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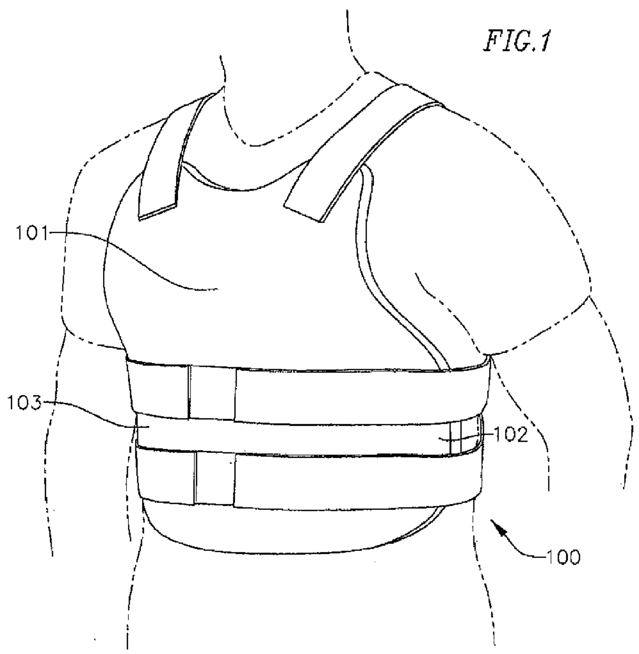
(54) **Title**: BULLET PROOF VEST

FIG.1



(57) Abstract: A flexible bullet proof vest configured to absorb and dissipate the energy from a projectile and percussion waves is provided. In one embodiment, the bullet proof vest includes a gel substrate panel having a front surface and a rear surface opposite the front surface, and a plurality of ballistic-grade sheets stacked on the front surface of the gel substrate gel.

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BULLET PROOF VEST

FIELD OF THE INVENTION

[0001] The present invention relates generally to ballistics protection apparatuses, and more particularly to a bullet proof vest.

BACKGROUND

[0002] Ballistics protection apparatuses, such as bullet proof vests, are commonly worn by military and law enforcement personnel during high-risk operations. Conventional ballistics protection apparatuses are configured to prevent ballistics, such as bullets and shrapnel, from penetrating the apparatus. Conventional light-weight bullet proof vests are configured to protect a user against lower-power weapons, such as 9mm handguns and .357 Magnums. However, such conventional light-weight bullet proof vests provide inadequate protection against high-powered weapons. In order to protect against higher-powered weapons, such as a .44 Magnum and a 9mm sub-machine gun, conventional ballistics protection apparatuses rely upon multiple additional layers of Kevlar, which makes the bullet proof vest heavy and bulky. Additionally, some conventional bullet proof vests rely upon metal plate inserts to protect against high-powered weapons, which add considerable weight to the vest and thereby limits the mobility and agility of the user. Conventional bullet proof vests also offer insufficient protection against percussive blasts (i.e., conventional bullet proof vests do not offer adequate sound pressure level reduction).

SUMMARY

[0003] The present invention relates generally to ballistics protection apparatuses, and more particularly to a ballistics-grade article and a bullet proof vest configured to absorb and dissipate the energy from projectiles, percussion waves, and heat sources. In one embodiment, the ballistics-grade article includes a gel substrate panel having a front surface and a rear surface opposite the front surface and a plurality of ballistic-grade sheets stacked on the front surface of the gel substrate panel. Each of the plurality of ballistic-grade sheets may include ultra-high molecular weight polyethylene (UHMwPE) fibers. The UHMwPE fibers may be either unidirectionally oriented fibers or a micro-weave of interconnected longitudinal fibers and transverse fibers. In one embodiment, the article includes forty ballistic-grade sheets. In one embodiment, the gel substrate panel includes polyurethane and a catalyst. In an embodiment in which the gel substrate panel has a thickness of approximately 3/8 inch, the article is configured to provide a sound pressure level reduction of approximately 166 decibels. In one embodiment, the article further includes front and rear panels coupled together around the gel substrate and the plurality of ballistic-grade sheets. The front and rear panels can be made of polyvinylchloride (PVC). In one embodiment, when

the article is struck with a .22 caliber projectile at a velocity of approximately 1430 feet per second, the article experiences a maximum g-force of approximately 90.5G. In one embodiment, when the article is struck with a .44 Magnum semi-jacketed hollow point projectile at a velocity of approximately 1430 feet per second, the article is configured to yield a back-face deformation of less than approximately 38mm.

[0004] In one embodiment, the bullet proof vest includes a carrier configured to be worn by a user and an insert configured to be received in the carrier. The insert includes a gel substrate panel having a front surface and a rear surface opposite the front surface and a plurality of ballistic-grade sheets stacked on the front surface of the gel substrate panel. In one embodiment, the insert also includes front and rear panels coupled together around the gel substrate panel and the plurality of ballistic-grade sheets. In one embodiment, the gel substrate panel is configured to provide a sound pressure level reduction of approximately 166 decibels. In one embodiment, when the bullet proof vest is struck with a .44 Magnum semi-jacketed hollow point projectile at a velocity of approximately 1430 feet per second, the bullet proof vest is configured to yield a back-face deformation of less than approximately 38mm. In one embodiment, when the bullet proof vest is struck with a .22 caliber projectile at a velocity of approximately 1430 feet per second, the bullet proof vest experiences a maximum g-force of approximately 90.5 G.

