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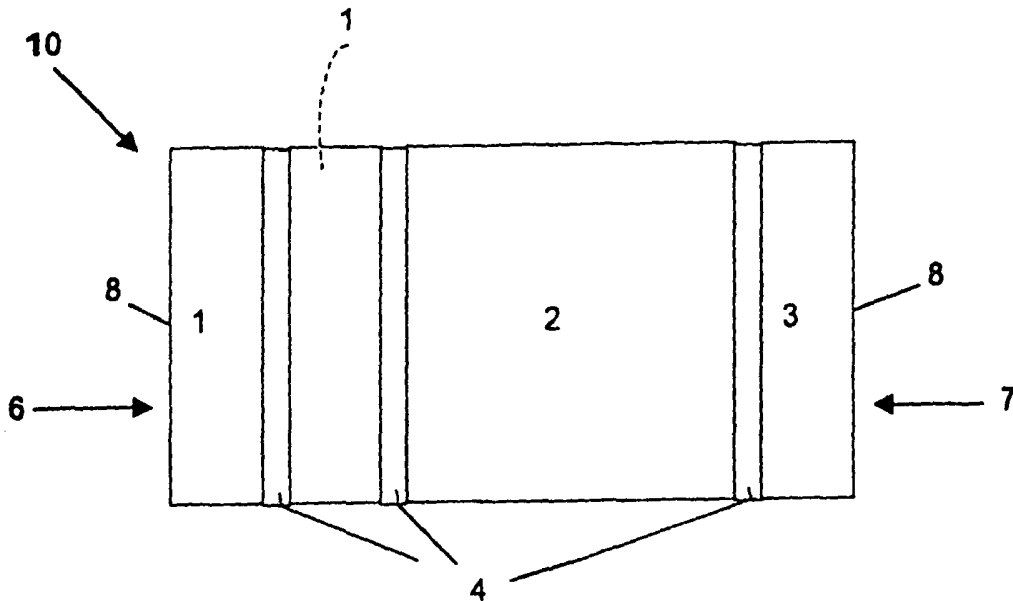
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(54) Title: ONE WAY BULLET-RESISTANT TRANSPARENT PANEL MEETING NIJ LEVEL III STANDARDS AND ARMOR PIERCING BULLET-RESISTANT TRANSPARENT PANEL



(57) Abstract: Transparent panels having unidirectional bullet-resisting characteristics contain at least one sheet of glass, several intermediate sheets formed of an acrylic resin or further glass sheets, and an inner sheet formed of a polycarbonate resin. A transparent adhesive bonds the sheets to each other to form the panel. The level of bullet resistance capability is measured according to NIJ standards and the panels have a Level III or Level IV rating.

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ONE WAY BULLET-RESISTANT TRANSPARENT PANEL MEETING NIJ
LEVEL III STANDARDS AND ARMOR PIERCING
5 BULLET-RESISTANT TRANSPARENT PANEL

Technical Field:

The invention relates generally to bullet-resistant transparent panels and more specifically to unidirectional
10 bullet-resistant transparent panels meeting National Institute of Justice (NIJ) Standard Level III and to transparent panels that resist armor piercing bullets.

Many prior art panels are formed of front or impact shock receiving layers formed of glass and solid resinous
15 materials such as polycarbonate, acrylic and rubber-modified acrylics, among many other materials. The back layer, facing away from the direction of impact, is generally formed of a polycarbonate.

One type, as described for example in U.S. Patent No.
20 4,594,290, to Fischer et al., is formed of transparent sheets of glass or cast acrylic, a polyurethane sheet and a urethane-modified acrylic sheet. However, such protective panels are not unidirectional and these panels prevent bullet penetration from either side.

25 U.S. Patent 5,747,159 to Labock teaches a panel having unidirectional bullet-resisting properties. The panel is formed of an outer sheet of an acrylic resin and an inner sheet of a polycarbonate resin. In order to meet NIJ Standard Level III, the panel is both thick, 41.6 - 45.6
30 mm, and heavy 80-90 Kg per square meter.

Disclosure of Invention:

This invention relates to a one way bullet-resistant transparent panel meeting NIJ level III standards and an armor piercing bullet-resistant transparent panel which for products of this type is comparatively light, thin, bullet-resistant, and provides unidirectional characteristics.

