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Pagano et al.

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[54] **UNIVERSAL APPLIQUE ARMOR**

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[73] Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, D.C.

[22] Filed: **Sept. 6, 1968**

[21] Appl. No.: **758,656**

[52] **U.S. Cl.** ..... **89/36 H**

[51] **Int. Cl.** **F41h 7/04**

[58] **Field of Search** ..... 89/36 R, 36 A, 36 H; 105/394; 109/49.5, 78, 79, 80, 82, 83, 84, 85; 114/9, 10, 14; 52/627; 244/121

[56] **References Cited**

UNITED STATES PATENTS

787,065	4/1905	White	114/12
796,768	8/1905	Steinmetz	114/84
1,508,421	9/1924	Taegen	109/83
1,632,360	6/1927	Wilson	296/24
2,032,344	3/1936	Barrows et al.	52/627 X
2,379,266	6/1945	Whiton	114/14 X
3,228,361	1/1966	Ritter	109/84
3,351,374	11/1967	Forsyth et al.	89/36

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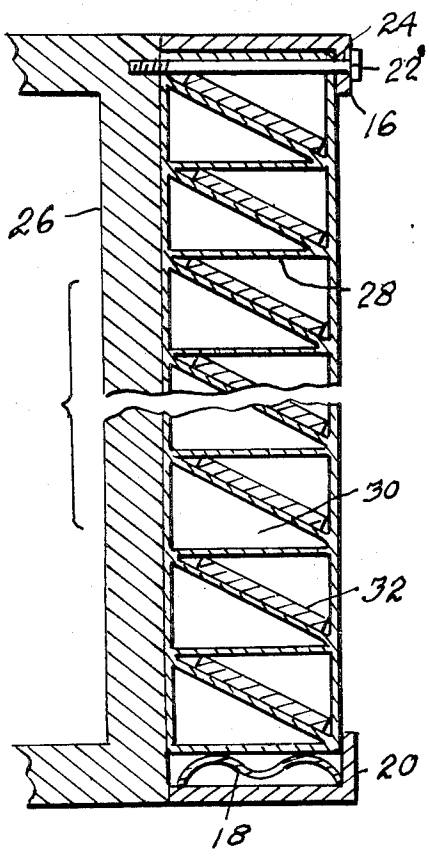
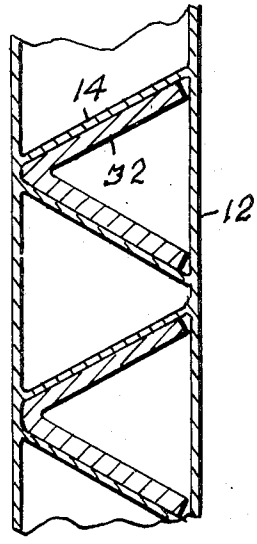
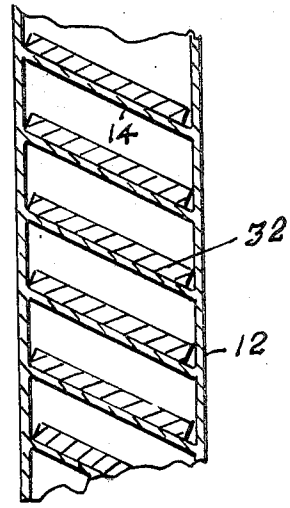
[57] **ABSTRACT**

An envelope or panel member having formed therein a plurality of angled holding slots adopted to loosely support armor elements disposed in the designated holding slots. Air space areas within the envelope can be sealed or filled with plastic, or the like, depending on need for buoyancy to overall vehicle design. In this developed form, a complete panel or envelope is ready for application to the side of an armored vehicle.

7 Claims, 9 Drawing Figures







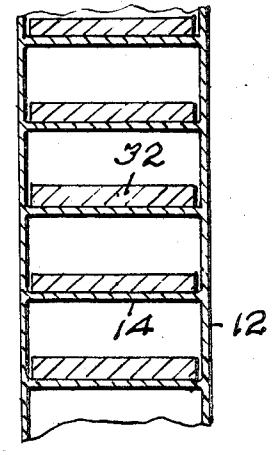


Fig. 1.