[0005] A method of manufacturing a bullet proof vest is also provided. In one embodiment, the method includes cutting a roll of ballistic-grade fabric into a plurality of ballistic-grade sheets, providing a gel panel having a front surface and a rear surface opposite the front surface, and stacking the plurality of ballistic-grade sheets on the front surface of the gel panel. Each of the plurality of ballistic-grade sheets may include ultra-high molecular weight polyethylene (UHMwPE) fibers oriented either unidirectionally oriented or as a micro-weave of interconnected longitudinal fibers and transverse fibers. In one embodiment, the method also includes providing a front panel, providing a rear panel, and coupling the front and rear panels together around the plurality of sheets and the gel panel to define a composite insert. The front and rear panels can be coupled together by radio frequency welding. In one embodiment, the method also includes providing a carrier configured to be worn by a user and inserting the composite insert into the carrier.

[0006] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of a bullet proof vest according to the present invention are described with reference to the following figures. The same reference numerals are used throughout the figures to reference like features and components. The figures are not necessarily drawn to scale.

[0008] FIG. 1 is a perspective view of a bullet proof vest according to one embodiment of the present invention;

[0009] FIGS. 2A and 2B are a cross-sectional view and an enlarged portion of the cross-sectional view, respectively, of the bullet proof vest of FIG. 1;

[0010] FIG. 3 is a comparative chart illustrating the test results of bullet proof vest of the present invention and a fabric article; and

[0011] FIG. 4 is a flowchart illustrating the tasks of manufacturing the bullet proof vest of FIG. 1 according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0012] The present invention is directed to a flexible, light-weight, high-density bullet proof vest. The bullet proof vest of the present invention is configured to absorb and dissipate the kinetic energy of high-powered projectiles striking the bullet proof vest. The bullet proof vest is also configured to absorb and dissipate percussive energy (e.g., a shock wave) and thereby protect the user from nearby explosives or other concussive devices. Moreover, the bullet proof vest is a thermal insulator configured to protect the user in extreme temperatures.

[0013] In FIG. 1, a user is illustrated wearing a bullet proof vest **100** according to one embodiment of the present invention. The bullet proof vest **100** includes a generally rectangular body portion **101** and two flaps **102, 103** extending outward from opposite sides of the body portion **101**. As illustrated in FIG. 1, the body portion **101** is configured to extend approximately from the user's shoulders down to the user's waist, and the flaps **102, 103** are configured to at least partially wrap around the sides of the user's torso. In one embodiment, the body portion **101** is approximately 12 inches wide and approximately 16.5 inches long, and each of the flaps **102, 103** is approximately 4.75 inches wide and approximately 8.5 inches long. It will be appreciated, however, that the present invention is not limited to the dimensions recited above, and any other suitable dimensions may be selected based upon the size of the user and the desired coverage area. In one embodiment in which the bullet proof vest **100** is constructed according to the above-referenced dimensions, the bullet proof vest **100** weighs approximately 7 pounds.

[0014] With reference now to the cross-section illustrated in FIGS. 2A and 2B, the bullet proof vest **100** includes a plurality of ballistic-grade sheets **104**, a gel substrate panel **105**, front and rear panels **106, 107**, respectively, and a carrier **108** configured to be worn by a user. In the illustrated embodiment, the gel substrate **105** includes a front surface **109** and a rear surface **110** opposite the front surface **109**. The ballistic sheets **104** are stacked on the front surface **109** of the gel substrate **105**. Together, the front and rear panels **106, 107** are configured to encapsulate the gel substrate **105** and the ballistic sheets **104**. The front panel

106 is stacked on top of the ballistic-grade sheets 104 and the rear panel 107 abuts the rear surface 110 of the gel substrate 105.

[0015] With continued reference to FIGS. 2A and 2B, the front and rear panels **106, 107** are coupled together, thereby defining an interior cavity **111** housing the gel substrate panel **105** and the ballistic sheets **104** (i.e., the gel substrate panel **105** and the ballistic sheets **104** are encapsulated between the front and rear panels **106, 107**). The front and rear panels **106, 107** may be coupled together by any suitable means, such as welding (e.g., radio frequency welding or friction stir welding), bonding, or mechanically fastening. In one embodiment, the front and rear panels **106, 107** are seam welded together along their respective peripheries. In one embodiment, the front and rear panels **106, 107** are polyvinylchloride (PVC) panels having a 20 gauge thickness, although it will be appreciated that the panels **106, 107** may have any other suitable thickness, such as between 10 gauge and 40 gauge. Together, the gel substrate **105**, the ballistic sheets **104**, and the front and rear panels **106, 107** define a composite insert **112** configured to be inserted into a pocket in the ballistic-rated carrier **108**. The ballistic-rated carrier **108** may be made from any suitably durable material, such as nylon. In one embodiment, the ballistic-rated carrier **108** is CORDURA fabric sold by Invista, with its corporate headquarters located in Wichita, Kansas, U.S.A.

