APPARATUS AND METHOD FOR THE PROTECTION OF A VEHICLE FROM ROCKET-PROPELLED GRENADES

Inventors: Stuart N. Rosenwasser, Washington, DC (US); Arie Zigler, Washington, DC (US); Yeshayahu Goldstein, Gaithersburg, MD (US); Todd David Lockwood, Alexandria, VA (US); William Kellner, Lovettsville, VA (US); Peter J. Lohr, Morganton, VA (US)

Appl. No.: 12/308,453
PCT Filed: Jul. 31, 2007
PCT No.: PCT/US2007/017108
§ 371 (c)(1), (2), (4) Date: Jan. 21, 2011

An apparatus for protecting a vehicle having a body from a rocket-propelled grenade (RPG), comprising a panel comprised of a plurality of spaced, generally parallel bars positioned in spaced outward relation to said body of said vehicle.
APPARATUS AND METHOD FOR THE PROTECTION OF A VEHICLE FROM ROCKET-PROPELLED GRENADES

CROSS REFERENCE TO RELATED CASE

[0001] The present invention is related to and claims the benefit of PCT/US2007/17108 filed Jul. 31, 2007 and of U.S. Provisional patent application No. 60/834,389, filed on Jul. 31, 2006, and entitled “Apparatus And Method For The Protection Of A Vehicle From Rocket-Propelled Grenades (RPGs).”

BACKGROUND OF THE INVENTION

[0002] 1. Field Of The Invention
[0003] The present invention relates to armaments and more particularly to apparatus and methods for the protection of a vehicle from a rocket-propelled grenade (RPG).

[0004] 2. Brief Description Of Prior Developments
[0005] RPGs are a class of generally shoulder-fired weapons having a shaped explosive charge and which are propelled by a rocket against heavily armored, lightly armored, and unarmored vehicles, bunkers or other fortified positions, and other targets.

[0006] Because the shaped explosive charge concentrates the force of the detonated explosive, RPGs are a serious threat to both armored and unarmored vehicles. The prior art suggests a number of methods and apparatus, either active or passive, which may be effective in providing protection for vehicles from RPGs. Several previous passive methods have utilized arrays of round steel bars or slats. However these apparatus are too heavy for many vehicles, do not achieve full effectiveness in protecting the vehicle and its occupants, suffer extensive damage after an encounter, and are difficult to repair and maintain.

[0007] A need, therefore, still exists for an improved highly effective, light weight, low cost apparatus and method for the protection for vehicles from RPGs.

SUMMARY OF INVENTION

[0008] The present invention is an apparatus for protecting a vehicle having a body from a rocket-propelled grenade (RPG), comprising one or more panels comprised of a plurality of spaced, generally parallel bars positioned in spaced outward relation to said body of said vehicle.

[0009] The present invention also encompasses a method for protecting a vehicle having a body from a rocket-propelled grenade (RPG) comprising the step of positioning one or more panels comprised of a plurality of spaced generally parallel bars in spaced outward relation to said vehicle. The panels are designed to achieve maximum theoretical effectiveness while minimizing weight, damage to the adjacent structure, and operational interferences while simplifying repair.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention is further described with reference to the accompanying drawings wherein:
[0011] FIG. 1 is a perspective view of a vehicle equipped with the RPG defense system of the present invention;
[0012] FIG. 2 is a side-elevational view of a vehicle equipped with the RPG defense system shown in FIG. 1;
[0013] FIG. 3a and FIG. 3b are views of the vehicle shown in FIG. 2 in which the RPG defense system is shown respectively in its deployed and its collapsed position;
[0014] FIG. 4 is a schematic drawing showing the operation of the system of the present invention to cause the shaped explosive charge in an RPG to be disabled from detonating;
[0015] FIGS. 5A-5D depict illustrative embodiments of a bushing according to one embodiment of the invention.
[0016] FIG. 6A depicts an illustrative embodiment of fencing employing multiple panels to completely surround a vehicle according to one embodiment of the invention.
[0017] FIG. 6B depicts an illustrative embodiment of fencing employing multiple panels to completely surround a vehicle according to one embodiment of the invention.
[0018] FIGS. 7A and 7B depict a hinge according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Referring to FIGS. 1 and 2, there is shown a vehicle 10 with a body 12. The vehicle 10 shown is a military Humvee utility vehicle, but it will be understood by those skilled in the art that the system of this invention may be adapted for use on military engineering vehicles as well as on many other types of heavily or lightly armored military vehicles or unarmored military vehicles or on civilian vehicles. On one side of the vehicle there is a front door 14 and a rear door 16. On the opposite side of the vehicle 10 there is also a front door 18 and a side door 20. Spaced outwardly from the doors 14, 16, 18 and 20 there are respectively panels 22, 24, 26 and 28.