It has been surprisingly found, as will be shown more particularly below, that when the glass, acrylic and polycarbonate sheets are of the below described thicknesses, the laminated panel exhibits unidirectional bullet-resisting characteristics. The panels of the present invention are particularly useful in constructing enclosures, such as in/on a vehicle, a protective cage for a teller, or other such protective closures. In addition to the panel protecting against projectiles such as bullets and other shells fired from "outside" at the panel, the panel permits insiders to fire weapons against the attackers through the panel.

With the foregoing and other objects in view there is provided, in accordance with the invention, a panel effective for blocking penetration of a bullet. The panel is formed of an outer sheet formed of glass, an acrylic resin layer having a thickness of about 25 to about 35 mm, an inner sheet formed of a polycarbonate resin, and an adhesive bonding the outer sheet, the acrylic resin layer, and the inner sheet to each other.

Preferably the outer sheet has a thickness of about 4 mm to about 8 mm, and the inner sheet has a thickness of about 4 mm to about 8 mm. In addition, the adhesive has a thickness of about 0.1 mm to about 2 mm.

At least one of the outer sheet and the inner sheet has a scratch-resistant coating formed thereon on a face thereof not coated with the bonding adhesive.

In accordance with a feature of the invention, the
5 outer sheet, the acrylic resin layer, and the inner sheet have a flat or curved configuration. For example, the outer sheet, the acrylic resin layer, and the inner sheet are bonded to each other to have a shape of a windshield.

Ideally, the outer sheet has a thickness of about 6
10 mm, the acrylic resin layer has a thickness of about 30 mm, the inner sheet has a thickness of about 6 mm, and the bonding adhesive is disposed between the sheets and the layer and has a thickness of about 1.3 mm.

The panel has a first side and a second side, the
15 panel prevents an object from penetrating the first side but allows a bullet to traverse the panel when fired at the second side. More specifically, the panel meets National Institute of Justice Standard Level III for bullet penetration prevention.

20 With the foregoing and other objects in view there is further provided, in accordance with the invention, a transparent panel effective for blocking the penetration of a bullet. The transparent panel is formed of a first glass sheet, a second glass sheet bonded to the first glass
25 sheet, a first acrylic sheet bonded to the second glass sheet, a second acrylic sheet bonded to the first acrylic sheet, a third acrylic sheet bonded to the second acrylic sheet, a polycarbonate sheet bonded to the third acrylic sheet, a first side, and a second side. The transparent
30 panel meets National Institute of Justice Standard Level IV and prevents a penetration of a bullet through the transparent panel when fired at the first side, but allows

a penetration of a further bullet through the transparent panel when fired at the second side.

Preferably, the first glass sheet has a thickness in a range of about 4 mm to about 8 mm, the second glass sheet has a thickness in a range of about 10 mm to about 14 mm, the first, second and third acrylic sheets each have a thickness in a range of about 7 mm to about 12 mm, and the polycarbonate sheet has a thickness in a range of about 4 mm to about 8 mm.

10 In accordance with a feature of the invention, the first and second glass sheets are annealed glass sheets.

In accordance with a preferred embodiment of the invention, the first glass sheet has a thickness of about 6 mm, the second glass sheet has a thickness of about 12 mm, the first, second and third acrylic sheets each have a thickness of about 9.5 mm, and the polycarbonate sheet has a thickness of about 6 mm.

With the foregoing and other objects in view there is additionally provided, in accordance with the invention, a panel effective for blocking the penetration of a bullet. The panel is formed of a first glass sheet, a second glass sheet bonded to the first glass sheet, an acrylic sheet bonded to the second glass sheet, a polycarbonate sheet bonded to the acrylic sheet, a first side, and a second side. The panel meets National Institute of Justice Standard Level IV and prevents a penetration of the bullet through the panel when fired at the first side, but allows a penetration of a further bullet through the panel when fired at the second side.

30 In a preferred embodiment of the invention, the first glass sheet has a thickness in a range of about 4 mm to about 8 mm, the second glass sheet has a thickness in a range of about 10 mm to about 14 mm, the acrylic sheet has

a thickness in a range of about 25 mm to about 35 mm, and the polycarbonate sheet has a thickness in a range of about 4 mm to about 8 mm.

In accordance with an added feature of the invention, the first glass sheet has a thickness of about 6 mm, the second glass sheet has a thickness of about 12 mm, the acrylic sheet has a thickness of about 30 mm, and the polycarbonate sheet has a thickness of about 6 mm.

With the foregoing and other objects in view there is yet additionally provided, in accordance with the invention, a panel effective for blocking the penetration of a 50 caliber bullet. The panel is formed of a first glass sheet, a second glass sheet bonded to the first glass sheet, a third glass sheet bonded to the second glass sheet, a fourth glass sheet bonded to the third glass sheet, a fifth glass sheet bonded to the fourth glass sheet, and a polycarbonate sheet bonded to the fifth glass sheet.

