Title: LIGHTWEIGHT ARMOR PLATES, SYSTEMS INCLUDING SAME AND METHODS OF USE THEREOF

Abstract: A lightweight armor plates, systems including same and methods of use thereof. Disclosed is a transparent armor plate which includes at least one glass layer, at least one plastic layer which contributes at least 50% of a total weight of the plate, at least one adhesive bonding two layers together. Further disclosed is an opaque armor plate including at least two hardened metal layers and a force-dissipating layer. Whether opaque or transparent, a total weight of the plate is less than approximately exactly 50 kg/m². Further disclosed is a system for protecting a target from impact by a projectile including at least one armor plate as disclosed and a positioning device to engage and retain the armor plate in a position between the target and the projectile. Further disclosed is a method of protecting a target from impact by a projectile including ascertaining at least one source from which a projectile is likely to emanate and employing a positioning device to position at least one armor plate in a position between the target the ascertained source.
LIGHTWEIGHT ARMOR PLATES, SYSTEMS INCLUDING SAME AND METHODS OF USE THEREOF

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to lightweight armor plates, systems including same and methods of use thereof and, more particularly, to an armor plate which may be reversibly attached to protect a target from a projectile.

The recent increase in political unrest, financially motivated crime and/or terrorism in many areas of the world has caused many people to fear that they are potential targets for attack with firearms or explosive devices.

Typically, protection from bullets or shrapnel required use of expensive and heavy armor. True armored vehicles, such as tanks and other vehicles designed to withstand artillery shells and rockets are obviously ill suited to urban travel.

Previously available armor for normal vehicles was typically so heavy that it required use of very large motors and/or all wheel drive transmission systems. This meant that retrofitting a typical passenger vehicle with armor was virtually infeasible.

Further, the cost of typical armoring for a vehicle is prohibitive, owing in part to the types of materials employed and in part to the amount of armor employed.

These considerations also apply to armoring static targets such as buildings, windows and bus stops. Similarly, portable bulletproof protection has typically been limited to "flack jackets" and helmets which offer no protection for the face and often leave arms and legs unprotected.

There is thus a widely recognized need for, and it would be highly advantageous to have, lightweight armor plates, systems including same and methods of use thereof devoid of the above limitations.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a lightweight transparent armor plate. The plate includes: (a) at least one glass layer placed to receive an initial impact from a projectile; (b) at least one plastic layer, the plastic layer situated behind the glass layer and designed and constructed to be impenetrable by the projectile, the plastic layer includes at least approximately 50% of a total weight of the plate; (c) at least one adhesive, the adhesive bonding two of the layers together. Preferably, the total
weight of the plate is less than approximately exactly 50 kg/M² of the plate. The degree of transparency of the plate permits visibility therethrough by a user thereof.

According to another aspect of the present invention there is provided lightweight opaque armor plate. The plate includes: (a) a first hardened metal layer, the first hardened metal layer placed to receive an initial impact from a projectile; (b) a force dissipating layer, the force dissipating layer situated behind the first hardened metal layer and is designed and constructed to absorb and disperse energy from the projectile, (c) a second hardened metal layer, the second hardened metal layer situated behind the force dissipating layer and is designed and constructed to prevent penetration by the projectile. Preferably, the total weight of the plate is less than approximately exactly 50 kg/M² of the plate.

According to yet another aspect of the present invention there is provided a system for protecting a target from impact by a projectile. The system includes: (a) at least one lightweight armor plate; and (b) a positioning device designed and constructed to engage and retain the at least one lightweight armor plate in a position between the target and the projectile. Preferably, a total weight of the armor plate is less than approximately exactly 50 kg/M².

According to still another aspect of the present invention there is provided a method of protecting a target from impact by a projectile, the method includes: (a) ascertaining at least one source from which a projectile is likely to emanate; and (b) employing a positioning device to engage and retain at least one lightweight armor plate in a position between the target and the at least one source from which a projectile is likely to emanate.

According to further features in preferred embodiments of the invention described below, a total thickness of the at least one glass layer, the at least one plastic layer and the at least one adhesive is in the range of approximately 30 to approximately 40 mm.