[0020] Referring, for example, to panel 22, each of the panels includes a plurality of spaced, parallel horizontal bars as at horizontal bars 30 and 32. As will be described in greater detail below, each of these horizontal bars, as at bars 30 and 32, is preferably cross sectionally square or otherwise cross sectionally rectangular or otherwise has at least one angular feature on its outer side, including a triangular or other polygonal shape. According to one embodiment, the horizontal bars are implemented as ½ inch square high strength aluminum alloy bars with a 2¼ inch spacing between horizontal bars, although other sizes and spacings may be used, including a 3° spacing. Additionally, other materials may be used, such as steel, carbon fiber, and/or high strength aluminum alloys, including 7075-T6 aluminum.

[0021] Each of the horizontal bars is attached to two spaced parallel vertical bars 34 and 36, which may be spaced at apart at regular or irregular amounts. According to one embodiment, the spacing may be in the range of 16 inches to 36 inches, though smaller or larger spacings may be used. The panels are each also suspended from four horizontal posts as at posts 36, 40, 42 and 44 in the case of panel 22. The panel 22 is also pivotally attached to the posts. For example, post 38 is attached to the body 12 at pivot 46 and is attached to the panel 22 at pivot 48. The horizontal bars may be deployed at a distance from the vehicle to permit sufficient breakup of the RPG prior to impact with the vehicle. The range of spacing from the outside of the vehicle can be a long as desired. In general it should not be too close to the vehicle. According to one embodiment of the invention, the spacing between the horizontal bars and the vehicle is between 8-12 inches. A larger spacing may be used.

[0022] In addition to the protection provided by the horizontal and vertical bar modular fencing sections, further protection may be provided by providing a shock attenuating...
backup layer on the outside of the vehicle. The layer may be comprised of metal or a composite honeycomb, multi-layer fiber reinforced polymer matrix composites, such as Kevlar (Aramid fibers), Spectra or Dynenea (polyethylene fibers). This attenuating layer may be used to attenuate peak pressure in the explosive caused by collision of an RPG with the vehicle surface, which decreases the probability of initiation of a high order rapid deflagration of the residual explosive. The shock attenuating backup layer may not be required on vehicles already equipped with heavy armor plates.

As is shown in FIGS. 3a and 3b, the panels as, for example, panels 22 and 24 may be pivotable upwardly and inwardly from the lower deployed position, respectively at 50 and 52 to upper collapsed positions 54 and 56, respectively. It will be understood that the upper collapsed positions 54 and 56 provided a reduced transverse dimension to allow easier maneuvering of the vehicle 10 in, for example, tight spaces. The collapsible feature of the invention also allows for ease of stage and transport of the vehicle with which the system is used. There is also a one-inch aluminum honeycomb attenuator 58 over the armored vehicle doors. This additional attenuator and the armor works with the system of this invention to protect the vehicle occupants from the doded RPG impact and blast effects.

The vertical members may also be secured to a horizontal portion of the vehicle, or other portions of the vehicle, without a pivot connection. This may be particularly useful for portions of the vehicle that do not need to be accessed regularly, such as the front or rear portions of the vehicle or non-doored side portions of the vehicle.

According to one embodiment of the invention, the horizontal bars are secured to the vertical bars using bushings. The bushings help to prevent or minimize rotation of the horizontal bars upon RPG impact and permit deformation and movement of a horizontal bar through the vertical support upon impact with a RPG, blast debris, or fragments. This serves to minimize transfer of load and subsequent deformation and damage of the vertical support members and overall structure. According to one embodiment, the bushings are designed to break away, during impact, to further reduce transfer of impact loads to support structure. This may be accomplished by using a material that is strong enough to withstand vehicle operation loads but less strong than the vertical and horizontal members. Examples include polymer materials such as Delrin, Nylon, or other injection moldable or castable plastics.

One embodiment of a bushing is shown in FIGS. 5A-5D. Referring to FIG. 5A, the bushing 500 includes an inner cavity that fits around a horizontal bar. The inner cavity accommodates the shape of the horizontal bar to facilitate attachment to it. In addition, the vertical bars may include features to facilitate attachment of the bushings, including holes, including D shaped holes. According to one embodiment, the inner cavity is a ½ inch square and fits around ½ inch square horizontal bars. Each horizontal bar is inserted through the inner hole in the bushing and is secured by friction. In one embodiment stop screws (ADD-FIG. 3a and 3b, #9) inserted near the ends of each horizontal bar are employed to prevent the bars from shifting horizontally during operation and to secure the bushings to the vertical member. In another embodiment, clamps on the protruding length of selected horizontal bars, adjacent to and outside the vertical member, may be used to stabilize the assembly.

