

PASSIVE ROOF ARMOR

BACKGROUND OF THE INVENTION

The present invention relates generally to passive armor.

5 In the prior art, armor for the roof of military vehicles were unable to defeat bomblet type threats.

SUMMARY OF THE INVENTION

10 It is an object of the invention to provide a roof armor that is able to defeat bomblet type or other multihit threats.

It is another object of the invention to provide a lighter and more efficient passive armor.

The invention provides a unique configuration of layers of glass, steal, ceramic and epoxy, that provides an efficient passive armor.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cut away view of a preferred embodiment of the invention.

20 Figure 2 illustrates an enlarged view part of the embodiment illustrated in Figure 1.

Figure 3 is another cut away view of the embodiment illustrated in Figure 1 along lines 3-3.

Figure 4 is a cut away view of the embodiment illustrated in Figure 1, with additional covering.

25 Figure 5 is a view of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A passive armor system 10, as shown in Figures 1 through 4, comprises first base plate 12, a second base plate 13, a plurality of armor stacks 14,

a cover box 15, a plurality of bolts 16, and an outer skin 17. Such a passive armor system 10 may be used on a military vehicle or a shelter.

In the manufacture of the preferred embodiment the plurality of armor stacks 14 are assembled. Figure 2 provides a detailed view of an armor stack of the plurality of armor stacks 14. In the assembly of an armor stack, a first layer of adhesive 20 is applied to a first side of a tile 19. A first sheet of glass 21, is placed on the first layer of adhesive 20 so that a first side of the first sheet of glass 21 is contiguous with the first layer of adhesive 20 as shown, and with the first layer of adhesive 20 between the first side of the ceramic tile 19 and the first side of the first sheet of glass 21. A second layer of adhesive 22 is placed on a second side of the first sheet of glass 21. A first side of a second sheet of glass 23 is placed on the second layer of adhesive 22. A third layer of adhesive 24 is placed on a second side of the second sheet of glass 23. A first side of a third sheet of glass 25 is placed on the third layer of adhesive 24. In the preferred embodiment, the tile 19 is a ceramic tile which is made of silicon carbide. The tile 19 is 1.18 inches thick. Various types of ceramics can be used and is not limited to silicon carbide. The first, second, and third sheets of glass 21, 23, 25 are Pyrex and between 0.25 inches to 1 inch thick. The first, second, and third layers of adhesive 20, 22, 24 are of SC-11 flexible epoxy and are between 0.015 inches and 0.1 inches thick. Wire shims are used to provide the desired thickness of the first, second, and third layers of adhesive 20, 22, 24 and to reduce the bubbles in these layers.

The cover box 15 forms five sides of a box with an open side, with a face opposite from the open side of the cover box 15, forming the largest surface area of the cover box 15, and with a flange surrounding the remaining sides of the cover box 15. A layer of adhesive is applied to the inner surface of the face of the cover box 15. The plurality of armor stacks 14 are placed in the cover box 15, with the third sheet of glass 25 placed on the layer of adhesive applied to the inner face of the cover box 15. Preferably, the plurality of armor stacks 14 are spaced in a range between 0.015 inches and 0.250 inches apart. Adhesive is poured to fill the remaining spaces between the armor stacks 14 in the cover box 15, forming an adhesive matrix 28. In the preferred embodiment, wire shims are used to provide desired spacings

between the armor stacks 14. The adhesive matrix is of SC-11 flexible epoxy. The cover box 15 is made of steel and is between 0.06 inches and 0.2 inches thick.

After the adhesive matrix 28 has cured, the first base plate 12 and the second base plate 13 are bolted to the flange surrounding the cover box 15 with a plurality of bolts 16 to cover the open side of the cover box 15. In the preferred embodiment of the invention, the first base plate is steel and between 0.25 inches and 0.5 inches thick. The second base plate is titanium and is between 0.5 inches and 2 inches thick.

Spacers 30 are placed over the heads of the plurality of bolts 16. An outer skin 17 is placed over the spacers and the cover box 15, where the outer skin 17 is a cloth impregnated with an adhesive. In the preferred embodiment, the spacers are of balsa wood. The adhesive is SC-11 flexible epoxy.

The armor system 10 is attached to a hull of a vehicle or structure. In the preferred embodiment, the armor system is attached to the roof of an armored vehicle.