[0016] In one embodiment, each of the ballistic sheets **104** includes ultra-high molecular weight polyethylene (UHMwPE) fibers. The polyethylene fibers may oriented either uni-directionally or in a micro-weave having a plurality of interconnected longitudinal fibers and transverse fibers. In one embodiment, the ballistic sheets **104** are DYNEEMA unidirectional (UD) sheets sold by Koninklijke DSM N.V., with its corporate headquarters located at Het Overloon 1, 6411 TE Heerlen, the Netherlands. In one embodiment, the ballistic sheets **104** include nano-fibers. In one embodiment, the bullet proof vest **100** includes forty ballistic sheets **104**, although it will be appreciated that any other suitable number of ballistic sheets **104** may be used depending upon the desired ballistics rating level of the bullet proof vest **100**.

[0017] The gel substrate panel **105** (also referred to herein as a "blunt force trauma panel (BFTP)") is configured to absorb and dissipate the energy from projectiles, percussion waves (e.g, explosive device), and heat sources. In one embodiment, the gel panel **105** has an elastic limit of approximately 250 ft-lbs per square inch, although it will be appreciated that the gel panel **105** may have any other suitable elastic limit, depending upon the desired ballistics rating of the bullet proof vest **100**, and still fall within the scope and spirit of the present invention. The gel panel **105** also has a high chemical resistivity to a variety of chemicals, including hydrocarbons and acids. In one embodiment, the gel panel **105** has a melting point of approximately 850°F and a freezing point of approximately -150° F (i.e., the BFTP is configured to maintain its gel-like consistency between approximately -150° F and 850°F). The gel panel **105** is also flash-flame proof and configured to withstand 0 Kelvin.

Additionally, the gel panel **105** is configured to act as a thermal insulator (i.e., the gel panel **105** has a low thermal conductivity). The gel panel **105** is also configured to be "self-healing" such that the gel flows into any areas damaged by a projectile (i.e., the gel is configured to fill any voids caused by a projectile striking the bullet proof vest **100**). The gel panel **105** is configured to maintain its adhesive properties up until approximately 185°F. The gel panel **105** is also anti-bacterial and inert to the human anatomy. The gel panel **105** is also gas impermeable and hydrophobic. In one embodiment, the gel panel **105** comprises polyurethane and a catalyst. In one embodiment, the gel panel **105** is MITgel sold by Moor Innovative Technologies, LLC, 2011 State Avenue NE, Olympia, Washington 98506.

[0018] The gel panel **105** may have a thickness ranging between approximately 1/4 inch and 1/2 inch depending upon the desired ballistics rating level of the bullet proof vest **100**. In one embodiment, the gel panel **105** has a thickness of 3/8 inch. In an embodiment of the bullet proof vest **100** in which the gel panel **105** is 3/8 inches thick, the bullet proof vest **100** has a noise reduction rating (NRR) or sound pressure level (SPL) reduction of approximately 166 decibels ("dBs") (i.e., the intensity of a sound pressure wave will be reduced by approximately 166 dBs after passing through a 3/8 inch thick gel panel **105**).

[0019] The bullet proof vest **100** of the present invention was tested in accordance with the U.S. National Institute of Justice ("NIJ") standard NIJ-STD-0101.06 Level IIIA (abbreviated, modified). The tests were conducted in an indoor range with the muzzle of the test barrel mounted 16.5 feet from the target bullet proof vest **100**. The test barrel was also positioned at various oblique angles relative to the front surface of the target bullet proof vest **100**. The projectile velocity was measured 8.25 feet from the target bullet proof vest **100** by four infrared velocity light screens operating in conjunction with time-based frequency counters. Penetrations were determined by examining a 5.5-inch thick clay block mounted behind the target bullet proof vest **100**. When the projectile strikes the target bullet proof vest **100** and does not penetrate the bullet proof vest **100**, the impact of the projectile can make a depression in the clay block placed behind the bullet proof vest **100**. The depth of the depression in the clay block is known as back-face deformation ("BFD"). The tests were conducted using .44 Magnum, 240 grain ("gr."), semi-jacketed hollow point ("SJHP") bullets having a velocity of 1430 feet per second ("fps") +/- 30 fps. The results of the tests conducted on two test samples (A and B) are summarized in Table 1 below. As shown in Table 1, the tested bullet proof vests **100** met or exceeded the requirements for a ballistics rating of NIJ Level IIIA.

Test Sample	**Shot No.**	**Ballistic Threat**				**Results**		
		Projectile Weight (gr.)	Powder Weight (gr.)	Obliquity (deg.)	Velocity (feet/sec)	Penetration	BFD (mm)	Pass/Fail

A	1	240.2	12.7	0°	1440	Partial	30.40	Pass
A	2	240.0	12.7	0°	1418	Partial	30.50	Pass
A	3	240.5	12.7	0°	1416	Partial	30.55	Pass
A	4	240.1	12.8	30°	1434	Partial	-	Pass
A	5	240.1	12.8	45°	1448	Partial	-	Pass
A	6	240.4	12.8	0°	1448	Partial	20.82	Pass
B	1	239.3	12.8	0°	1462	Partial	31.63	Pass
B	2	238.9	12.7	0°	1418	Partial	33.56	Pass
B	3	239.1	12.7	0°	1445	Partial	37.56	Pass
B	4	238.7	12.8	30°	1437	Partial	-	Pass
B	5	240.1	12.8	45°	1429	Partial	-	Pass
B	6	240.5	12.8	0°	1439	Partial	19.03	Pass