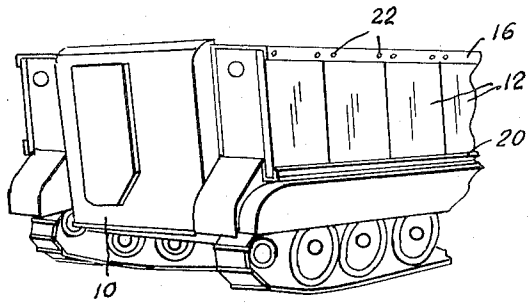
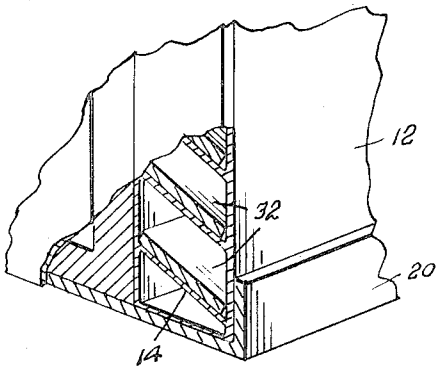


Fig. 2.



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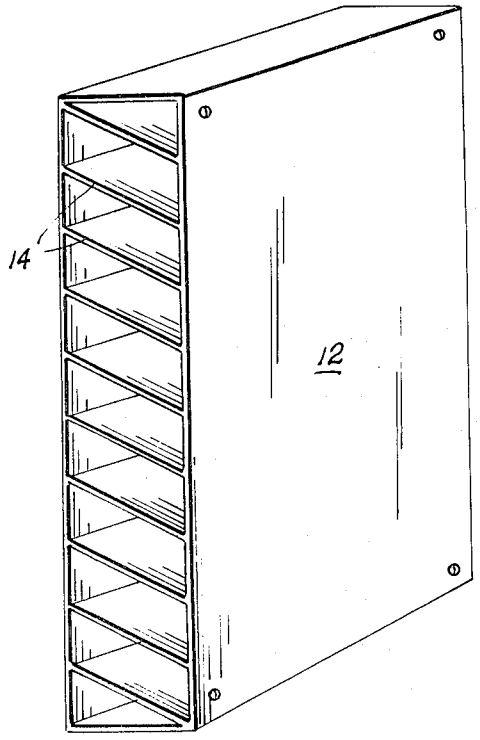

Fig. 4.

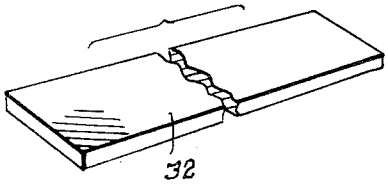

Fig. 5.

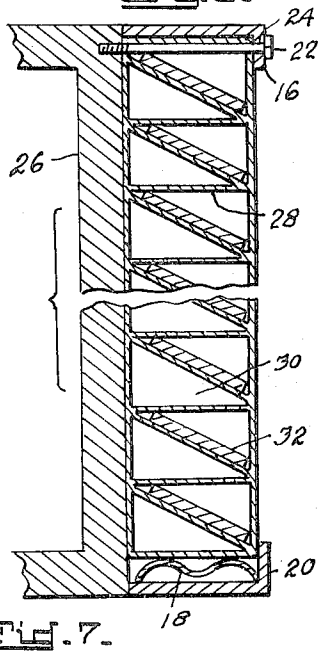

Fig. 6.

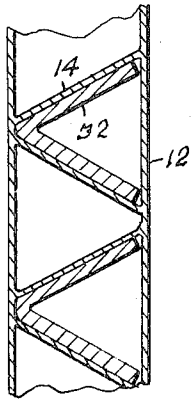

Fig. 8.