Figure 5 illustrates another embodiment of a box cover 45 with a plurality of armor stacks 46. In this embodiment, the armor stacks 46 are staggered so that corners of four armor stacks 46 do not meet at a single point as in the previous embodiment. This provides greater protection in a multihit situation.

While preferred embodiments of the present invention have been shown and described herein, it will be appreciated that various changes and modifications may be made therein without departing from the spirit of the invention as defined by the scope of the appended claims.



WHAT IS CLAIMED IS:

1. An armor system, comprising:
a plurality of armor stacks, wherein each armor stack comprises; a
5 ceramic tile with a first side and a second side; a first layer of adhesive on the first
side of the ceramic tile;
a first sheet of glass with a first side and a second side, wherein the
first side of the first sheet of glass is contiguous to the first layer of adhesive;
a second layer of adhesive on the second side of the first sheet of
10 glass;
a second sheet of glass with a first side and a second side, wherein the
first side of the second sheet of glass is contiguous to the second layer of adhesive;
a third layer of adhesive on the second side of the second sheet of
glass; and
15 a third sheet of glass with a first side and a second side, wherein the
first side of the third sheet of glass is contiguous to the third layer of adhesive; and
a cover box, with an open side and with an interior and exterior
wherein the plurality of armor stacks are on the interior of the cover box.
- 20 2. The armor system, as recited in claim 1, further comprising a
first base plate covering the open side of the cover box and mechanically connected
to the cover box.
3. The armor system, as recited in claim 2, further comprising a
25 second base plate covering the open side of the cover box and mechanically connected
to the cover box.
4. The armor system, as recited in claim 3, further comprising, a

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cloth impregnated with an adhesive covering the exterior of the cover box.

- 5 5. An armor system, comprising:
a plurality of armor stacks, wherein each armor stack comprises;
a ceramic tile with a first side and a second side;
a first layer of adhesive on the first side of the ceramic tile;
a first sheet of glass with a first side and a second side,
wherein the first side of the first sheet of glass is contiguous to the first layer of
adhesive;
10 a second layer of adhesive on the second side of the first sheet of
glass; and
a second sheet of glass with a first side and a second side, wherein the
first side of the second sheet of glass is contiguous to the second layer of adhesive;
a cover box, with an open side and with an interior and exterior
15 wherein the plurality of armor stacks are on the interior of the cover box; and
a first base plate covering the open side of the cover box and
mechanically connected to the cover box.
- 20 6. The armor system, as recited in claim 5, further comprising a
second base plate covering the open side of the cover box and mechanically connected
to the cover box.
- 25 7. The armor system, as recited in claim 6, further comprising, a
cloth impregnated with an adhesive covering the exterior of the cover box.
8. The armor system, as recited in claim 7, wherein the ceramic
tile is made of silicon carbide, and wherein the box cover is steel.

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9. The armor system, as recited in claim 8, wherein the first sheet of glass and the second sheet of glass are Pyrex.

5 10. A method of manufacturing an armor system, comprising the steps of:

manufacturing a plurality of armor stacks, comprising the steps of:

placing first layers of adhesive on first sides of a plurality of tiles;

10 placing first sides of a plurality of first sheets of glass on the first layers of adhesive;

placing second layers of adhesive on second sides of the plurality of the first sheets of glass; and

placing first sides of a plurality of second sheets of glass on the second layers of adhesive;

15 placing a layer of adhesive in a cover box;

placing the plurality of armor stacks in the cover box;

filling the cover box with adhesive; and

securing a base plate to the cover box.

20 11. The method of manufacturing an armor system, as recited in claim 10, further comprising the steps of:

placing third layers of adhesive on second sides of the plurality of second sheets of glass; and

25 placing first sides of a plurality of third sheets of glass on the third layers of adhesive, and wherein the step of placing the plurality of armor stacks in the cover box, places the third sheets on the layer of adhesive in the cover box.

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12. The method of manufacturing an armor system, as recited in claim 11, further comprising the steps of;

placing spacers around the cover box;

covering the spacers and the cover box with cloth; and

5 impregnating the cloth with an adhesive.

13. The method of manufacturing an armor system, as recited in claim 12, further comprising, the step of mounting the base plate on the hull of a vehicle.