Table 1

[0020] The bullet proof vest **100** of the present invention was also tested and compared against a vest having forty ballistic sheets **104** comprised of UHMwPE fibers, but without the gel layer **105**. The results of the test are depicted in FIG. 3. Specifically, FIG. 3 depicts the g-loading experienced by the bullet proof vest **100** compared against the g-loading experienced by the vest without the gel panel **105** when stuck by a projectile. The test was performed using .22 to .762 X 39 caliber ballistic projectiles travelling at a velocity of approximately 1430 fps +/- 30 fps. As illustrated in FIG. 3, the vest without the gel panel **105** experienced a maximum load of 829.40 G at the time of impact. In contrast, the bullet proof vest **100** of the present invention experienced 22.52 G at the time of impact and a maximum load of 90.59 G at 2ms after initial impact. A g-load of 90.59 G corresponds to the user experiencing a back-face signature ("BFS") of approximately 0.25 inches at the area of impact. Additionally, the vest without the gel panel **105** experienced a very narrow g-load peak, indicating that the load imparted by the projectile was not well dispersed along the surface of the ballistic sheets **104** (i.e., the load was localized to the area of impact). In contrast, the g-load peak experienced by the bullet proof vest **100** of the present invention is relatively wide, which indicates that the load was well dispersed across and throughout the gel layer **105**. Moreover, the gel panel **105** acts as a dampener. As illustrated in FIG. 3, the bullet proof vest **100** of the present invention experienced no g-loading 10ms after the projectile was fired, whereas the vest having only the ballistic sheets **104** continued to experience an oscillating g-load over 18ms after the projectile was fired.

[0021] With reference now to FIG. 4, a method **200** of manufacturing the bullet proof vest **100** of the present invention will be described. In one embodiment, the method **200** includes a task **205** of cutting a roll of polyethylene into a plurality of ballistic sheets **104** having a desired shape and size. The desired shape and size of the ballistic sheets **104** is based upon the size of the intended user and the desired protection area. In one embodiment, the polyethylene roll includes ultra-high molecular weight polyethylene (UHMwPE) fibers oriented either unidirectionally or in a micro-weave of interconnected longitudinal fibers and transverse fibers. In one embodiment, the method **200** includes a task **210** of verifying the correct grain orientation of the fibers of the micro-weave or unidirectional UHMwPE fibers. The method **200** also includes a task **215** of stacking the desired number of ballistic sheets **104**, based upon the desired ballistics rating of the bullet proof vest **100**. In one embodiment, the desired number of ballistic sheets **104** is forty, although it will be appreciated that the bullet proof vest **100** may include any other suitable number of ballistic sheets **104**. The method **200** also includes a task **220** of providing a gel substrate panel **105** (i.e., a blunt force trauma panel (BFTP)) having the desired ballistic protection properties. The gel substrate panel **105** may have a thickness between 1/4" and 1/2", such as 3/8 inch thick. In one embodiment, the method **200** includes verifying the desired properties of the gel panel **105**, such as size, thickness, weight, and density. The method **200** also includes a task **225** of providing two panels **106**, **107** (i.e., a front panel and a rear panel) having a desired thickness, size, and shape. In one embodiment, the panels are polyvinylchloride (PVC) panels having a 20 gauge thickness.

[0022] The method **200** also includes a task **230** of coupling the front and rear panels **106**, **107** together around the gel panel **105** and the ballistic sheets **104** to form a composite insert **112**. In one embodiment, the task **230** of coupling the front and rear panels **106**, **107** together includes a task **235** of placing the rear panel **107** in a radio-frequency (RF) seam welding tool. The task **230** of coupling the front and rear panels **106**, **107** also includes a task **240** of placing the gel substrate panel **105** on the rear panel **107** in the RF tool and a task **245** of placing the stack of ballistic sheets **104** on the front surface **109** of the gel panel **105**. The task **230** of coupling the front and rear panels **106**, **107** together also includes a task **250** of placing the front panel **106** on top of the ballistic sheets **104** and a task **255** of actuating the RF tool to weld the front and rear panels **106**, **107** together, thereby encapsulating the gel panel **105** and the ballistic sheets **104** between the front and rear panels **106**, **107**. Together, the gel substrate panel **105**, the ballistic sheets **104**, and the front and rear panels **106**, **107** define a composite insert **112**. The method **200** may also include a task **260** of inserting the composite insert **112** into a pocket in a ballistics-grade carrier **108** configured to be worn by a user.

[0023] While in one embodiment, the method **200** of manufacturing the bullet proof vest **100** may include each of the tasks described above and shown in FIG. 4, in other embodiments of the present invention, one or more of the tasks described above and shown in FIG. 4 may be absent and/or additional tasks may be performed. Furthermore, in the method of manufacturing the bullet proof vest **100** according to one embodiment, the tasks may be performed in the order depicted in FIG. 4. However, the present invention is not limited thereto and, in a method of manufacturing the bullet proof vest **100** according to other embodiments of the present invention, the tasks described above and shown in FIG. 4 may be performed in any other suitable sequence. For example, in one embodiment, the task **205** of cutting the polyethylene roll into a plurality of ballistic sheets **104** is performed before the task **220** of providing the gel substrate panel **105**, while in an alternate embodiment, the task **220** of providing the gel substrate panel **105** is performed before the task **205** of cutting the polyethylene roll into a plurality of ballistic sheets **104**.