According to still further features in the described preferred embodiments the at least one glass layer includes at least two glass layers.

According to still further features in the described preferred embodiments the at least one plastic layer includes at least two plastic layers.
According to still further features in the described preferred embodiments the at least one plastic layer is constructed of a material selected from the group consisting of an acrylic plastic and polycarbonate.

According to still further features in the described preferred embodiments the plate further includes a reversible attachment device.

According to still further features in the described preferred embodiments the at least one adhesive is selected from the group consisting of PVB (polyvinyl butyral) and polyurethane.

According to still further features in the described preferred embodiments a total thickness of the first and second hardened metal layers and the force dissipating layer is in the range of approximately 6 to approximately 40 mm, more preferably approximately 22 to approximately 32 mm, alternately but also more preferably, approximately 6 to approximately 12 mm.

According to still further features in the described preferred embodiments the first and second hardened metal layers are each independently constructed of a material selected from the group consisting of heat treated aluminum, and a heat-treated alloy.

According to still further features in the described preferred embodiments the force-dissipating layer is constructed of a material selected from the group consisting of polyurethane, Kevlar™, dynima, an acrylic plastic, magnesium, aluminum and iron.

According to still further features in the described preferred embodiments the plate further includes a coating.

According to still further features in the described preferred embodiments the at least one lightweight armor plate is selected from the group consisting of a transparent armor plate and an opaque armor plate wherein the transparent and opaque armor plates are as described hereinafter.

According to still further features in the described preferred embodiments the positioning device includes at least one item selected from the group consisting of a reversible attachment device, a permanent attachment device, a base and an article of clothing modified to accommodate the at least one lightweight armor plate.

According to still further features in the described preferred embodiments the method further includes causing a total weight of the armor plate to be less than approximately exactly 50 kg/M².
According to still further features in the described preferred embodiments the method further includes providing the at least one lightweight armor plate, wherein the lightweight armor plate includes at least one item selected from the group consisting of a transparent armor plate and an opaque armor plate wherein the transparent and opaque armor plates are as described herein above.

According to still further features in the described preferred embodiments the employing a positioning device includes employing at least one item selected from the group consisting of a reversible attachment device, a permanent attachment device, a base and an article of clothing modified to accommodate the at least one lightweight armor plate.

According to still further features in the described preferred embodiments the first and second hardened metal layers each independently contain at least one material selected from the group consisting of aluminum, magnesium, silicon, titanium, copper, manganese and chromium.

The present invention successfully addresses the shortcomings of the presently known configurations by providing portable lightweight armor plates, systems including the plates and methods of use thereof.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The invention is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

FIG. 1 is a cross section of a lightweight transparent armor plate according to the present invention;
FIG. 2 is a cross section of a lightweight opaque armor plate according to the present invention;
FIG. 3 is a perspective view of a reversible attachment device according to the present invention;
FIG. 4 is a perspective view of a carrying case for a portable armoring system;
FIG. 5 is a simplified flow diagram illustrating a sequence of steps in a method according to the present invention; and
FIG. 6 is a perspective view of a portable shelter constructed of armor plates according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of lightweight armor plates, systems including same and methods of use thereof which can be employed to protect a target from damage caused by projectiles including, but not limited to, bullets.

Specifically, the present invention can be used to armor a vehicle or a portion thereof. Alternately, or additionally, the present invention may be employed to protect a structure such as a building or bus stop, or a portion thereof such as a window or a door. Alternately, the present invention may be employed as a portable bulletproof shelter for one or more people. Alternately, the present invention may be employed in construction of improved bulletproof clothing.

The principles and operation of lightweight armor plates, systems including same and methods of use thereof according to the present invention may be better understood with reference to the drawings and accompanying descriptions.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

For purposes of this specification and the accompanying claims, the term "projectile" includes, but is not limited to, a bullet fired from a weapon such as, for
example, an M-16, an AK-47 (i.e. Kalashnikov), a Galil assault rifle, an Uzi machine
gun, a pistol, a rifle or similar. Projectile further includes a collection of small
projectiles, for example buckshot fired from a shotgun shell or shrapnel from an
explosive device.