10 14. An armor system, comprising:

a plurality of armor stacks, wherein each armor stack comprises;

a ceramic tile with a first side and a second side;

a first layer of adhesive on the first side of the ceramic tile;

15 side of the first sheet of glass is contiguous to the first layer of adhesive;

a second layer of adhesive on the second side of the first sheet of glass;

and

a second sheet of glass with a first side and a second side, wherein the first side of the second sheet of glass is contiguous to the second layer of adhesive; and

20 a metallic base plate on the second side of the ceramic tile.

15. An armor system comprising:

a plurality of armor stacks, wherein each armor stack comprises;

a silicon carbide tile with a first side and second side;

25 a first layer of adhesive on the first side of the silicon carbide tile;

a first sheet of glass with a first side and a second side, wherein the first side of the first sheet of glass is contiguous to the first layer of adhesive;





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a second layer of adhesive on the second side of the first sheet of glass; and
a second sheet of glass with a first side and a second side, wherein the first
side of the second sheet of glass is contiguous to the second layer of
adhesive.

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**AMENDED CLAIMS**

[received by the International Bureau on 14 November 1997 (14.11.97);
original claims 1-15 replaced by new claims 1-16 (3 pages)]

1. An armor system, comprising:
a plurality of armor stacks, wherein each armor stack comprises;
an opaque ceramic tile with a first side and a second side;
a first layer of adhesive on the first side of the opaque ceramic
tile;
a first sheet of glass with a first side and a second side,
wherein the first side of the first sheet of glass is contiguous to the first layer of
adhesive;
a second layer of adhesive on the second side of the first sheet
of glass; and
a second sheet of glass with a first side and a second side,
wherein the first side of the second sheet of glass is contiguous to the second layer
of adhesive.
2. The armor system, as recited in claim 1, further comprising a
cover box, with an open side and with an interior and exterior wherein the plurality
of armor stacks are on the interior of the cover box.
3. The armor system, as recited in claim 2, wherein each of the
plurality of armor stacks, further comprises:
a third layer of adhesive on the second side of the second sheet of glass;
and
a third sheet of glass with a first side and a second side, wherein the first
side of the third sheet of glass is contiguous to the second layer of adhesive.
4. The armor system, as recited in claim 3, further comprising a first
base plate covering the open side of the cover box and mechanically connected to the
cover box.
5. The armor system, as recited in claim 4, further comprising a





second base plate covering the open side of the cover box and mechanically connected to the cover box.

6. The armor system, as recited in claim 5, further comprising, a cloth impregnated with an adhesive covering the exterior of the cover box.

7. The armor system, as recited in claim 1, further comprising a cover box, with an open side and with an interior and exterior wherein the plurality of armor stacks are on the interior of the cover box.

8. The armor system, as recited in claim 7, further comprising a first base plate covering the open side of the cover box and mechanically connected to the cover box.

9. The armor system, as recited in claim 8, further comprising a second base plate covering the open side of the cover box and mechanically connected to the cover box.

10. The armor system, as recited in claim 9, further comprising, a cloth impregnated with an adhesive covering the exterior of the cover box.

11. The armor system, as recited in claim 7, wherein the ceramic tile is made of silicon carbide, and wherein the cover box is steel.

12. The armor system, as recited in claim 11, wherein the first sheet of glass and the second sheet of glass are Pyrex.

13. A method of manufacturing an armor system, comprising the steps of:

manufacturing a plurality of armor stacks, comprising the steps of:

placing first layers of adhesive on first sides of a plurality of tiles;

placing first sides of a plurality of first sheets of glass on the first





layers of adhesive;

placing second layers of adhesive on second sides of the plurality of the first sheets of glass; and

placing first sides of a plurality of second sheets of glass on the second layers of adhesive;

placing a layer of adhesive in a cover box;

placing the plurality of armor stacks in the cover box;

filling the cover box with adhesive; and

securing a base plate to the cover box.

14. The method of manufacturing an armor system, as recited in claim 13, further comprising the steps of:

placing third layers of adhesive on second sides of the plurality of second sheets of glass; and

placing first sides of a plurality of third sheets of glass on the third layers of adhesive, and wherein the step of placing the plurality of armor stacks in the cover box, places the third sheets on the layer of adhesive in the cover box.

15. The method of manufacturing an armor system, as recited in claim 14, further comprising the steps of;

placing spacers around the cover box;

covering the spacers and the cover box with cloth; and

impregnating the cloth with an adhesive.

16. The method of manufacturing an armor system, further comprising, the step of mounting the base plate on the hull of a vehicle.