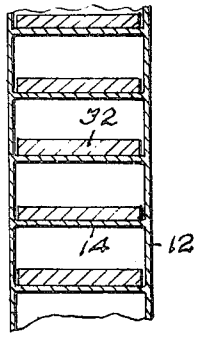

Fig. 7.

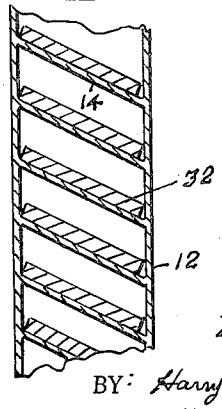

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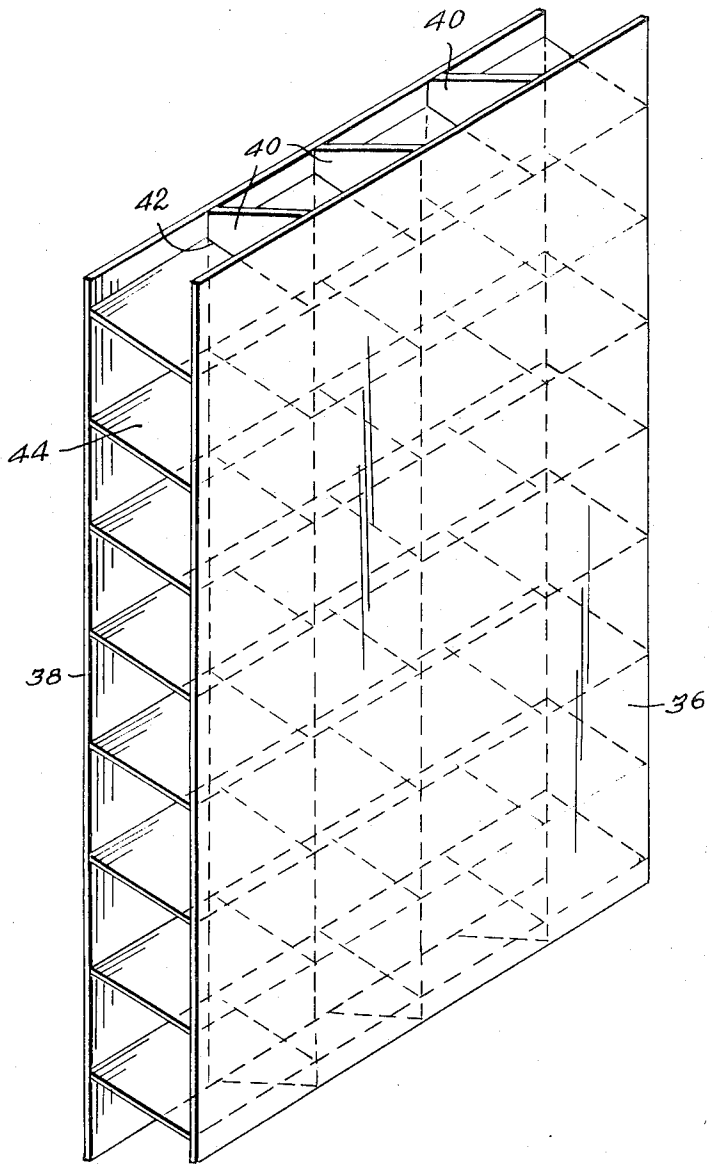
Fig. 9



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UNIVERSAL APPLIQUE ARMOR

This invention relates to armor, and more particularly to a new and improved unique panel device which may be quickly detachably secured to the outside of a military vehicle, or the like, to provide added armor protection therefor.

The invention consists of a new and unique envelope or panel member having therein a plurality of angled holding slots adopted to loosely support armor elements placed in the designated holding slots. Air space areas within the envelope can be sealed or filled with plastics, or the like, depending on need for buoyancy to overall vehicle design. In this developed form, a complete panel or envelope is ready for application to the side of an armored vehicle, the same being accomplished by inserting the envelope into opposed rail or channel members attached to the side of the vehicle. The panel is then locked in place by means of locking pins.

