiments of the present invention may also comprise, moving the arming switch **10** from the first (safe) position to the second (armed) position using an actuator device **50** operably engaged between the system housing **20** and the arming switch **10** (see, for example, FIG. **4**D (showing the contact between a piston **51** of the actuator device **50** and a bearing surface **10**B defined by a cutaway of the arming switch **10**) in response to a signal received by the actuator device **50**.

[0058] As described herein with respect to SA system **1** embodiments including a second acceleration safety device **60** (configured to be capable of disabling a normally short-circuited electrical pathway between a control device and a portion of the explosive train (and/or the actuator device **50**), for example), the providing step may further comprise providing a wiring assembly **62** (see, for example, FIGS. **7**, **12** and **13**) operably engaged with the system housing **20** and configured to be capable of short circuiting a signal suitable for actuating the explosive train and/or initiating movement of the actuator device **50**. According to such embodiments, the method may further comprise disabling the wiring assembly **62** (i.e. by cutting one or more wires, as shown in FIG. **7** and/or by disengaging a slider switch **66**B from the contacts on the wiring assembly **62** (as shown in FIGS. **12** and **13**)), in response to the acceleration force, using a second acceleration safety device **60** operably engaged with the system housing **20**, such that the signal is capable of being transmitted to the actuator device **50** and/or some portion of the explosive train carried by the projectile **100**. Following the disabling step, such method embodiments may further comprise a step for transmitting the signal to the actuator device **50** such that the actuator device **50** is capable of moving the arming switch **10** from the first (safe) position (see FIG. **10**) to the second (armed) position (see FIG. **11**. In some embodiments, the transmitting step may further comprise transmitting a signal from a control device carried by the system housing **20** (and/or a circuit board **80** disposed therein), wherein the signal is configured to be capable of actuating at least a portion of the explosive train (such as the detonator **11** carried by the arming switch **10**).

[0059] Many modifications and other embodiments of the system and method set forth herein will come to mind to one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A safing and arming system adapted to be operably engaged with a projectile including an explosive train, the projectile being adapted to be launched from a launch bore, the system comprising:

an arming switch configured to be movable from a first position to a second position, the arming switch being further configured to operably engage a detonator such that, when the arming switch is in the first position, the detonator operably engaged therewith is substantially out of alignment with the explosive train and such that, when the arming switch is in the second position, the detonator operably engaged therewith is substantially aligned with the explosive train such that the explosive train is capable of being armed;

a first acceleration safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the first acceleration safety device being further configured to disengage the arming switch so as to allow the arming switch to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile; and

a proximity safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the proximity safety device being further configured to sense an inner wall defining the launch bore so as to allow the arming switch to be moved to the second position, such that the explosive train is capable of being armed, when the projectile is launched from the launch bore.

2. A safing and arming system according to claim **1**, wherein the proximity safety device comprises:

a first pin slidably disposed in a first pin, the first pin including a first end configured to contact the inner wall of the launch bore and a second end configured to engage the arming switch so as to normally retain the arming switch in the first position when the projectile is disposed within the launch bore; and a biasing element operably engaged with the first pin, and configured to bias the first pin towards the inner wall of the launch bore such that, when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed.

3. A safing and arming system according to claim **1**, further comprising an actuator device operably engaged with the arming switch and configured to be capable of moving the arming switch from the first position to the second position in response to a signal.

4. A safing and arming system according to claim **3**, wherein the proximity safety device further comprises a tab configured to normally cover an optical sensor in communication with the detonator, the tab being configured to uncover the optical sensor when the projectile is launched from the launch bore such that the optical sensor is capable of transmitting the signal to the actuator device so that the actuator device is capable of moving the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

5. A safing and arming system according to claim **3**, further comprising:

a wiring assembly configured to short circuit the signal to prevent the signal from being transmitted to the actuator device; and

a second acceleration safety device configured to be capable of disabling the wiring assembly in response to the acceleration force such that the signal is capable of being transmitted to the actuator device.