STATEMENT UNDER ARTICLE 19

Claims 1 and 11 have been amended; and Claims 2 and 3 have been added to correspond to the pending U.S. patent application. No new matter has been added.

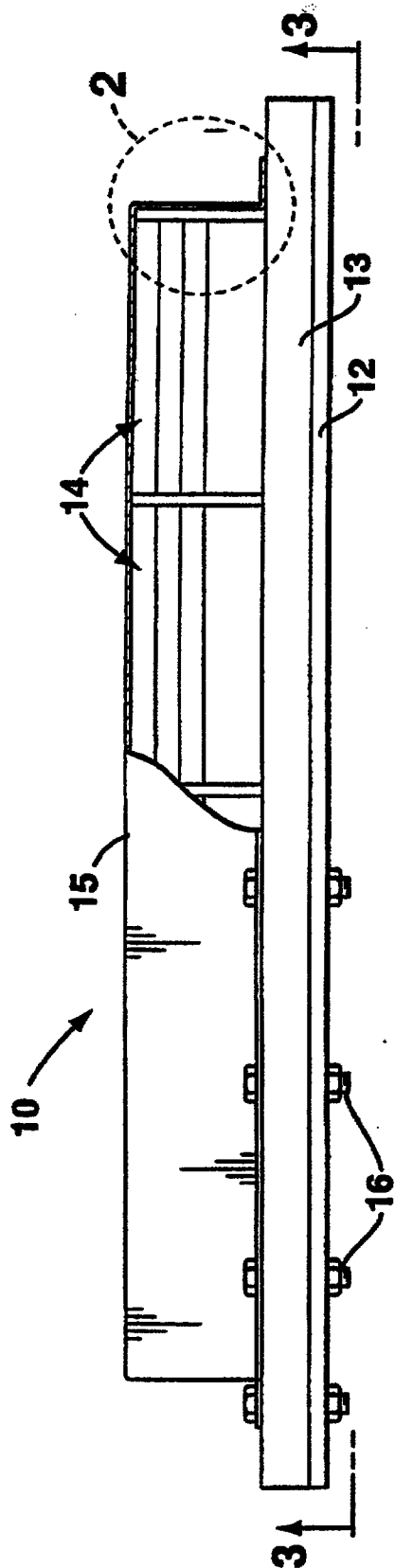


FIG. 1

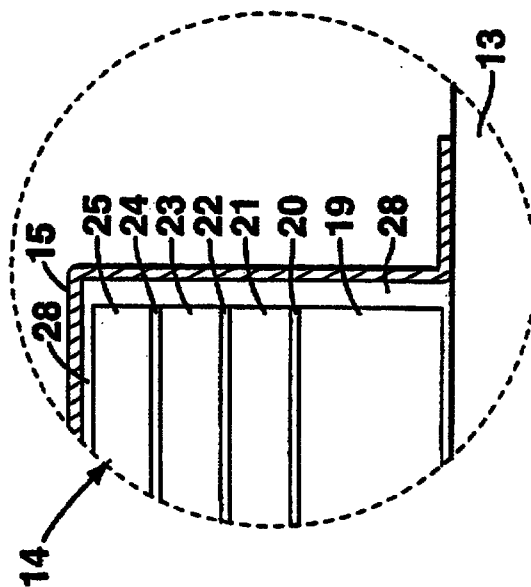