In accordance with another feature of the invention, the first glass sheet has a thickness of about 4 mm to about 8 mm, the second glass sheet has a thickness of about 15 mm to about 24 mm, the third glass sheet has a thickness of about 15 mm to about 24 mm, the fourth glass sheet has a thickness of about 15 mm to about 24 mm, the fifth glass sheet has a thickness of about 8 mm to about 15 mm, and the polycarbonate sheet has a thickness of about 4 mm to about 8 mm.

In accordance with another feature of the invention, the adhesive is a polyvinyl butural copolymer, urethane, or a polyester copolymer for bonding the sheets to each other.

In accordance with a concomitant feature of the invention, the first glass sheet has a thickness of about 6 mm, the second glass sheet has a thickness of about 19.5

mm, the third glass sheet has a thickness of about 19.5 mm, the fourth glass sheet has a thickness of about 19.5 mm, the fifth glass sheet has a thickness of about 12.5 mm, and the polycarbonate sheet has a thickness of about 6 mm.

5

Brief Description of Drawings:

Fig. 1 is a diagrammatic, sectional view of a first embodiment of a bullet-resistant panel according to the invention;

10 Fig. 2 is a diagrammatic, sectional view of a second embodiment of the bullet-resistant panel according to the invention;

Fig. 3 is a diagrammatic, sectional view of a third embodiment of the bullet-resistant panel according to the invention; and

15 Fig. 4 is a diagrammatic, sectional view of a fourth embodiment of the bullet-resistant panel according to the invention.

20 Best Mode for Carrying out the Invention:

Referring now to the figures of the drawings in detail and first, particularly to Fig. 1, thereof, there is shown a first embodiment of a bullet-resistant panel 10. The bullet-resistant panel 10 is formed of an outer transparent sheet 1 of glass, a layer of an acrylic resin sheet 2, and an inner transparent sheet 3 of a polycarbonate resin. A transparent polyurethane or urethane adhesive 4 is disposed between the sheets 1-3 bonding them together to form the integral panel 10.

30 The acrylic resin sheet 2 has a high degree of hardness, but is somewhat brittle. On the other hand, the polycarbonate resin sheet 3 is less hard than the acrylic resin sheet 2, but is elastic or less brittle. By using

the combination of the three types of sheets 1, 2, 3 to form the panel 10, the outer glass sheet 1 and the acrylic resin sheet 2 impart a high degree of hardness to an outer face of the panel 10 receiving an impact, such as by a projectile, for example a shell, shell fragments, a bullet, a stone, a rock or the like, and attenuates the force of the impact. The polycarbonate resin sheet 3 on the inner face of the panel 10 absorbs the attenuated force and supports the acrylic resin sheet 2 against breaking or shattering. The combination of the three sheets 1, 2, 3 thus provide a high degree of resistance against penetration or shattering by a projectile.

Surprisingly, it has been found that the panel 10 illustrated in Fig. 1 has unidirectional bullet-resisting characteristics if the sheets 1-3 are made of predetermined thicknesses. Most preferably, the outer transparent sheet 1 of glass has a thickness of about 4 mm to about 8 mm, preferably about 6 mm, the acrylic resin sheet 2 has a thickness about 25 to about 35 mm, and the inner transparent sheet 3 of polycarbonate resin has a thickness of about 4 mm to about 8 mm, preferably about 6 mm. The sheets 1, 2, 3 are bonded together by the transparent polyurethane or urethane adhesive 4. Such a panel has been found to block the penetration of a 7.62 x 39 mm, 7.62 x 51 mm, and 5.51 x 45 mm bullets when fired from a first side of the outer glass sheet 1, but not when fired from a second side of the inner polycarbonate resin sheet 3. In other words, from the second or inner side one can shoot a bullet through the panel from the inner side and the panel 10 will at least partially self-seal itself after the bullet has passed through the panel 10.

The outer transparent sheet 1 is formed of standard glass. The polycarbonate sheet 3 is manufactured by GE.

The acrylic resin sheet 2 is a cast acrylic sheet also manufactured by GE.

The adhesive 4 is a clear liquid polyurethane or urethane adhesive commonly available for bonding polycarbonate to itself, glass or metal. In general the adhesive has an elongation of about 300%, and is preferably applied at a thickness of about 0.1 to about 2 mm, and most preferably is applied at a thickness of about 1.3 mm.