6. A safing and arming system according to claim **1**, wherein the arming switch comprises a rotatable cylinder having a central axis and defining an arming channel extending radially outward from the central axis, the arming channel being configured to receive the detonator such that, as the rotatable cylinder is rotated from the first position to the second position, the detonator becomes substantially aligned with the explosive train so that the explosive train is capable of being armed.

7. A safing and arming system according to claim **1**, wherein the first acceleration safety device comprises:

a first setback weight slidably disposed in a first setback weight chamber;

a second pin configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position; and

a first linkage arm operably engaged between the first setback weight and the second pin such that, as the first setback weight slides within the first setback weight chamber in response to the acceleration force, the first linkage arm is configured to disengage the second pin from the arming switch so as to allow the arming switch to be moved to the second position.

8. A safing and arming device according to claim **7**, wherein the first setback weight is configured to slide within the first setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

9. A safing and arming system according to claim **5**, wherein the second acceleration safety device comprises:

a second setback weight slidably disposed in a second setback weight chamber;

a cutting device slidably disposed in a cutting channel; and

a second linkage arm operably engaged between the second setback weight and the cutting device such that, as the second setback weight slides within the second setback weight chamber in response to the acceleration force, the second linkage arm is configured to move the cutting device within the cutting channel such that the cutting device cuts at least one wire within the wiring assembly so that the signal is capable of being transmitted to the actuator device.

10. A safing and arming device according to claim **9**, wherein the second setback weight is configured to slide within the second setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

11. A safing and arming system according to claim **5**, wherein the wiring assembly comprises electrical connections selected from the group consisting of:

a short circuit connection to ground for the signal;

a short circuit connection to ground for a detonator arming signal;

a short circuit connection to ground for an electronic controller configured to control the detonator; and

combinations thereof.

12. A safing and arming system adapted to be operably engaged with a projectile including an explosive train, the projectile being adapted to be launched from a launch bore, the system comprising:

an arming switch configured to be movable from a first position to a second position, the arming switch being further configured to operably engage a detonator such that, when the arming switch is in the first position, the detonator operably engaged therewith is substantially out of alignment with the explosive train and such that, when the arming switch is in the second position, the detonator operably engaged therewith is substantially aligned with the explosive train such that the explosive train is capable of being armed;

an actuator device operably engaged with the arming switch and configured to move the arming switch from the first position to the second position in response to a signal; and

a proximity safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the proximity safety device being further configured to sense an inner wall defining the launch bore so as to allow the arming switch to be moved to the second position when the projectile is launched from the launch bore, such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed, the proximity safety device further comprising a tab configured to normally cover an optical sensor in communication with the detonator, the tab being configured to uncover the optical sensor when the projectile is launched from the launch bore such that the optical sensor is capable of transmitting the signal to the actuator device so that the actuator device is capable of moving the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

13. A safing and arming system according to claim **12**, wherein the proximity safety device further comprises:

a first pin slidably disposed in a first pin channel, the first pin including a first end configured to contact the inner wall of the launch bore, the first pin also including a second end configured to engage the arming switch so as to normally retain the arming switch in the first position, the tab being configured to extend from the first pin so as to normally cover the optical sensor in communication with the detonator when the projectile is disposed within the launch bore; and

a biasing element operably engaged with the first pin, and configured to bias the first pin towards the inner wall of the launch bore such that, when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch so that the actuator device is capable of moving the arming switch to the second position, such that the explosive train in capable of being armed and such that the tab uncovers the optical sensor so that the optical sensor is capable of transmitting the signal to the actuator device to move the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

14. A safing and arming system according to claim **12**, further comprising a first acceleration safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the first acceleration safety device being further configured to disengage the arming switch in response to an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile.

15. A safing and arming system according to claim **12**, further comprising:

a wiring assembly configured to short circuit the signal to prevent the signal from being transmitted to the actuator device; and

a second acceleration safety device configured to be capable of disabling the wiring assembly in response to a force having a selected magnitude and a selected duration, imparted on the second acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile such that the signal is capable of being transmitted to the actuator device.