The general purpose of the present disclosure is to provide a more practical and economical means of applying known projectile defeating materials and principles in combat vehicles. Underlying projectile defeating mechanism for this concept has been tested and proven under another development known as "Lightweight Applique Ribbed Armor" and set forth in a copending application, Ser. No. 697,565 filed 9 Jan. 68. The present invention is viewed as a major step forward over the above identified disclosure.

The design concept proposed herein eliminates design and material problems currently being encountered in attempts to functionally adopt ribbed and composite armor configurations in vehicles. Specifically these involve difficulties created by the necessity to fabricate by welding and/or to make special mechanical attachments.

The above and other objects of the invention will more fully appear from the following more detailed description, and from the drawings, wherein:

FIG. 1 is a view of a combat vehicle with the envelopes or panels mounted thereon.

FIG. 2 is a sectional view showing how the envelope seats in the lower envelope supporting channel.

FIG. 3 is a perspective view of the envelope per se.

FIG. 4 shows an insert armor element.

FIG. 5 is a cross section of the preferred form of envelope showing the same mounted on a tank by means of upper and lower channel members.

FIG. 6 is a cross section showing an alternate form of envelope.

FIG. 7 is a cross section showing a further alternate form of envelope.

FIG. 8 is a cross section showing a still further alternate form of envelope; and

FIG. 9 is a perspective view of another alternate form of envelope showing vertical spars therein.

Referring now to the drawings, the numeral **10** designates an armored vehicle having mounted on the opposed sides thereof a plurality of envelope or panel members **12**, the same having mounted angularly therein a plurality of support members **14**, the entire unit being formed of aluminum, or the like. Numberal **16** designates an upper support channel or rail, the same running the entire length of tank **10** and having openings **24** therein to receive locking pins **22**. A lower channel member **20**, is provided, the same running the entire length of tank **10** and having mounted therein a shock-dampener and holding spring **18**. Numeral **28** designates cross webbing and holding slots, air of fill spaces **30**. Numeral **32** designates insert armor, FIG. **4**, the same comprising rectangularly shaped insert elements adapted to be inserted in between and to rest upon supporting members **14**.

Alternate forms of prefabricated envelopes **12** are shown in FIGS. **5, 6, 7, 8**, and **9**, the same comprising the same type of envelope shown in FIG. **3**, but in FIG. **5** supports or webbing are used. In FIG. **6** the insert armor supporting members **14** are arranged to form a succession of V-shaped openings into which are inserted insert armor plates **32** in opposed position within envelope **12** to provide additional means to shatter and break up a projectile after the same has passed through the outer surface of the envelope. In FIG. **7**, the insert armor **32** is supported within the envelope minus the webbing **28**. FIG. **8** shows the supporting members as superimposed parallel transverse supports for use only on oblique vehicle surfaces; and FIG. **9** shows a different type of envelope wherein front **36** and back **38**, skin members have sandwiched therebetween spaced apart vertical spar members **40** having formed therein angular slots **42** adapted to receive and hold insert elements **44**.

The manner in which the device is used, is as follows:

It has been found that the optimum armor design for a combat vehicle is to employ a combination of armor materials — an outside envelope or panel which provides a container adapted to uniquely hold materials which will shatter and break up a projectile and a backup plate which will absorb the resultant dispersion of fragments. Since aluminum is readily fabricated and performs most effectively as an absorber of fragments, it has been the material most often preferred as the inner layer or vehicle shell structure. The outer layer or applique material, has been open to a broad group of materials and configurations.

The common material prerequisite in these appliques is to reliably induce projectile shattering. This has been achieved through the used of high hardness materials. As indicated above, constructional economics, ease of fabrication by welding, and ballistic effectiveness support aluminum as the best choice for the basic vehicle shell. Higher rigidity for the weight is also achieved.