To facilitate deployment, according to one embodiment of the invention, sets of the horizontal and vertical bars may be made to accommodate particular vehicles or multiple vehicles. The sets may be configured to have the same cross sections, so that multiple horizontal and vertical members and bushings may be stacked in predetermined lengths so that when they break as a result of a RPG or other incident, the broken pieces may be removed and new pieces put in place. This allows for 80-90% commonality of hardware and assemblies between different vehicles. Each vehicle may require different attachment members to pivotally connect modular fencing sections of horizontal and vertical bars to the vehicle or to secure the modular fencing sections without a pivotal connection to other parts of a vehicle. Additional sections may be attached with hinged sections to permit the effective width of the vehicle to be reduced when maneuvering in tight quarters. This also facilitates crew ingress and egress and access to parts of the vehicle that need frequent access.

FIGS. 7A and 7B depict a hinge according to an embodiment of the present invention. Referring to FIGS. 7A and 7B, the hinge includes hinges 700, a hinge spring plate 710, a pin hinge 720, a cotter pin 730, a flat washer 740, a hinge spring 750 and bolts and nuts 760. The hinges 700 are U shaped and attach to one another via the pin hinge 720 and cotter pin. A pair of hinge spring plates attach to the hinges and are used to secure the hinge spring 750. The bolts and nuts are used to secure the hinge spring plate to the hinges. The hinges themselves attach to the vehicle and to horizontal or vertical bars to facilitate opening and closing of sections of fencing. The hinges may be attached using any of the techniques referenced herein. It will be understood that beyond pins and nuts and bolts, other fasteners and fastening techniques and pivotal connections may be used. For example, detents, rivets, welding, adhesive, screws and/or other techniques may be used.

According to one embodiment of the invention, the modular fencing system is mechanically assembled and does not require any welding, thus eliminating softening of a heat treated vehicle hull and/ or armor plates, which tends to reduce blast protection capability of a hull. Rather, the fencing sections are secured to a vehicle using bolts. Beyond bolts, other fasteners or fastening techniques may be used, including clamps, removable pins, utilizing either ball detents or cotter pins, allow easy securing of the fencing sections to the vehicle and release of hinged doors or total removal of selected sections where required.

FIGS. 6A and 6B are illustrative views of additional vehicles with modular fencing systems according to embodiments of the present invention.

Operation

Referring to FIG. 4, the operation of the RPG defense system of the present invention is shown. An RPG is shown generally at 60 and includes a piezoelectric nose initiator 62, an outer ogive 64, an inner ogive 66, a shaped charge cone 68, a shaped explosive charge 70, and a base detonator 72. The system of the present invention which interacts with the PRG includes a horizontal bar 74 which is cross sectionally square and which has consequently outer angular features 76 and 78. As described above the system also includes other spaced, parallel horizontal bars as at bar 80 which is also cross sectionally square and which consequently has outer angular features 82 and 84.
As is conventional, when an RPG hits a target (not shown) the piezoelectric nose initiator 62 would produce an electric current which would be transmitted to the detonator 72 which detonates the explosive charge 70. In the case shown in FIG. 4, however, the outer ogive 64 contacts angular feature 82 of horizontal bar 80 so as to deform the outer ogive 64 to cause it to contact inner ogive 66 to short-circuit current produced at piezoelectric nose initiator 62 and thereby disable the means for detonating the explosive 70.

It will be appreciated that a lightweight, low-cost and effective RPG defense system for lightly armored and engineering vehicles as well as other vehicles which operate by disabling the RPG shaped charge electronic fusing circuit has been described. This system also works with the existing vehicle armor and optional attenuation to protect occupants from RPG impact and blast effects. The system is also field installable and maintainable. The system may also be made removal or collapsible. The system will also have a minimal effect on driver visibility.

While the present invention has been described in connection with the preferred embodiments of the various figures, it is to be understood that other similar embodiments may be used or modifications or additions may be made to the described embodiment for performing the same function of the present invention without deviating therefrom. Therefore, the present invention should not be limited to any single embodiment, but rather construed in breadth and scope in accordance with the recitation of the appended claims.