[0024] While this invention has been described in detail with particular references to exemplary embodiments thereof, the exemplary embodiments described herein are not intended to be exhaustive or to limit the scope of the invention to the exact forms disclosed. Persons skilled in the art and technology to which this invention pertains will appreciate that alterations and changes in the described structures and methods of assembly and operation can be practiced without meaningfully departing from the principles, spirit, and scope of this invention, as set forth in the following claims. Although relative terms such as "outer," "inner," "upper," "lower," "below," and "above," and similar terms have been used herein to describe a spatial relationship of one element to another, it is understood that these terms are intended to encompass different orientations of the various elements and components of the device in addition to the orientation depicted in the figures.

WHAT IS CLAIMED IS:

1. An article configured to absorb and dissipate the energy from a projectile and percussion waves, the article comprising:

a gel substrate panel having a front surface and a rear surface opposite the front surface; and

a plurality of ballistic-grade sheets stacked on the front surface of the gel substrate panel.

2. The article of claim 1, wherein each of the plurality of ballistic-grade sheets comprises ultra-high molecular weight polyethylene (UHMwPE) fibers.

3. The article of claim 2, wherein the UHMwPE fibers are selected from the group consisting of unidirectional fibers and a micro-weave of interconnected longitudinal fibers and transverse fibers.

4. The article of claim 1, wherein the article comprises forty ballistic-grade sheets.

5. The article of claim 1, wherein the gel substrate panel comprises polyurethane and a catalyst.

6. The article of claim 1, further comprising:

a front panel; and

a rear panel, wherein the front and rear panels are coupled together around the gel substrate and the plurality of ballistic-grade sheets.

7. The article of claim 6, wherein the front and rear panels comprise polyvinylchloride (PVC).

8. The article of claim 1, wherein the gel substrate panel has a thickness of approximately 3/8 inch.

9. The article of claim 8, wherein the gel substrate panel is configured to provide a sound pressure level reduction of approximately 166 decibels.

10. The article of claim 1, wherein, when the article is struck with a .22 caliber projectile at a velocity of approximately 1430 feet per second, the article experiences a maximum g-force of approximately 90.5g.

11. The article of claim 1, wherein, when the article is struck with a .44 Magnum semi-jacketed hollow point projectile at a velocity of approximately 1430 feet per second, the article is configured to yield a back-face deformation of less than approximately 38mm.

12. A bullet proof vest comprising:
a carrier configured to be worn by a user; and
an insert configured to be received in the carrier, the insert comprising:
a gel substrate panel having a front surface and a rear surface opposite the front surface; and
a plurality of ballistic-grade sheets stacked on the front surface of the gel substrate panel.

13. The bullet proof vest of claim 12, wherein the insert further comprises:
a front panel; and
a rear panel, wherein the front and rear panels are coupled together around the gel substrate and the at least one ballistic-grade sheet.

14. The bullet proof vest of claim 12, wherein the gel substrate panel is configured to provide a sound pressure level reduction of approximately 166 decibels.

15. The bullet proof vest of claim 12, wherein, when the bullet proof vest is struck with a .44 Magnum semi-jacketed hollow point projectile at a velocity of approximately 1430 feet per second, the bullet proof vest is configured to yield a back-face deformation of less than approximately 38mm.

16. The bullet proof vest of claim 12, wherein, when the bullet proof vest is struck with a .22 caliber projectile at a velocity of approximately 1430 feet per second, the bullet proof vest experiences a maximum g-force of approximately 90.5 G.

17. A method of manufacturing a bullet proof vest, the method comprising:
cutting a roll of ballistic-grade fabric into a plurality of ballistic-grade sheets;
providing a gel panel having a front surface and a rear surface opposite the front surface; and
stacking the plurality of ballistic-grade sheets on the front surface of the gel panel.

18. The method of claim 17, further comprising:
providing a front panel;

providing a rear panel; and

coupling the front and rear panels together around the plurality of sheets and the gel panel to define a composite insert.

19. The method of claim 18, wherein coupling the front and rear panels comprises radio frequency welding the front and rear panels together.

20. The method of claim 18, wherein each of the plurality of sheets comprises ultra-high molecular weight polyethylene (UHMwPE) fibers.