As shown best in FIGS. **1, 2** and **3** of the drawings, the rectangularly shaped box-like envelope member **12**, is formed of aluminum, or the like, with angled holding slots **14** loaded with metallic inserts or proven material type or combination **32**, to make the envelope an armor applique. These metallic elements extend the entire width of the envelope **12** and are of the same configuration as the holding member and can be of various thicknesses. The choice of material used for the insert element is determined by cost-weight characteristics necessary to achieve maximum break-up of an impacting projectile while still retaining intact surfaces for sustaining subsequent hits. Placement of these insert elements is achieved by simply sliding or pressing in place within the slots in the envelope one or more inserts in each angular support member. A change or removal of elements when necessary can also be made in similar fashion. Insert elements could be prepared from

current low cost 500 BHN alloy (i.e., XAR-30) steel, or harder (600 BHN) alloy steel 0.45*c*, plain high carbon steel 1080 or ceramic tile (backed with doron or high hardness steel). Air space areas **30** can be sealed or filled with plastics depending on need for buoyancy to overall vehicle design. In this developed form, a complete panel or module of applique armor is ready for application to the vehicle.

Application of envelope **12** to tank back-up plate **26** is achieved through upper and lower support channels **16, 20,** by pressing the panel first into lower channel **20** against spring member **18,** which runs the entire length of the channel. Once the spring has been depressed by the bottom of envelope **12,** the envelope is tilted forward until the top of the envelope engages upper channel **16** and when pressure is released the envelope snaps into place, as shown in FIG. **5.** Or the reverse of the above would be satisfactory, spring **18** could be placed in channel **16** and the top of the envelope could be inserted in the upper channel and the envelope swung into lower channel **20** and snapped into place. The panel is firmly retained in place by insertion of locking pin **22** which pass through opening **24** in the channels **16, 20,** through the envelope and on into back-up plate **26** to hold the envelope against movement.

The envelopes are secured to the back-up plate in series on each side of the vehicle, as shown best in FIG. **1** of the drawings, and can be secured to each end of the vehicle, if desired, for added protection.

Although aluminum is suggested for use in fabricating the envelope or panel, the container design offers many ways for lightweight construction while still affording needed structural strength, such as use of magesium, titanium or aluminum alloys fabricated from sheet metal or fabricated by extrusion methods. It also suggests alternate design embodiments which permit simple alteration for improved ballistic design of new or established vehicle design by simply spacing the panel from the back-up plate (primary vehicle structure) or changing the material type of thickness of the insert elements.

In the alternate type of envelope shown in FIG. **6,** the holding supports **14** are arranged within the envelope **12** to form a succession of V-shaped openings adapted to receive insert armor in opposed position also V-shaped.

The alternate shown in FIG. **7** discloses the insert supports in much the same position as shown in FIG. **5,** but without the transverse webs, and the alternate shown in FIG. **8,** wherein the spaced transverse insert supports are located within the envelope parallel to each other and finds usage only on oblique vehicle surfaces. As to the alternate shown in FIG. **9,** the same comprises a lightweight construction consisting of two opposed skins **36, 38,** having sandwiched therebetween vertical spar members **40** having formed therein slanted slots **42** through which are passed armor elements **44.** Various types of materials and thicknesses can be used for the envelopes structure and the slotted spar members provide for the thickness, height, angle and center-to-center distances required to locate the armor insert elements for the specific armor module concerned. The longer length dimension of the spar may be flanged to facilitate joining to the skins by mechanical (rivets, etc.) or welding (resistance, spots, etc.) methods. The number of spars used will vary depending on the overall armor module design that is required. The spars are located and joined to the skins in such a way that the insert element can be assembled through loosely fitted slots without difficulty and without great force. The armor insert elements can also be joined to the skin by welding to secure them in their locations. Securing the armor elements can also be accomplished by many other methods, for example, retaining plates can be fastened at opposite ends of the skins and parallel to the spars or after assembly of the armor inserts the end of the skins can be coined or swadged to provide a retaining arrangement.