FIG. 2

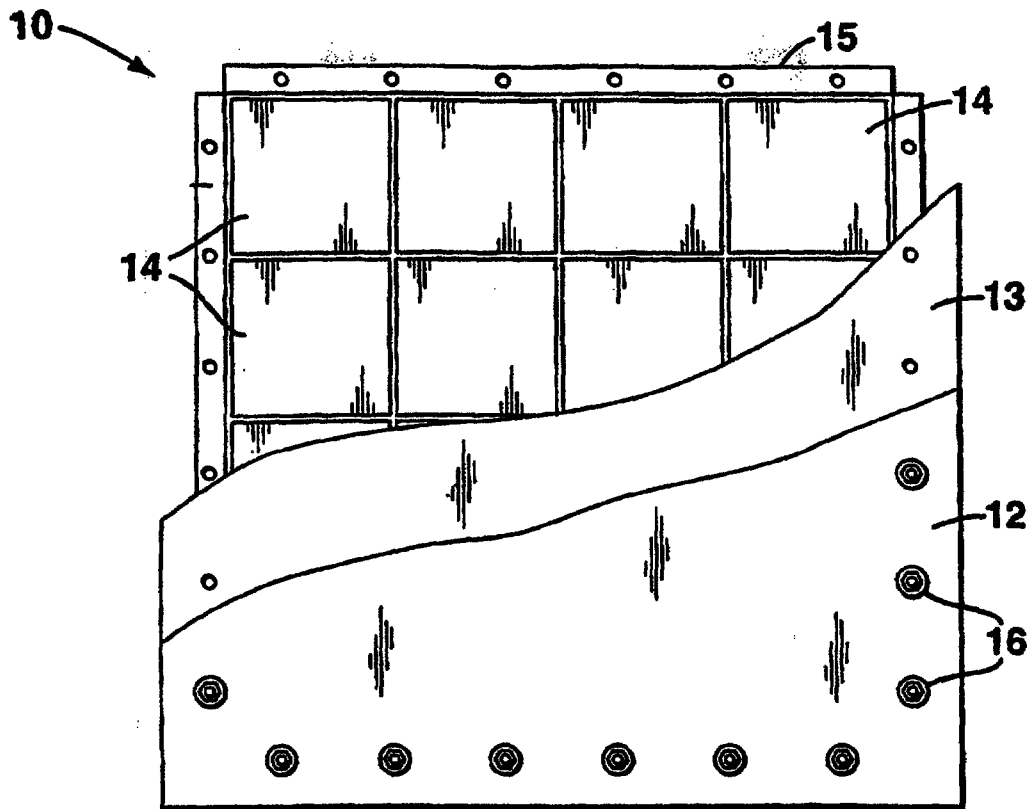


FIG. 3

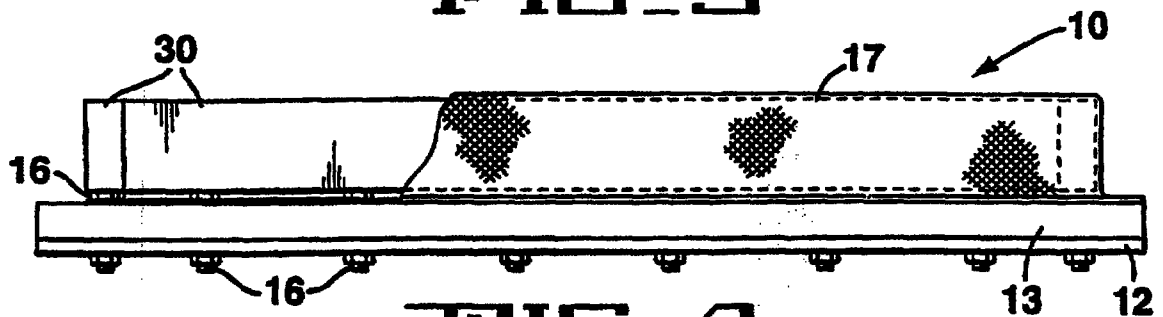


FIG. 4

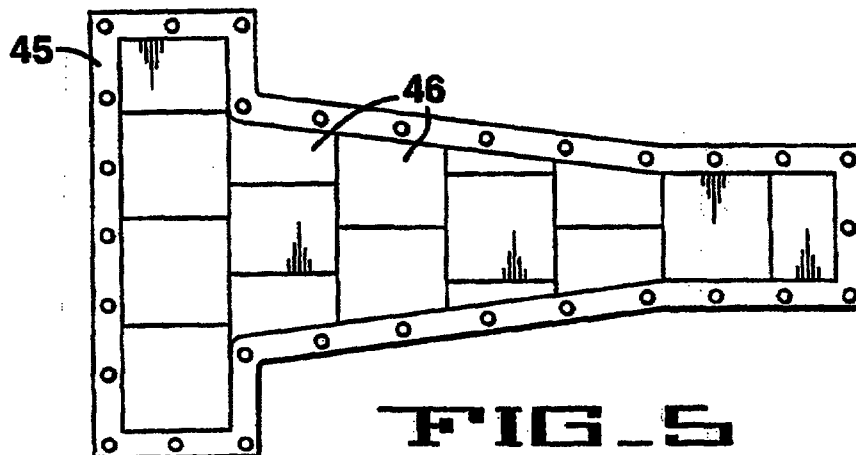


FIG. 5



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WHAT IS CLAIMED IS:

1. An armor system, comprising:
 - a plurality of armor stacks, wherein each armor stack comprises;
 - an opaque ceramic tile with a first side and a second side;
 - a first layer of adhesive on the first side of the opaque ceramic tile;
 - a first sheet of glass with a first side and a second side, wherein the first side of the first sheet of glass is contiguous to the first layer of adhesive;
 - a second layer of adhesive on the second side of the first sheet of glass; and
 - a second sheet of glass with a first side and a second side, wherein the first side of the second sheet of glass is contiguous to the second layer of adhesive.
2. The armor system, as recited in claim 1, further comprising a cover box, with an open side and with an interior and exterior wherein the plurality of armor stacks are on the interior of the cover box.
3. The armor system, as recited in claim 2, wherein each of the plurality of armor stacks, further comprises:
 - a third layer of adhesive on the second side of the second sheet of glass;
 - and
 - a third sheet of glass with a first side and a second side, wherein the first side of the third sheet of glass is contiguous to the second layer of adhesive.
4. The armor system, as recited in claim 3, further comprising a first base plate covering the open side of the cover box and mechanically connected to the cover box.
5. The armor system, as recited in claim 4, further comprising a



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second base plate covering the open side of the cover box and mechanically connected to the cover box.

6. The armor system, as recited in claim 5, further comprising, a cloth impregnated with an adhesive covering the exterior of the cover box.

7. The armor system, as recited in claim 1, further comprising a cover box, with an open side and with an interior and exterior wherein the plurality of armor stacks are on the interior of the cover box.

8. The armor system, as recited in claim 7, further comprising a first base plate covering the open side of the cover box and mechanically connected to the cover box.

9. The armor system, as recited in claim 8, further comprising a second base plate covering the open side of the cover box and mechanically connected to the cover box.

10. The armor system, as recited in claim 9, further comprising, a cloth impregnated with an adhesive covering the exterior of the cover box.

11. The armor system, as recited in claim 7, wherein the ceramic tile is made of silicon carbide, and wherein the cover box is steel.

12. The armor system, as recited in claim 11, wherein the first sheet of glass and the second sheet of glass are Pyrex.

13. A method of manufacturing an armor system, comprising the steps of:

manufacturing a plurality of armor stacks, comprising the steps of:

placing first layers of adhesive on first sides of a plurality of tiles;

placing first sides of a plurality of first sheets of glass on the first



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layers of adhesive;

placing second layers of adhesive on second sides of the plurality of the first sheets of glass; and

placing first sides of a plurality of second sheets of glass on the second layers of adhesive;

placing a layer of adhesive in a cover box;

placing the plurality of armor stacks in the cover box;

filling the cover box with adhesive; and

securing a base plate to the cover box.

14. The method of manufacturing an armor system, as recited in claim 13, further comprising the steps of:

placing third layers of adhesive on second sides of the plurality of second sheets of glass; and

placing first sides of a plurality of third sheets of glass on the third layers of adhesive, and wherein the step of placing the plurality of armor stacks in the cover box, places the third sheets on the layer of adhesive in the cover box.

15. The method of manufacturing an armor system, as recited in claim 14, further comprising the steps of;

placing spacers around the cover box;

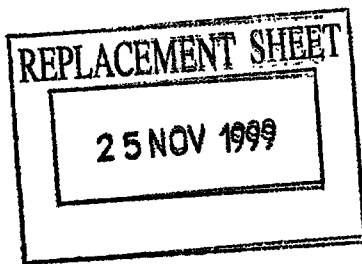
covering the spacers and the cover box with cloth; and

impregnating the cloth with an adhesive.

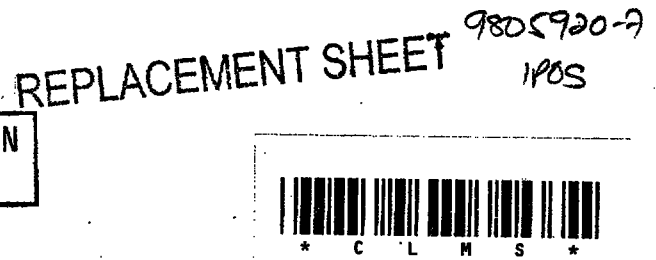
16. The method of manufacturing an armor system, further comprising, the step of mounting the base plate on the hull of a vehicle.