For purposes of this specification and the accompanying claims, the term
"explosive device" includes, but is not limited to, a hand grenade, a pipe bomb and an
explosive packet worn or carried by a suicide bomber. Specifically, suicide bombers are
known to include small metal pieces (e.g. screws, nails) within the explosive packet to
produce shrapnel. These small metal pieces are included within the definition of
projectile.

For purposes of this specification and the accompanying 'claims, the term
"impenetrable" indicates a capability of preventing penetration by a projectile fired from
a weapon at a distance of fifty meters, more preferably four to five meters, most
preferably zero to one meter from the armor plate.

Referring now to the drawings, Figure 1 illustrates a lightweight transparent
armor plate 20. Plate 20 includes at least one glass layer 22 placed to receive an initial
impact from a projectile 34 (pictured as an arrow) on an impact surface 36. Plate 20
further includes at least one plastic layer 26 or 28 situated behind glass layer 22 and
designed and constructed to be impenetrable by projectile 34 which is typically, but not
always, a bullet fired from a gun at close range as detailed hereinafore. Plastic layer 26
or 28 constitutes at least approximately 50% of a total weight of plate 20. Plate 20
further includes at least one adhesive 30 or 32. Adhesive 30 or 32 bonds two of the
layers of plate 20 together. Plate 20 is further designed and constructed so that a total
weight of the plate is less than approximately exactly 50 kg/M². Preferably plate 20 is
supplied in relatively small pieces so that a total weight of each piece does not exceed
20 kg, more preferably 15 kg, still more preferably 10 kg, most preferably 5 kg. The
degree of transparency of the plate permits visibility therethrough by a user thereof. This
means that plate 20 may be used as, for example, a face-shield of a helmet or a window
of a building or a vehicle. Preferably, plate 20 is used in conjunction with an existing
window, most preferably plate 20 is reversibly attachable to an existing window to
render it bulletproof. For these purposes, larger plates 20 or 40 may be preferred, for
example plates having dimensions of 1 X 2 M. Such large plates will weigh
approximately 100 kilos and would potentially require two people to install. Alternately or additionally, a single person operating installation equipment might be employed.

Plate 20 preferably has a total thickness in the range of approximately 30 to approximately 40 mm. This includes the thickness of at least one glass layer 22 and 24, the at least one plastic layer 26 and/or 28 and the at least one adhesive 30 and 32.

Figure 1 depicts a preferred embodiment of plate 20 which includes at least one glass layer composed of at least two glass layers 22 and 24. In this preferred embodiment of plate 20, at least one plastic layer 26 or 28 includes at least two plastic layers 26 and 28. The plastic layer may be constructed of a material selected from the group consisting of an acrylic plastic (e.g. 26) and polycarbonate (e.g. 28). Each plastic layer 26 or 28 may optionally be constructed of a number of thinner sheets of plastic bonded together until a desired thickness is achieved.

Preferably plate 20 further includes a reversible attachment device 38. For purposes of this specification and the accompanying claims, the phrase "reversible attachment device" includes, but is not limited to, at least one hook, at least one snap, at least one grommet, at least one cotter pin, Velcro™, at least one magnet, at least one suction cup, at least one button, at least one mounting bracket, at least one flexible strap, at least one engageable edge or combinations thereof. Reversibility of attachment may be achieved, for example, by installing a first portion of a reversible attachment device at a desired point of attachment and a companion portion of the reversible attachment device on the armor plate. Alternately, a reversible attachment device 38 may be reversibly attachable to both plate 20 and a desired point of attachment as depicted in Figure 3 of sling 60. Reversible attachment device 38 in the form of sling 60 includes at least one pocket 62 designed and constructed to engage and retain plate 20. Plate 20 may then be reversibly mounted, for example in a door of an automobile so that it covers a side window, by means of hooks 38 which slip over the doorframe surrounding the window. Preferably sling 60 includes additional pockets e.g. 64 and 66 attached by fasteners 70. Pockets 64 and 66 may accommodate additional plates 20 or 40 (Figure 2) to increase the area protected from projectile 34. Sling 60 may be mounted either on an exterior side or anterior side of a surface such as a car door. Plates 20 and 40 will conform to the size of the specific car door, or, more preferably, to a generic car
door dimension. Modifications in dimensions can easily produce slings 60 suited to a
variety of purposes including protection of various windows in a vehicle and windows
or doors of buildings.