Significant results are obtained when the panel 10 is formed as now described. The outer transparent sheet 1 of glass is about 5.5 mm or 6 mm, the acrylic resin sheet 2 is about 30 mm, the inner transparent sheet 3 formed of polycarbonate has a thickness of about 5.5 mm or 6 mm, and the transparent polyurethane adhesive 4 has a thickness of about 1.3 mm.

The outer transparent sheet 1 and/or the inner transparent sheet 3 optionally has a scratch-resistant coating 8 formed thereon on a face thereof not containing the transparent adhesive 4.

The panel 10 has a layered type of construction. Each layer has uniform mechanical properties that are insulated by the bonding agent 4 and the selection and thickness of the bonding agent can have a significant impact on the worthiness of the panel 10. Due to the layered construction, an incoming projectile requires more energy to penetrate the multiple layers when properly bonded.

Optionally, the transparent panel 10 shown in Fig. 1 can be modified by adding a second glass layer 1 having a thickness of about 4 mm to about 8 mm and has good properties at about 5.5 mm or 6 mm. The second glass layer 1 is shown by a dashed indicator line in Fig. 1. The second glass layer 1 provides extra hardness that adds to the bullet stopping power of the transparent panel 10.

Fig. 1 illustrates the transparent panel 10 having a flat configuration, such as may be used for side windows on a vehicle, building windows, windows for protective cages and the like. It will be appreciated that the panel can be shaped, angled, curved and/or bent and is not restricted to the flat configuration shown and can be used for other configurations such as windshields, curved glass panels and the like.

Fig. 2 is a second embodiment of a transparent panel 20 according to the invention. The second embodiment is an NIJ Level IV panel (armor piercing) panel that also has the one-way properties as in the first embodiment. On the return side or shooting out, NIJ Level III non-armor piercing ammo can be used. More specifically, the second embodiment will also stop armor piercing bullets from penetrating from a first direction 28 but will allow bullets (e.g. non-armor piercing) to penetrate from a second or other direction 29 as in the first embodiment. The bullets penetrating from the permeable side will retain approximately 75% of their velocity upon exiting the panel 20.

The panel 20 is bonded together to maintain the properties of a one-piece assembly. The individual mechanical characteristics of the materials used in each layer act independently and are not affected by the mechanical characteristics of the other layers or by the applied bonding agent such as bonding with urethane based adhesives or glues.

Fig. 2 shows the panel 20 formed of a first glass layer 21 having a thickness of about 4 - 8 mm, preferably about 6 mm, a second glass layer 22 having a thickness of about 10 - 14 mm, preferably about 12 mm, a first acrylic layer 23 having a thickness of about 7 - 12 mm, preferably

about 9.5 mm, a second acrylic layer 24 having a thickness of about 7 - 12 mm, preferably about 9.5 mm, a third acrylic layer 25 having a thickness of about 7 - 12 mm, preferably about 9.5 mm, and a polycarbonate layer 26
5 having a thickness of about 4 - 8 mm, preferably about 6 mm. The layers 21-26 are bonded together using an adhesive 27 such as urethane or polyurethane.

The glass layers 21, 22 may be standard glass or annealed glass which is glass that has been softened
10 usually by a thermal process. More specifically, annealed glass is not as rigid and brittle as standard glass.

The second embodiment enjoys several advantages over prior art panels. First, the panel 20 has a high bullet blocking capability and can block armor piercing ammo.
15 Second, there is no distortion of objects or images seen through the panel 20. Third, a high level of clarity is achieved and thus the panel 20 is idea for use as windshields. Fourth, the panel 20 provides unidirectional bullet blocking behavior and unidirectional bullet
20 permeable behavior.

Fig. 3 shows a third embodiment of a bullet-resistant panel 30. The third embodiment is also an NIJ Level IV panel (armor piercing) panel that also has the one-way properties as in the first embodiment. On the return side
25 or shooting out side, NIJ Level III non-armor piercing ammo can be used. More specifically, the third embodiment will also stop bullets from penetrating from a first direction 41 but will allow bullets to penetrate from a second or other direction 42 as in the first and second embodiments.
30 The bullets penetrating from the permeable side will retain approximately 75% of their velocity upon exiting the panel 30.

As with the first and second embodiments, the third embodiment can be installed on vehicles, buildings, guard towers, windshields and any other installations that require a high level of light transparency and minimum distortion and at the same time the ability to withstand armor piercing shells and bullets.