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layers of adhesive:

placing second layers of adhesive on second sides of the plurality of the first sheets of glass; and

placing first sides of a plurality of second sheets of glass on the second layers of adhesive:

placing a layer of adhesive in a cover box;

placing the plurality of armor stacks in the cover box;

filling the cover box with adhesive; and

securing a base plate to the cover box.

14. The method of manufacturing an armor system, as recited in claim 13, further comprising the steps of:

placing third layers of adhesive on second sides of the plurality of second sheets of glass; and

placing first sides of a plurality of third sheets of glass on the third layers of adhesive, and wherein the step of placing the plurality of armor stacks in the cover box, places the third sheets on the layer of adhesive in the cover box.

15. The method of manufacturing an armor system, as recited in claim 14, further comprising the steps of;

placing spacers around the cover box;

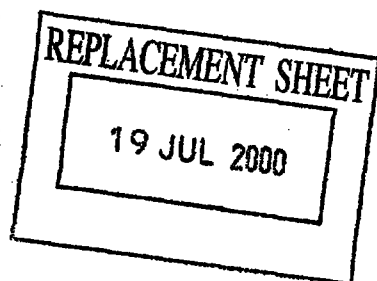
covering the spacers and the cover box with cloth; and

impregnating the cloth with an adhesive.

16. The method of manufacturing an armor system, as recited in claim 15, further comprising the step of mounting the base plate on the hull of a vehicle.

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layers of adhesive:

placing second layers of adhesive on second sides of the plurality of the first sheets of glass; and

placing first sides of a plurality of second sheets of glass on the second layers of adhesive:

placing a layer of adhesive in a cover box;

placing the plurality of armor stacks in the cover box;

filling the cover box with adhesive; and

securing a base plate to the cover box.

14. The method of manufacturing an armor system, as recited in claim 13, further comprising the steps of:

placing third layers of adhesive on second sides of the plurality of second sheets of glass; and

placing first sides of a plurality of third sheets of glass on the third layers of adhesive, and wherein the step of placing the plurality of armor stacks in the cover box, places the third sheets on the layer of adhesive in the cover box.

15. The method of manufacturing an armor system, as recited in claim 14, further comprising the steps of;

placing spacers around the cover box;

covering the spacers and the cover box with cloth; and

impregnating the cloth with an adhesive.

16. The method of manufacturing an armor system, as recited in claim 15, further comprising the step of mounting the base plate on the hull of a vehicle.

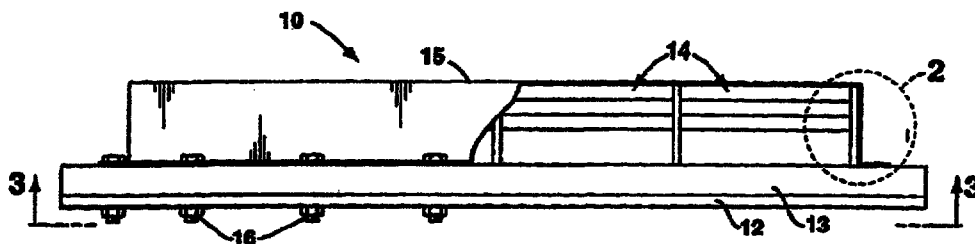


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/US97/08511 (22) International Filing Date: 19 May 1997 (19.05.97) (30) Priority Data: 08/657,717 ☒ 30 May 1996 (30.05.96) ☒ US (71) Applicant: UNITED DEFENSE, L.P. [US/US]; Suite 700, 1525 Wilson Boulevard, Arlington, VA 22209 (US). ☒ (72) Inventors: SINGH, Paul, P.; 923 Boar Circle, Fremont, CA 94539 (US). MIDDIONE, Mark, Albert; 16 Cooper's Hawk Court, Scotts Valley, CA 95066 (US). ☒ (74) Agent: CALDWELL, John, W.; Woodcock Washburn Kurtz Mackiewicz & Norris, 46th floor, One Liberty Place, Philadelphia, PA 19103 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>With amended claims.</i>	

(54) Title: **PASSIVE ROOF ARMOR** ☒

(57) Abstract

The invention provides an improved passive armor system. The armor system uses armor stacks of ceramic tiles (19) connected to layers of glass (21, 23, 25). The armor stacks are then adhered to the inside of a cover box (15). The cover box (15) is then secured to a base (12, 13) and then covered with a cloth impregnated with an adhesive (17).