Layers of plate 20 are preferably bonded one to another with at least one
adhesive such as, for example, PVB 30 or polyurethane 32. PVB 30 is typically
supplied as thin sheets which are heat-sealed to, for example, two layers of glass 22 and
24 or a glass layer 24 and a plastic layer (e.g. 26 or 28). Polyurethane 32 may be applied
as, for example, a liquid glue to bond acrylic 26 and/or polycarbonate 28 layers to each
other. Alternately, or additionally polyurethane 32 may be supplied as thin sheets which
are heat-sealed to bond two layers.

The present invention is further embodied by a lightweight opaque armor plate
40 (Figure 2). Plate 40 includes a first hardened metal layer 42, placed to receive an
initial impact from a projectile 34 on an impact surface 36. Plate 40 further includes a
force-dissipating layer, the force-dissipating layer 44 situated behind first hardened
metal layer 42. Force dissipating layer 44 is designed and constructed to absorb and
disperse energy from projectile 34. Force dissipating layer 44 may be constructed of a
material such as, for example polyurethane, Kevlar™, dynima, magnesium, aluminum,
an acrylic plastic or iron. Plate 40 further includes a second hardened metal layer 46
situated behind force dissipating layer 44 and designed and constructed to prevent
penetration by projectile 34. Preferably, the total weight of plate 40 is less than
approximately exactly 50 kg/M². Preferably plate 40 is supplied in relatively small
pieces so that a total weight of each piece does not exceed 20 kg, more preferably 15 kg,
still more preferably 10 kg, most preferably 5 kg. Plate 40 may be used as, for example,
a body shield, a portion of a helmet or a portable protective wall. Preferably, plate 40 is
used in conjunction with an existing surface such as, for example, a car door. Most
preferably plate 40 is reversibly attachable to an existing surface to render it bulletproof.

Preferably a total thickness of plate 40 is in the range of approximately 22 to
approximately 32 mm in order to provide protection from a rifle bullet. Thinner plates,
for example 6mm to 12 mm may be employed to provide protection from pistol bullets.
These thicknesses include the thicknesses of first and second hardened metal layers (42
and 46) and force dissipating layer 44. Preferably first and second hardened metal
layers (42 and 46) are each constructed of, for example, heat-treated aluminum or a heat-treated alloy (e.g. aluminum alloy). Thus, layers 42 and 46 may be similar in composition or different in composition.

The heat-treated aluminum alloy may include, for example, magnesium, copper, silicon or combinations thereof. Thus, according different preferred embodiments of the invention, the first and second hardened metal layers 42 and 46 may each independently contain materials including, but not limited to aluminum, magnesium, silicon, titanium, copper, manganese and chromium.

Examples of alloys known to be useful in construction hardened metal layers 42 and 46 are provided in table 1. These compositions are provided as examples only and are not intended to limit the scope of the invention. One ordinarily skilled in the art of metallurgy will be able to adjust the exact composition of an alloy to slightly alter weight or elasticity by adding, for example, rare earth metals such as tungsten, molybdenum or beryllium according to guidelines set forth in metallurgy texts. Addition of small quantities of such metals to the alloy is within the scope of the present invention.
TABLE 1: Alloys useful in construction of hardened metal layers

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>WEIGHT PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium (Mg)</td>
<td>0.3- 3.0</td>
</tr>
<tr>
<td>Silicon (Si)</td>
<td>0.0- 8.0</td>
</tr>
<tr>
<td>Titanium (Ti)</td>
<td>0.0- 1.0</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.0- 5.0</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.0- 1.0</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.0- 5.0</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>70.0-100.0</td>
</tr>
</tbody>
</table>

Thus, according to some preferred embodiments of the invention hardened metal layers 42 or 46 may include 0.45 to 0.6% magnesium; 6.7 to 7.5% silicon; approximately 0.2% titanium and aluminum, for example 91.7 to 92.65% aluminum.