16. A safing and arming system according to claim **12**, wherein the arming switch comprises a rotatable cylinder having a central axis and defining an arming channel extending radially outward from the central axis, the arming channel being configured to receive the detonator such that, as the rotatable cylinder is rotated from the first position to the second position, the detonator becomes substantially aligned with the explosive train so that the explosive train is capable of being armed.

17. A safing and arming system according to claim **14**, wherein the first acceleration safety device comprises:

a first setback weight slidably disposed in a first setback weight chamber;

a second pin configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position; and

a first linkage arm operably engaged between the first setback weight and the second pin such that, as the first setback weight slides within the first setback weight chamber in response to the acceleration force, the first linkage arm is configured to disengage the second pin from the arming switch so as to allow the arming switch to be moved to the second position.

18. A safing and arming device according to claim **17**, wherein the first setback weight is configured to slide within the first setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

19. A safing and arming system according to claim **15**, wherein the second acceleration safety device comprises:

a second setback weight slidably disposed in a second setback weight chamber;

a cutting device slidably disposed in a cutting channel; and

a second linkage arm operably engaged between the second setback weight and the cutting device such that, as the second setback weight slides within the second setback weight chamber in response to the acceleration force, the second linkage arm is configured to move the cutting device within the cutting channel such that the cutting device cuts at least one wire within the wiring assembly so that the signal is capable of being transmitted to the actuator device.

20. A safing and arming device according to claim **19**, wherein the second setback weight is configured to slide within the second setback weight chamber in response to the acceleration force having the selected magnitude and the selected duration.

21. A safing and arming system according to claim **15**, wherein the wiring assembly comprises electrical connections selected from the group consisting of:

a short circuit connection to ground for the signal;

a short circuit connection to ground for a detonator arming signal;

a short circuit connection to ground for an electronic controller configured to control the detonator; and

combinations thereof.

22. A method for safing and arming a projectile including an explosive train, using a safing and arming system, the projectile being adapted to be launched from a launch bore, the method comprising:

securing an arming switch in a first position so as to normally retain the arming switch in the first position, the arming switch being configured to be movable from the first position to a second position, and to operably engage a detonator such that, when the arming switch is in the first position, the detonator operably engaged therewith is substantially out of alignment with the explosive train and such that, when the arming switch is in the second position, the detonator operably engaged therewith is substantially aligned with the explosive train such that the explosive train is capable of being armed;

releasing the arming switch so as to allow the arming switch to be moved to the second position, the arming switch being released in response to:

an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the projectile by an acceleration of the projectile with respect to the launch bore during a launch of the projectile; and

a determination that the projectile has been launched from the launch bore.

23. A method according to claim **22**, wherein the securing step further comprises:

securing the arming switch in the first position with a first acceleration safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position; and

securing the arming switch in the first position with a proximity safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the proximity safety device being further configured to sense an inner wall defining the launch bore.

24. A method according to claim **22**, wherein the releasing step further comprises:

disengaging a first acceleration safety device from the arming switch so as to allow the arming switch to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile;

sensing the inner wall of the launch bore with a proximity safety device;

determining when the inner wall is no longer sensed by the proximity safety device, after disengaging the first acceleration safety device from the arming switch; and

disengaging the proximity safety device from the arming switch after the determining step so as to allow the arming switch to be moved to the second position such that the explosive train is capable of being armed when the projectile is launched from the launch bore.

25. A method according to claim **24**, wherein the proximity safety device comprises a first pin slidably disposed in a first pin channel, and the method further comprises:

contacting an inner wall of the launch bore with a first end of the first pin when the projectile is disposed within the bore;

engaging a second end of the first pin with the arming switch so as to normally retain the arming switch in the first position when the projectile is disposed within the bore; and

biasing the first pin towards the inner wall of the launch bore, with a biasing element operably engaged therewith, such that, when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed.

26. A method according to claim **24**, further comprising moving the arming switch from the first position to the second position, with an actuator device operably engaged therewith, in response to a signal received by the actuator device.