The panel 30 is formed of a first sheet 31 of glass and has a range of about 4 to about 8 mm, ideally about 6 mm. A second sheet 33 of glass is bonded to the first sheet 31. A bonding agent 32 that is clear and has the desired light transparency properties is used. The second sheet 33 has a thickness in a range of about 10 to about 14 mm, ideally about 12 mm. A third sheet 35 of an acrylic layer is bonded to the second sheet 33 using the adhesive 32. The third sheet 35 has a thickness in a range of about 25 to about 35 mm, ideally about 30 mm. A fourth sheet 39 of a polycarbonate layer is bonded to the third sheet 35. The fourth sheet 39 has a thickness in a range of about 4 to about 8 mm, ideally about 6 mm. A scratch resistance layer 40 is optionally applied onto the polycarbonate sheet 39.

The bonding agent 32 is preferably polyester or PVB. PVB or polyvinyl butural is a synthetic material in the form of a film and is commercially available in different thicknesses. The bonding agent 32 has a thickness of about 0.03 mm. Alternatively, a urethane or polyurethane having a thickness of .06 - 2 mm could be used. Of course the bonding agent 32 is merely exemplary as many types of adequate bonding agents are available.

The transparent panel 30 will generally be capable of resisting penetration against 7.62 x 39 caliber (Kalachnikov AK-47) armor piercing and 5.56 (M-16) armor

piercing bullets. The panel 30 meets the NIJ Level IV standard for armor piercing bullets.

It is further noted that as in the first and second embodiments of the present invention the third panel 30 is also unidirectional. The panel 30 will block the penetration of a bullet when fired from side 41 of the outer glass sheet 31, but not when fired from side 42 of the inner polycarbonate sheet 39.

Fig. 4 shows a fourth embodiment of a bullet-resistant panel 50. The unique feature of the panel 50 is that it will stop a 50 caliber bullet. However, the panel 50 is not unidirectional. The panel 50 is formed of a first glass layer 51 having a thickness of about 4 to about 8 mm, preferably about 6 mm. A second glass layer 52 is adjacent the first glass layer 51 and has a thickness of about 15 to about 24 mm, preferably about 19.5 mm. A third glass layer 53 is adjacent the second glass layer 52 and has a thickness of about 15 to about 24 mm, preferably about 19.5 mm. A fourth glass layer 54 is adjacent the third glass layer 53 and has a thickness of about 15 to about 24 mm, preferably about 19.5 mm. A fifth glass layer 55 is adjacent the fourth glass layer 51 and has a thickness of about 8 to about 15 mm, preferably about 11.5 mm. A sixth polycarbonate layer 56 is adjacent the fifth glass layer 55 and has a thickness of about 4 to about 8 mm, preferably about 6 mm.

A bonding agent 57 preferably polyester, PVB, or urethane is used to bond the first through sixth panels 51-56 to each other.

As noted above, the panel 50 will stop a 50 caliber projectile shot when shot at a first side 58.

Claims

1. A panel effective for blocking penetration of a bullet,
the panel comprising:

5

an outer sheet formed of glass;

an acrylic resin layer having a thickness of about 25 to
about 35 mm;

10

an inner sheet formed of a polycarbonate resin; and

an adhesive bonding said outer sheet, said acrylic resin
layer, and said inner sheet to each other.

15

2. The panel according to claim 1, wherein:

said outer sheet has a thickness of about 4 mm to about 8
mm; and

20

said inner sheet has a thickness of about 4 mm to about 8
mm.

3. The panel according to claim 1, wherein said adhesive
has a thickness of about 0.1 mm to about 2 mm.

25

4. The panel according to claim 1, wherein at least one of
said outer sheet and said inner sheet has a scratch-
resistant coating formed thereon on a face thereof not
coated with said bonding adhesive.

30

5. The panel according to claim 1, wherein said outer sheet, said acrylic resin layer, and said inner sheet have a flat or curved configuration.

5 6. The panel according to claim 1, wherein said acrylic resin layer is disposed between said inner sheet and said outer sheet.

7. The panel according to claim 2, wherein:

10

said outer sheet has a thickness of about 6 mm;

said acrylic resin layer has a thickness of about 30 mm;

15 said inner sheet has a thickness of about 6 mm; and

said bonding adhesive is disposed between said sheets and said layer and has a thickness of about 1.3 mm.

20 8. The panel according to claim 1, wherein said outer sheet, said acrylic resin layer, and said inner sheet bonded to each other have a shape of a windshield.

9. The panel according to claim 1, wherein said outer
25 sheet, said acrylic resin layer, and said inner sheet bonded to each other have a curved shape.