According to alternate preferred embodiments of the invention hardened metal layers 42 or 46 may include 2.1 to 2.9% magnesium; 1.2 to 2% copper; approximately 0.3% manganese; 0.18 to 0.35% chromium and aluminum, for example 94.45 to 96.22% aluminum.

According to additional alternate preferred embodiments of the invention hardened metal layers 42 or 46 may include 1.2% to 1.8% magnesium; 3.8 to 4.9% copper; approximately 0.3 to 0.9% manganese; and aluminum, for example 92.4 to 94.7% aluminum.

According to further additional alternate preferred embodiments of the invention hardened metal layers 42 or 46 may include 0.8 to 1.2% magnesium; 0.15 to 0.4% copper; approximately 0.4 to 0.8% silicon; and aluminum, for example 97.6 to 98.65% aluminum.

Methods for preparation of alloys are well known in the art and detailed description of common methods may be found, for example, in "Principles of Metal Casting" (eds.. Heine and Rosenthal, McGraw Hill Book Co.; 1955). and in "Symposium on Principles of Gating" published by the American Foundrymen's Society (1951) or in "Casting Aluminum" by C.W. Ammen (Tab Books Inc.;1985) or in
"Metallurgy of Aluminum Alloys by M. van Lancker (Chapman and Hall Ltd.; 1967). Each of these texts is fully included herein by reference.

The term "heat treatment" or "heat treated" as used herein preferably refers to a process which includes precipitation hardening, tempering, solution treatment or combinations thereof. As used herein, the term "tempering" specifically includes rapid cooling, for example by immersion in a chilled water bath or ice and water slurry.

Thus, one method for preparation of a hardened metal alloy according to the present invention includes solution treatment followed by tempering in an ice/water bath followed by precipitation hardening. This process imparts previously unachieved properties to the resultant alloy, for example elongation of 11%.

Solution treatment may be accomplished, for example by heating the alloy (e.g. aluminum alloy) to a temperature in excess of 500 degrees centigrade, more preferably 540 to 550 degrees centigrade, most preferably approximately 543 degrees centigrade a period of two to eighteen hours. The alloy is subsequently cooled to less than 60 degrees centigrade, more preferably 20 to 30 degrees centigrade by immersion in a liquid bath, for example an ice/water bath or chilled acetone/ethanol bath for four to ten seconds. This process imparts a "potential hardness" to the alloy.

Precipitation hardening may be accomplished by, for example, heating the alloy to a moderate temperature, preferably 150 to 170 degrees more preferably 155 to 165 degrees centigrade. Preferably, precipitation hardening is performed 24 hours or more after solution treatment.

These industrial processes are described in greater detail in American Standards MIL-A-21180 (casting); MIL-A-6088 (heat treatment) and MIL-ASTM-B26 (all published by the U.S. Government Printing office; 1971) which are fully incorporated herein by reference.

Preferably plate 40 further includes a reversible attachment device 38 as defined hereinabove. Thus, attachment device 38 may be, for example, sling 60 as pictured in figure 3 and described hereinabove. Alternatey, but also preferably, attachment device 38 may take the form of suction cups as pictured in Figure 2.

In order to facilitate ease of handling, plate 40 further includes a coating 48. Coating 48 may be, for example, rubber, plastic or fabric. Preferably fabric coatings are bonded to plate 40 with a suitable adhesive.
The present invention is further embodied by a system for protecting a target from impact by a projectile 34. The system includes at least one lightweight armor plate (e.g. 20 or 40; as described hereinabove) and a positioning device (e.g. 60 or 38) designed and constructed to engage and retain at least one lightweight armor plate 20 and/or 40 in a position between the target and projectile 34. Preferably, a total weight of the armor plate is less than approximately exactly 50 kg/M² and the armor plate is supplied in lightweight easily handled pieces as described hereinabove.

Positioning device 60 may alternately be embodied by a reversible attachment device 38 as defined hereinabove, a permanent attachment device (e.g. screws, nails, rivets, cement or glue), a base and an article of clothing modified to accommodate the at least one lightweight armor plate.