27. A method according to claim **26**, wherein the proximity safety device comprises a tab configured to normally cover an optical sensor in communication with the detonator and the actuator device, and the method further comprises:

moving the tab so as to uncover the optical sensor when the projectile is launched from the launch bore such that the optical sensor is capable of transmitting the signal to the actuator device; and

transmitting the signal from the optical sensor to the actuator device such that the actuator device is capable of moving the arming switch from the first position to the second position at a selected time after the projectile is launched from the launch bore.

28. A method according to claim **26**, further comprising:

Normally short-circuiting the signal with a wiring assembly to prevent the signal from being transmitted to the actuator device;

disabling the wiring assembly in response to the acceleration force with a second acceleration safety device such that the signal is capable of being transmitted to the actuator device; and

transmitting the signal to the actuator device such that the actuator device is capable of moving the arming switch from the first position to the second position.

29. A method for safing and arming a projectile including an explosive train, using a safing and arming system, the projectile being adapted to be launched from a launch bore, the method comprising:

securing an arming switch in a first position so as to normally retain the arming switch in the first position, the arming switch being configured to be movable from the first position to a second position, and to operably engage a detonator such that, when the arming switch is in the first position, the detonator operably engaged therewith is substantially out of alignment with the explosive train and such that, when the arming switch is in the second position, the detonator operably engaged therewith is substantially aligned with the explosive train such that the explosive train is capable of being armed;

determining when the projectile has exited the launch bore;

releasing the arming switch so as to allow the arming switch to be moved to the second position after a selected time period following the determining step;

uncovering an optical sensor configured to transmit a signal;

transmitting the signal to an actuator device operably engaged with the arming switch; and

moving the arming switch from the first position to the second position with the actuator device, in response to the transmitted signal, at a selected time after the transmitting step.

30. A method according to claim **29**, wherein the securing step further comprises securing the arming switch in the first position with a proximity safety device configured to be capable of operably engaging the arming switch so as to normally retain the arming switch in the first position, the proximity safety device further comprising a tab configured to normally cover an optical sensor in communication with the detonator, the proximity safety device being further configured to sense an inner wall of the launch bore.

31. A method according to claim **30**, further comprising:

determining when the inner wall of the launch bore is no longer sensed by the proximity safety device;

disengaging the proximity safety device from the arming switch after the determining step so as to allow the arming switch to be moved to the second position such that the explosive train is capable of being armed when the projectile is launched from the launch bore; and

moving the tab so as to uncover the optical sensor such that the optical sensor is capable of transmitting the signal.

32. A method according to claim **30**, further comprising:

contacting the inner wall of the launch bore with a first end of a first pin when the projectile is disposed within the launch bore, the first pin being slidably disposed in a first pin channel defined by the system and having the tab operably engaged therewith;

engaging a second end of the first pin with the arming switch so as to normally retain the arming switch in the first position when the projectile is disposed within the launch bore; and

biasing the first pin towards the inner wall of the launch bore, with a biasing element operably engaged with the first pin such that, when the projectile is launched from the launch bore, the first end of the first pin becomes unconstrained, and the second end of the first pin disengages the arming switch such that the arming switch is capable of being moved to the second position so that the explosive train is capable of being armed.

33. A method according to claim **29**, further comprising:

securing the arming switch in the first position with a first acceleration safety device; and

disengaging the first acceleration safety device from the arming switch so as to allow the arming switch to be moved to the second position, in response to an acceleration force having a selected magnitude and a selected duration, the acceleration force being imparted on the first acceleration safety device by an acceleration of the projectile with respect to the launch bore during a launch of the projectile.

34. A method according to claim **29**, further comprising:

Normally short-circuiting the signal with a wiring assembly to prevent the signal from being transmitted to the actuator device;

disabling the wiring assembly in response to the acceleration force with a second acceleration safety device such that the signal is capable of being transmitted to the actuator device; and

transmitting the signal to the actuator device such that the actuator device is capable of moving the arming switch from the first position to the second position.

35. A method according to claim **34**, wherein the disabling step comprises cutting at least one wire within the wiring assembly such that the signal is capable of being transmitted to the actuator device.

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