10. The panel according to claim 1, wherein the panel has a first side and a second side, the panel preventing an
30 object from penetrating said first side but allowing a bullet to traverse the panel when fired at said second side.

11. The panel according to claim 1, wherein the panel meets National Institute of Justice Standard Level III for bullet penetration prevention.

5 12. A transparent panel effective for blocking penetration of a bullet, the transparent panel comprising:

a first glass sheet;

10 a second glass sheet bonded to said first glass sheet;

a first acrylic sheet bonded to said second glass sheet;

a second acrylic sheet bonded to said first acrylic sheet;

15

a third acrylic sheet bonded to said second acrylic sheet;

a polycarbonate sheet bonded to said third acrylic sheet;

20 a first side; and

a second side, the transparent panel meeting National Institute of Justice Standard Level IV and preventing a penetration of the bullet through the transparent panel

25 when fired at said first side, but allowing a penetration of a further bullet through the transparent panel when fired at said second side.

13. The transparent panel according to claim 12, wherein

30

said first glass sheet has a thickness in a range of about 4 mm to about 8 mm;

said second glass sheet has a thickness in a range of about 10 mm to about 14 mm;

said first, second and third acrylic sheets each have a
5 thickness in a range of about 7 mm to about 12 mm; and

said polycarbonate sheet has a thickness in a range of about 4 mm to about 8 mm.

10 14. The transparent panel according to claim 12, wherein said first and second glass sheets are annealed glass sheets.

15 15. The transparent panel according to claim 12, wherein said sheets are bonded to each other with an adhesive.

16. The transparent panel according to claim 15, wherein said adhesive is an urethane glue.

20 17. The transparent panel according to claim 12, wherein said first glass sheet, said second glass sheet, said first acrylic sheet, said second acrylic sheet, said third acrylic sheet, and said polycarbonate sheet bonded to each other have a shape of a windshield.

25 18. The transparent panel according to claim 12, wherein said first glass sheet, said second glass sheet, said first acrylic sheet, said second acrylic sheet, said third acrylic sheet, and said polycarbonate sheet bonded to each
30 other have a curved shape.

19. The transparent panel according to claim 12, wherein

said first glass sheet has a thickness of about 6 mm;

said second glass sheet has a thickness of about 12 mm;

5 said first, second and third acrylic sheets each have a thickness of about 9.5 mm; and

said polycarbonate sheet has a thickness of about 6 mm.

10 20. The transparent panel according to claim 12, wherein the transparent panel prevents the penetration of an armor piercing bullet fired at said first side.

21. A panel effective for blocking penetration of a
15 bullet, the panel comprising:

a first glass sheet;

a second glass sheet bonded to said first glass sheet;

20 an acrylic sheet bonded to said second glass sheet;

a polycarbonate sheet bonded to said acrylic sheet;

25 a first side; and

a second side, the panel meeting National Institute of Justice Standard Level IV and preventing a penetration of the bullet through the panel when fired at said first side,
30 but allowing a penetration of a further bullet through the panel when fired at said second side.

22. The panel according to claim 21, wherein

said first glass sheet has a thickness in a range of about 4 mm to about 8 mm;

said second glass sheet has a thickness in a range of about
5 10 mm to about 14 mm;

said acrylic sheet has a thickness in a range of about 25 mm to about 35 mm; and

10 said polycarbonate sheet has a thickness in a range of about 4 mm to about 8 mm.

23. The panel according to claim 21, wherein said first and second glass sheets are annealed glass sheets.

15

24. The panel according to claim 21, wherein said sheets are bonded to each other with an adhesive.

25. The panel according to claim 24, wherein said adhesive
20 is an urethane glue.

26. The panel according to claim 21, wherein said first glass sheet, said second glass sheet, said acrylic sheet, and said polycarbonate sheet bonded to each other have a
25 shape of a windshield.

27. The panel according to claim 21, wherein said first glass sheet, said second glass sheet, said acrylic sheet, and said polycarbonate sheet bonded to each other have a
30 curved shape.

28. The transparent panel according to claim 21, wherein

said first glass sheet has a thickness of about 6 mm;

said second glass sheet has a thickness of about 12 mm;

5 said acrylic sheet has a thickness of about 30 mm; and

said polycarbonate sheet has a thickness of about 6 mm.