A base may be, for example a polygonal solid with an opening designed to engage and retain at least a portion of an edge of plate 20 or 40. Alternately, a base may be an assembly of legs, preferably collapsible legs.

An article of clothing modified to accommodate the at least one lightweight armor plate 20 or 40 may be produced, for example, by incorporating pockets designed to engage and retain plates 20 or 40 into, for example, the legs of a pair of trousers. Alternately, or additionally, plates 20 or 40 may be sown between layers of fabric when manufacturing a garment. The garment, in these cases, functions as reversible attachment device 38.

Alternately, or additionally, the invention may take the form of a portable bulletproof shelter 58 as depicted in Figure 6. Shelter 58 includes rigid supports 72 upon which pockets 62, 64, and 66 are arranged. Plates 20 and 40 are installed in pockets 62, 64, and 66. Wheels 74 allow a user of shelter 58 to easily adjust the location and/or position of shelter 58 during use. Transparent plate 20 allows visibility during use. Opaque plates 40 are employed in areas where visibility is not required. Reversible attachment devices 38 allow removal and insertion of plates 20 or 40. This facilitates assembly. Shelter 58 is preferably supplied in one or more carrying cases 80 as depicted in Figure 4.

The present invention is further embodied by a method 100 of protecting a target from impact by a projectile 34. Method 100 includes ascertaining 102 at least
one source from which a projectile 34 is likely to emanate and employing 104 a positioning device to engage and retain at least one lightweight armor plate (e.g. 20 or 40) in a position between the target and the at least one source from which a projectile is likely to emanate.

Method 100 preferably further includes causing 106 a total weight of the armor plate to be less than approximately exactly 50 kg/M². This may be accomplished, for example providing 108a transparent armor plate 20 as described hereinabove and or an opaque armor plate 40 as described hereinabove.

Employing 104 a positioning device may include employing, for example, a reversible 112 attachment device 38 as described hereinabove, a permanent 110 attachment device, a base (e.g. wheels 74 in Figure 6) or an article of clothing 114 modified to accommodate the at least one lightweight armor plate.

As an illustrative, non-limiting, example of use of the armored plates, system and method of the present invention, the following story of a telephone repairman is provided. The repairman typically drives his repair truck within the city limits of Utopia, where no shooting has occurred in recent memory. However, the outlying suburb of Chaos is within his service area and, occasionally he must travel north along a highway which passes past the village of Hades. Inhabitants of Hades habitually shoot at vehicles passing their village on the highway.

The repairman uses one of twenty repair trucks in the fleet of the telephone company. Each day he is assigned an available vehicle when he reports to work. The phone company has equipped all twenty vehicles with reversible attachment devices 38 in the form of metal snaps. The cost of installing snaps on all twenty vehicles was negligible compared to the cost of a single workmen's compensation lawsuit from an employee injured or killed by gunfire. Snaps are installed on the interior of the driver side door, the interior of the passenger side door and the interior of the frame surrounding the front windscreen and the midline of the ceiling over the front seat.

One day, the repairman reports for work and sees that he has a repair call in Chaos on his list of stops. Before beginning his daily rounds he stops at the dispatcher's office and requests one of three armoring kits purchased by the phone company to serve their twenty vehicles. The kit includes two suitcases 80 (Figure 4), each of which is equipped with a handle 82 and a closure means (e.g. zipper 79). One suitcase contains a
sling 60 with a small transparent armored plate 20 and two opaque armored plates 40. The total weight of this case, including contents is about 20 kilos. The second case contains a transparent plate 20, designed to cover a third, more preferably a half, of the front windscreen of the repair truck and weighing 10-30 kilos, more preferably 11-16 kilos. The repairman loads the two cases into the back of his truck.