During an attack the fired projectile contacts first the outer surface of the prefabricated applique envelope or container and pierces same. It next contacts the inserted steel, or the like, elements supported within the envelope which tend to shatter or break up the projectile. The vehicle armor then absorbs the resultant dispersion of fragments.

There has been disclosed herein a new and unique applique armor comprising a prefabricated lightweight envelope constructed of aluminum, or the like, having mounted therein angularly spaced slots adapted to receive one or more insert armor elements which may be inserted or removed from the envelope as desired, said envelope being designed to be detachably affixed to the back-up plate of an armored vehicle — direct contact or some predetermined space or distance — the same being snapped onto the vehicle by means of opposed supporting rails or channel members. The interior of the envelope may be filled with various types of plastic materials for added protection, if desired. The device provides adjustable armor protection, the same being achieved by merely altering the type of thickness of the high hardness armor elements placed in the designated holding slots or spacing the envelope or applique at some stand-off distance. The envelope concept eliminates cost and complexities of extensive fabrication by welding. As insert elements, high hardness metals or surface treated metals or other desirable material combinations, i.e., ceramic - high hardness steel, high carbon alloyed steels, carburaized steels, nitrided steels and roll bonded steels which were impossible or too dificult to fabricate by welding are now made feasible for application. This, in turn, can enhance overall armor effectiveness. The design provides an armor applique in ideal form for easy application to a vehicle structure. It is a self-contained package which can be handled and transported or stored in a convenient fashion and lends itself to rebuild or modification in the field and is adaptable for use against all small arms weapon threats. The small size of insert elements allows customized treatment for optimum ballistic properties, minimizes manufacturing problems encountered when either manufacturing or fabricating an armor material in large sections (decarburization, distortion, cutting, shaping, handling, heat treatment, equipment availability, etc.), enhances the concept of stock piling armor elements, bars of — low cost **500** BHN alloy (i.e., XAR-30) steel or harder 600 BHN alloy steel 0.45*c*, plain high carbon steel 1080 or ceramic tile (backed with doron or high hardness steel) for ready use either as a field item to armor or up-armor existing equipment or for new design and assures high quality levels at minimal costs. The external appearance does not reveal any salient armor feature (retains a conventional plate

look) and also offers inherent buoyancy to enhance vehicle floatation requirements.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

We claim:

1. An armored panel for use in combination with an armored vehicle comprising,

An envelope-type armored panel to be positioned on said vehicle, said panel having mounted therein a plurality of transverse supporting members arranged within said envelope,

insert armor members positioned in said envelope,

opposed channel members having spring means mounted therein to springably support said armored panel within said channel members, and,

additional bolt-type means to prevent movement of said panel within said channel members once said panel has been mounted in said channel members.

2. An armored panel for use in combination with an armored vehicle, as set forth in claim 1, wherein,

said envelope-type panel member has mounted therein a plurality, in parallel, transverse supporting members,

and having additional armor insert supports diagonally disposed within the spaces formed by said parallel transverse supports.

3. An armored panel as set forth in claim 1 wherein the plurality of superimposed transverse supporting members are arranged in parallel supporting relationship to receive and support insert armor members.

4. An armored panel as set forth in claim 3 wherein the plurality of superimposed transverse supporting members are arranged in diagonal relationship with respect to the skin members.

5. An armored panel as set forth in claim 1, wherein, the spaces formed between said transverse armor supporting members are adapted to receive fill material for buoyancy to overall vehicle design.

6. An armored panel as set forth in claim 1 wherein said envelope-type panel comprises opposed front and back skin members, a plurality of spar members disposed between said skin members, said spar members having formed therein angularly arranged slots adapted to receive in transverse relationship armor insert members.

7. An envelope-type panel as set forth in claim 6, wherein, said slotted spar members are arranged vertically and spaced apart between said opposed skin members.

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