29. The transparent panel according to claim 21, wherein
10 the bullet is an armor piercing bullet.

30. A panel effective for blocking penetration of a 50
caliber bullet, the panel comprising:

15 a first glass sheet;

a second glass sheet bonded to said first glass sheet;

a third glass sheet bonded to said second glass sheet;

20 a fourth glass sheet bonded to said third glass sheet;

a fifth glass sheet bonded to said fourth glass sheet;

25 a polycarbonate sheet bonded to said fifth glass sheet.

31. The panel according to claim 30, wherein said first to
fifth glass sheets are annealed glass sheets.

30 32. The panel according to claim 30, wherein all of said
sheets are bonded to each other with an adhesive.

33. The panel according to claim 30, wherein the panel is a transparent panel that does not distort images.

34. The panel according to claim 30, wherein said first-
5 fifth glass sheets and said polycarbonate sheet have a shape of a windshield.

35. The panel according to claim 30, wherein said first-
10 fifth glass sheets and said polycarbonate sheet have a curved shape.

36. The panel according to claim 30, wherein said first glass sheet has a thickness of about 4 mm to about 8 mm.

15 37. The panel according to claim 36, wherein said second glass sheet has a thickness of about 15 mm to about 24 mm.

38. The panel according to claim 37, wherein said third glass sheet has a thickness of about 15 mm to about 24 mm.

20 39. The panel according to claim 38, wherein said fourth glass sheet has a thickness of about 15 mm to about 24 mm.

40. The panel according to claim 39, wherein said fifth
25 glass sheet has a thickness of about 8 mm to about 15 mm.

41. The panel according to claim 40, wherein said polycarbonate sheet has a thickness of about 4 mm to about
8 mm.

30 42. The panel according to claim 32, wherein said adhesive is selected from the group consisting of polyvinyl butural

copolymers, urethane, and polyester copolymers for bonding said sheets to each other.

43. The panel according to claim 30, further including a
5 scratch resistant layer applied to said first and fifth
sheet layers.

44. The panel according to claim 30, wherein said first
glass sheet has a thickness of about 6 mm.

10

45. The panel according to claim 44, wherein said second
glass sheet has a thickness of about 19.5 mm.

46. The panel according to claim 45, wherein said third
15 glass sheet has a thickness of about 19.5 mm.

47. The panel according to claim 46, wherein said fourth
glass sheet has a thickness of about 19.5 mm.

20 48. The panel according to claim 47, wherein said fifth
glass sheet has a thickness of about 12.5 mm.