As he approaches the city limits of Utopia, he stops the truck and assembles the armor system. Assembly and mounting is accomplished quickly, preferably in less than 2 minutes, more preferably in approximately 1 minute or less. He first mounts sling 60 on the interior of the driver side door. He then inserts a transparent plate 20 into pocket 62 of sling 60 and two opaque plates 40 into pockets 64 and 66 of sling 60. An additional transparent plate 20 is affixed to snaps on the interior frame of the front windscreen so that the left (driver's) side of the front windscreen is armored. The repairmen has chosen to employ 104 this configuration of positioning devices for plates 20 and 40 because he has ascertained 102 that projectiles 34 are most likely to emanate from Hades, which will be on his left as he travels north from Utopia to Chaos. The repairman travels without incident to Chaos.

Prior to returning to Utopia, the repairman moves sling 60 so that it hangs from snaps along the midline of the cabin interior. This positioning 104 is chosen because Hades will be on his right side as he travels south from Chaos to Utopia. Plate 20 on the front windscreen is not moved for the return trip. On his return trip, a sniper crouching in bushes three meters from the highway opens fire on the repair truck with an automatic rifle. Four projectiles 34 hit the repair truck. The first projectile 34 hits the left side of the front windscreen where it is stopped by plate 20 installed there, the second projectile 34 hits the right side of the front windscreen and then plate 40 in sling 60 hanging in the center of the passenger cabin. The third projectile hits the right front window of the truck and is similarly stopped by plate 40 in sling 60 hanging in the center of the passenger cabin. The fourth projectile hits the rear portion of the right side of the truck and passes through the truck behind the driver.

The glass layer 22 of plate 20 installed in the front windscreen is preferably replaced as it is cracked from the impact of the first projectile. Similarly, the front windscreen and front passenger side window of the truck are preferably replaced. However, the repairman has not been injured by projectiles 34 or glass shrapnel.
It will be appreciated that, if the repairman lived in Chaos, he could use the same armoring kit (plates 20 and 40, sling 60 and cases 80, for his own car and for his repair truck provided that reversible attachment devices are available in both vehicles. Alternately, or additionally, if the repairman visited Chaos frequently, he might choose to leave one or more components of the armoring kit installed all the time, instead of assembling and mounting them for specific trips.

Alternately, or additionally, two people traveling in the same vehicle could combine two kits to armor the full front windscreen and both front doors. Additional armoring kits could add protection to additional portions of a vehicle since the system of the present invention is fully modular.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.
WHAT IS CLAIMED IS:

1. A lightweight transparent armor plate, the plate comprising;
   (a) at least one glass layer placed to receive an initial impact from a
       projectile;
   (b) at least one plastic layer, said plastic layer situated behind said glass
       layer and designed and constructed to be impenetrable by said projectile, said plastic
       layer comprising at least approximately 50% of a total weight of the plate.
   (c) at least one adhesive, said adhesive bonding two of said layers
       together;

       wherein said total weight of the plate is less than approximately exactly 50
       kg/M² of the plate and wherein a degree of transparency thereof permits visibility
       therethrough by a user thereof.

2. The transparent plate of claim 1, wherein a total thickness of said at
   least one glass layer, said at least one plastic layer and said at least one adhesive is in
   the range of approximately 30 to approximately 40 mm.

3. The transparent plate of claim 1, wherein said at least one glass layer
   comprises at least two glass layers.

4. The transparent plate of claim 1, wherein said at least one plastic layer
   comprises at least two plastic layers.

5. The transparent plate of claim 1, wherein said at least one plastic layer
   is constructed of a material selected from the group consisting of an acrylic plastic
   and polycarbonate.

6. The transparent plate of claim 1, further comprising a reversible
   attachment device.

7. The transparent plate of claim 1, wherein said at least one adhesive is
   selected from the group consisting of PVB (polyvinyl butyrale) and polyurethane.
8. A lightweight opaque armor plate, the plate comprising:
   (a) a first hardened metal layer, said first hardened metal layer placed to receive an initial impact from a projectile;
   (b) a force dissipating layer, said force dissipating layer situated behind said first hardened metal layer and being designed and constructed to absorb and disperse energy from said projectile,
   (c) a second hardened metal layer, said second hardened metal layer situated behind said force dissipating layer and being designed and constructed to prevent penetration by said projectile;
   wherein a total weight of the plate is less than approximately exactly 50 kg/M² of the plate.