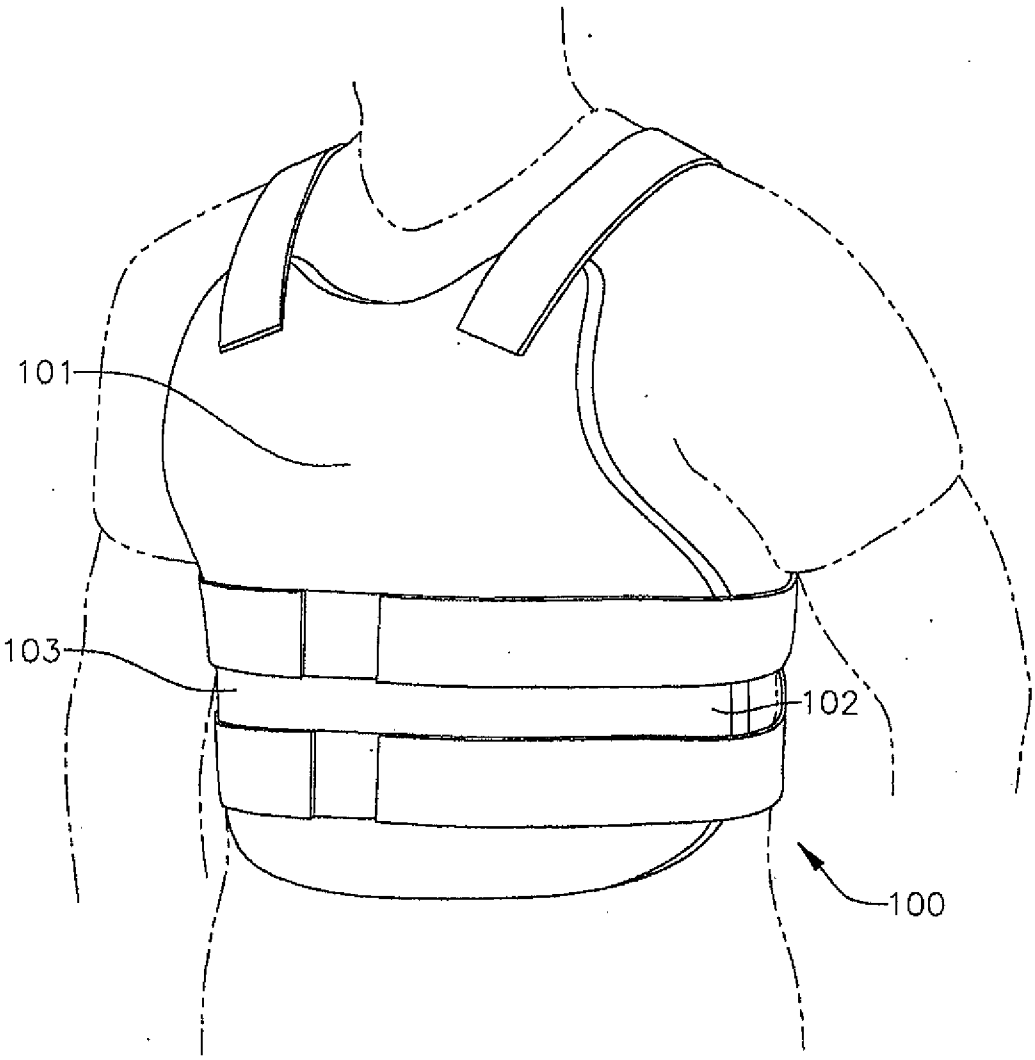
21. The method of claim 18, further comprising:

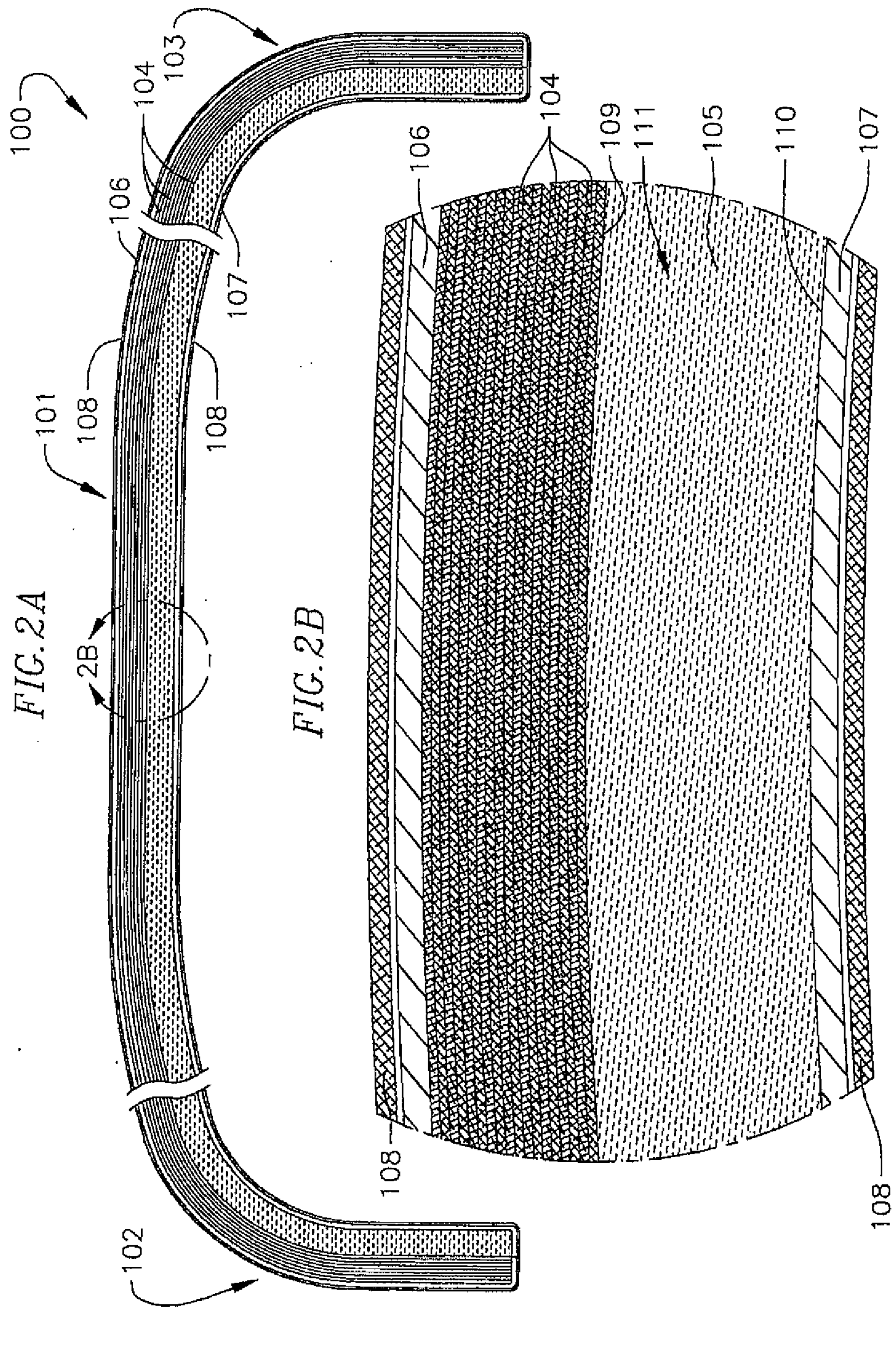
providing a carrier configured to be worn by a user; and