What is claimed is:

1. An apparatus for protecting a vehicle having a body from a rocket-propelled grenade (RPG), comprising:
   a panel comprised of a plurality of spaced, generally parallel bars positioned in spaced outward relation to said body of said vehicle.
2. The apparatus of claim 1 wherein the apparatus includes means for suspending the panel in spaced outward relation to said body of said vehicle.
3. The apparatus of claim 2 wherein the means for suspending the panel in spaced outward relation to said body of said vehicle comprises at least one post extending outwardly from said vehicle.
4. The apparatus of claim 3 wherein means are provided to pivot the post from a first horizontal position to a second canted position.
5. The apparatus of claim 4 wherein when the post is in the first horizontal position the panel is in a deployed position wherein the entire panel is in spaced outward adjacent relation to the body of the vehicle, and when the post is in the second canted position the panel is in a collapsed position wherein at least part of the panel is not positioned in spaced outward adjacent relation to the body of the vehicle.
6. The apparatus of claim 5 wherein the deployed position adjacent the body is a lower position and the collapsed position is an upper position.
7. The apparatus of claim 6 wherein the vehicle has a front side door and said panel is positioned adjacent said front door.
8. The apparatus of claim 7 wherein the vehicle also has a rear side door and there is a panel comprised of a plurality of spaced bars outwardly adjacent the rear door.
9. The apparatus of claim 8 wherein the vehicle has a second pair of front and rear side doors and there are a pair of panels comprised of a plurality of spaced bars outwardly adjacent the rear door in said second pair of front and rear side doors.
10. The apparatus of claim 1 wherein each of the bars has an angled feature.
11. The apparatus of claim 10 wherein the bars are cross-sectionally rectangular.
12. The apparatus of claim 11 wherein the bars are cross-sectionally square.
13. The apparatus of claim 1 wherein the RPG has a transverse dimension and the bars are spaced at a distance of less than said transverse dimension.
14. The apparatus of claim 1 wherein the bars are horizontal.
15. The apparatus of claim 14 wherein each of the horizontal bars is attached to at least one vertical bar.
16. The apparatus of claim 15 wherein there are a pair of parallel vertical bars and each of the horizontal bars is attached to both of said pair of vertical bars.
17. The apparatus of claim 1 wherein an attenuator and armor is interposed between the panel and the body of the vehicle.
18. A method for protecting a vehicle having a body from a rocket-propelled grenade (RPG) comprising the step of:
   positioning a panel composed of a plurality of spaced generally parallel bars in spaced outward relation to said vehicle.
19. The method of claim 18 wherein the rocket-propelled grenade (RPG) has a front piezoelectric element, an inner and outer ogive, an interior shaped explosive and a rearward detonator and the front piezoelectric element extends between two adjacent bars and at least one of said bars bends the outer ogive to contact the inner ogive to prevent detonation of the shaped explosive.
20. The method of claim 19 wherein the bars have at least one angled feature.
21. An apparatus for protecting a vehicle, comprising:
   horizontal members having:
   vertical members capable of being secured to a vehicle;
   bushings capable of securing the horizontal members to the vertical members;
   wherein the bushings are designed to break away upon impact by an armament and be sufficiently rigid to ensure detonation of the armament upon impact and to reduce transfer of impact loads to the vertical members and reduce the deformation of the vertical members.
22. The apparatus according to claim 21, wherein the horizontal members have at least three angular edges and wherein the bushings reduce rotation of the horizontal members.
23. The apparatus according to claim 22, wherein the horizontal and vertical members are comprised of a high strength aluminum alloy.
24. The apparatus according to claim 22, wherein the horizontal members are comprised of a carbon fiber reinforced composite.
25. The apparatus according to claim 22, wherein the horizontal and vertical members comprise a modular fencing system capable of being attached to the vehicle.
26. The apparatus according to claim 22, further comprising a shock attenuating layer that is capable of attachment to the vehicle to attenuate peak pressure in an explosion caused by collision of a rocket propelled grenade with the vehicle surface.
27. The apparatus according to claim 26, wherein the shock attenuating layer comprises at least one of a metal honeycomb, a composite honeycomb, and multi-layer fiber reinforced polymer matrix composites.
28. The apparatus according to claim 22, further comprising hinges capable of attachment to the vehicle and at least two vertical members to permit moving the horizontal and vertical members closer to the vehicle surface when required.

29. The apparatus according to claim 22, further comprising mounting hardware for affixing the vertical members to the vehicle.

30. The apparatus according to claim 29, wherein the mounting hardware and vertical members are attached to the vehicle using at least one of bolts and screws.

31. The apparatus according to claim 22, wherein the bushings include an internal hole that accommodates one of the horizontal members.

32. The apparatus according to claim 31, wherein the bushings include an external flat surface that facilitates securing to one of the vertical members.

33. The apparatus according to claim 31, wherein the bushing is comprised of a molded polymer material.

34. The apparatus according to claim 29, wherein the mounting hardware includes clamps.

35. The apparatus according to claim 25, further comprising hinges to rotatably secure modular sections to the vehicle to permit a section to operate as a door.