9. The opaque plate of claim 8, wherein a total thickness of said first and second hardened metal layers and said force dissipating layer is in the range of approximately 22 to approximately 32 mm.

10. The opaque plate of claim 8, wherein said first and second hardened metal layers are each independently constructed of a material selected from the group consisting of heat treated aluminum and a heat-treated alloy.

11. The opaque plate of claim 8, wherein said first and second hardened metal layers each independently contain at least one material selected from the group consisting of aluminum, magnesium, silicon, titanium, copper, manganese and chromium.

12. The opaque plate of claim 8, further comprising a reversible attachment device.

13. The opaque plate of claim 8, wherein said force dissipating layer is constructed of a material selected from the group consisting of polyurethane, Kevlar™, dynima, an acrylic plastic, magnesium, aluminum and iron.
14. The opaque plate of claim 8, further comprising a coating.

15. A system for protecting a target from impact by a projectile, the system comprising:
   (a) at least one lightweight armor plate; and
   (b) a positioning device designed and constructed to engage and retain
   said at least one lightweight armor plate in a position between the target and the projectile;
   wherein a total weight of said armor plate is less than approximately exactly
   50 kg/M².

16. The system of claim 15, wherein said at least one lightweight armor plate is selected from the group consisting of:
   (i) a transparent armor plate comprising;
       (1) at least one glass layer placed to receive an initial impact from a projectile;
       (2) at least one plastic layer, said plastic layer situated behind said glass layer and designed and constructed to be
           impenetrable by said projectile, said plastic layer comprising at least
           approximately 50% of said total weight of the plate.
       (3) at least one adhesive, said adhesive bonding two of
           said layers together;
   wherein a degree of transparency thereof permits visibility therethrough by a user thereof; and
   (ii) an opaque armor plate comprising:
       (1) a first hardened metal layer, said first hardened metal layer placed to receive an initial impact from a projectile;
       (2) a force dissipating layer, said force dissipating layer situated behind said first hardened metal layer and being designed and
           constructed to absorb and disperse energy from said projectile,
19.  A method of protecting a target from impact by a projectile, the method comprising:

(a) ascertaining at least one source from which a projectile is likely to emanate; and

(b) employing a positioning device to engage and retain at least one lightweight armor plate in a position between the target and said at least one source from which a projectile is likely to emanate.

19.  The method of claim 18, further comprising causing a total weight of said armor plate to be less than approximately exactly 50 kg/M².

20.  The method of claim 18, further comprising providing said at least one lightweight armor plate, wherein said lightweight armor plate includes at least one item selected from the group consisting of:

(i) a transparent armor plate comprising;

(1) at least one glass layer placed to receive an initial impact from a projectile;

(2) at least one plastic layer, said plastic layer situated behind said glass layer and designed and constructed to be impenetrable by said projectile, said plastic layer comprising at least approximately 50% of said total weight of the plate.

(3) at least one adhesive, said adhesive bonding two of said layers together;
wherein a degree of transparency thereof permits visibility therethrough by a user thereof; and

(ii) an opaque armor plate comprising:

(1) a first hardened metal layer, said first hardened metal layer placed to receive an initial impact from a projectile;

(2) a force dissipating layer, said force dissipating layer situated behind said first hardened metal layer and being designed and constructed to absorb and disperse energy from said projectile,

(3) a second hardened metal layer, said second hardened metal layer situated behind said force dissipating layer and being designed and constructed to prevent penetration by said projectile.

21. The method of claim 18, wherein said employing a positioning device includes employing at least one item selected from the group consisting of a reversible attachment device, a permanent attachment device, a base and an article of clothing modified to accommodate said at least one lightweight armor plate.

22. The opaque plate of claim 8, wherein a total thickness of said first and second hardened metal layers and said force dissipating layer is in the range of approximately 6 to approximately 12 mm.
FIGURE 3
ascertain source from which projectile is likely to emanate (102)

Provide transparent and/or opaque armor plate(s) (108)

cause total weight of armor plate to be less than 50 kg/m² (106)

employ positioning device to engage and retain armor plate (104)

Permanent fixation (110)

base (116)

Modified article of clothing (114)

Reversible fixation (112)