inserting the composite insert into the carrier.

22. The method of claim 18, wherein the gel panel is hydrophobic.

FIG.1




100
101
102
103
104
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2B
104
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111
105
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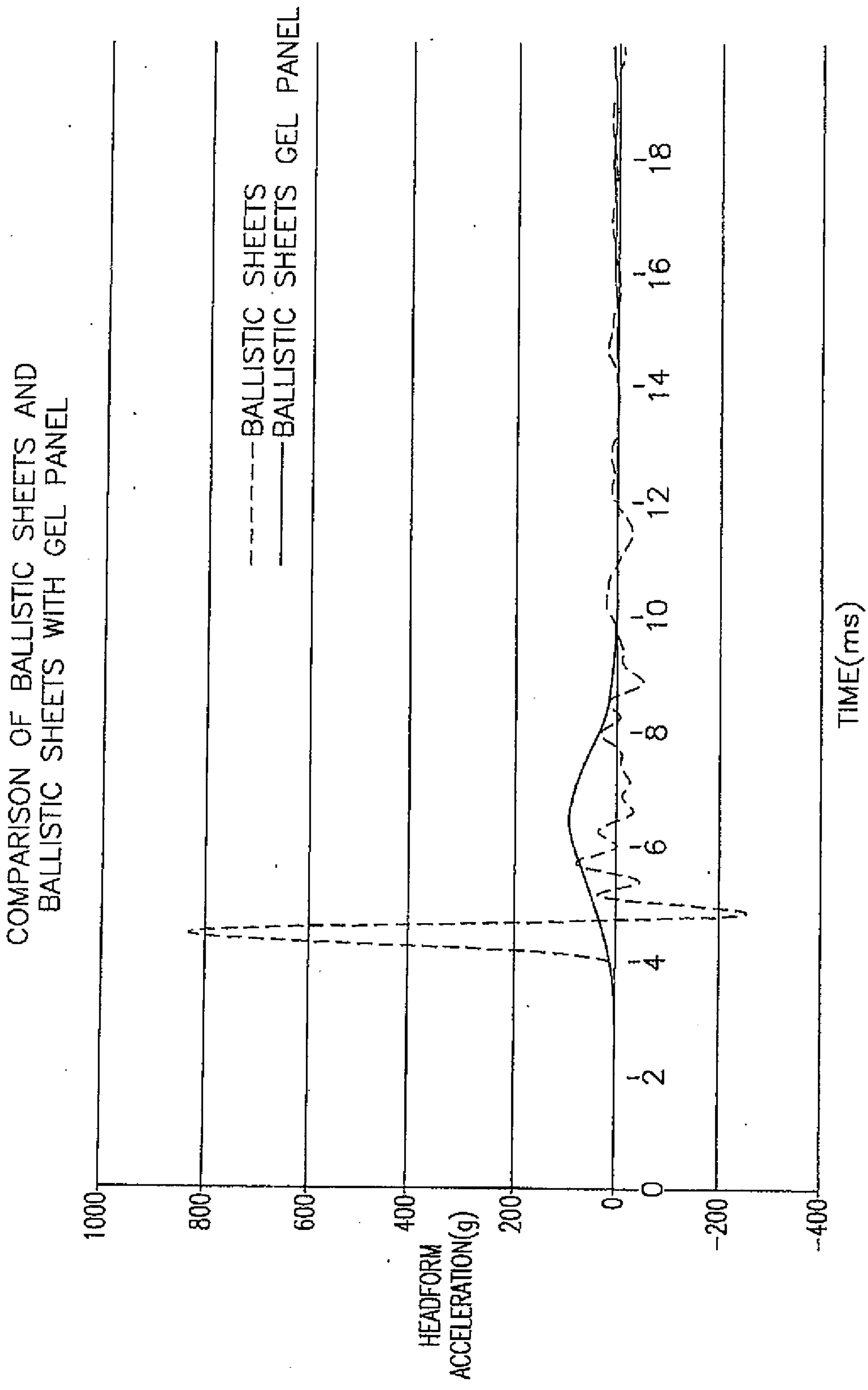
107
108

FIG. 2A

FIG. 2B

FIG. 3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BALLISTIC SHEETS WITH GEL PANEL
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TIME(ms)

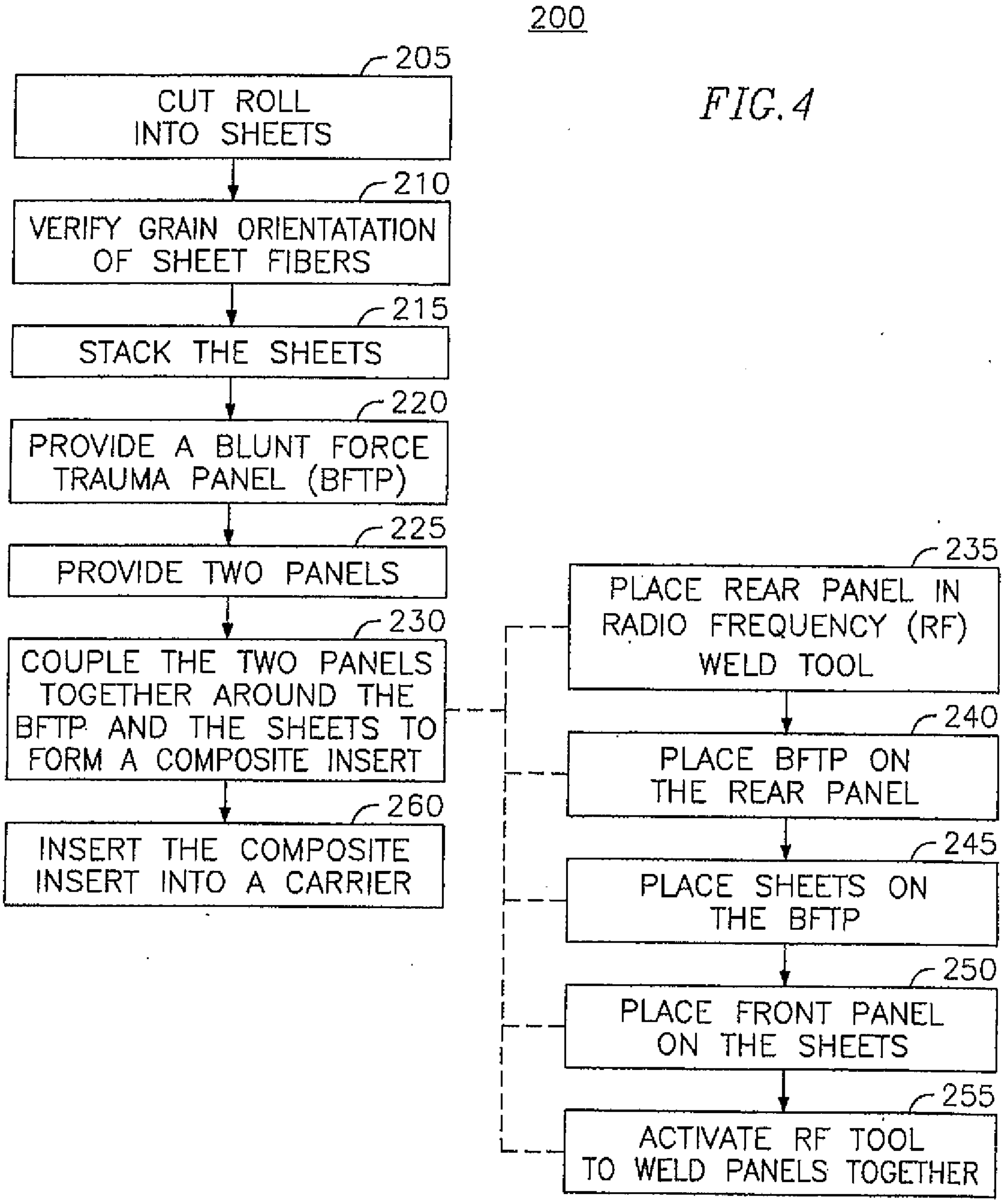
200
205
CUT ROLL INTO SHEETS
210
VERIFY GRAIN ORIENTATATION OF SHEET FIBERS
215
STACK THE SHEETS
220
PROVIDE A BLUNT FORCE TRAUMA PANEL (BFTP)
225
PROVIDE TWO PANELS
230
COUPLE THE TWO PANELS TOGETHER AROUND THE BFTP AND THE SHEETS TO FORM A COMPOSITE INSERT
260
INSERT THE COMPOSITE INSERT INTO A CARRIER
235
PLACE REAR PANEL IN RADIO FREQUENCY (RF) WELD TOOL
240
PLACE BFTP ON THE REAR PANEL
245
PLACE SHEETS ON THE BFTP
250
PLACE FRONT PANEL ON THE SHEETS
255
ACTIVATE RF TOOL TO WELD PANELS TOGETHER

FIG. 4