49. The panel according to claim 48, wherein said
polycarbonate sheet has a thickness of about 6 mm.

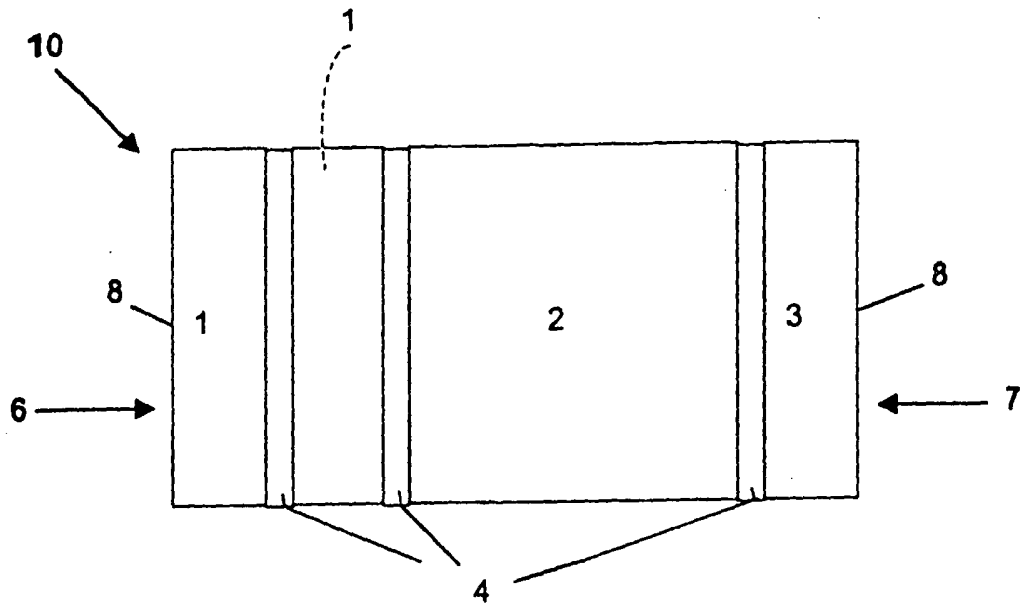


FIG. 1

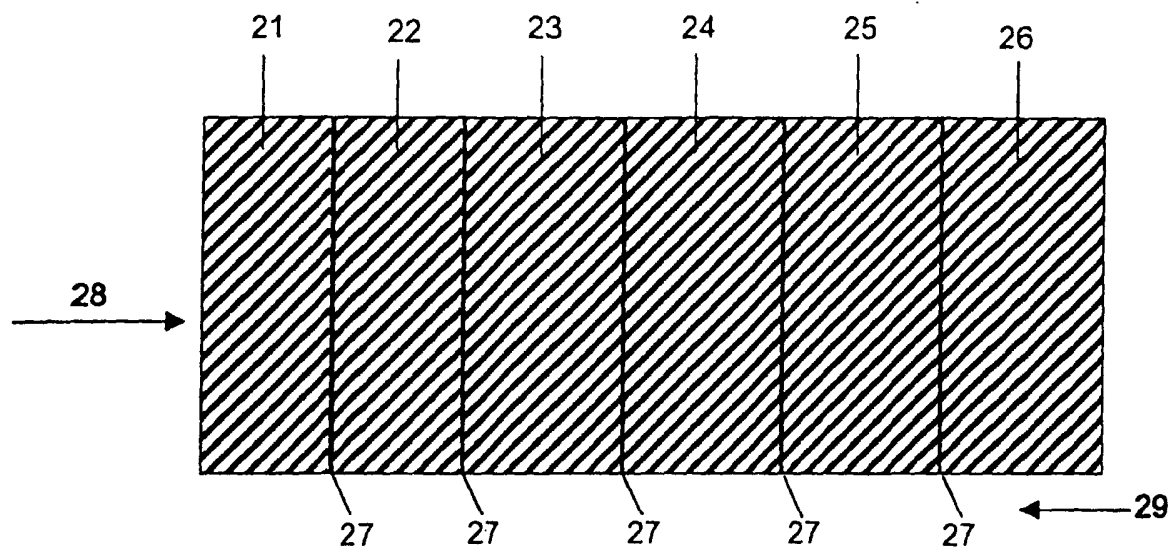


FIG. 2



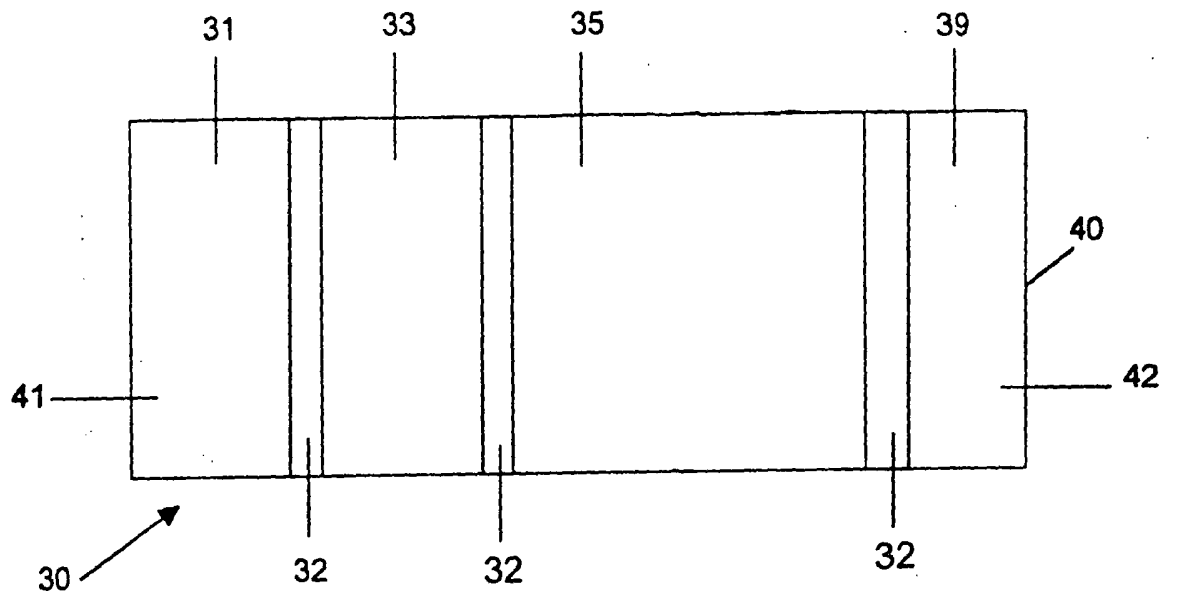


FIG. 3

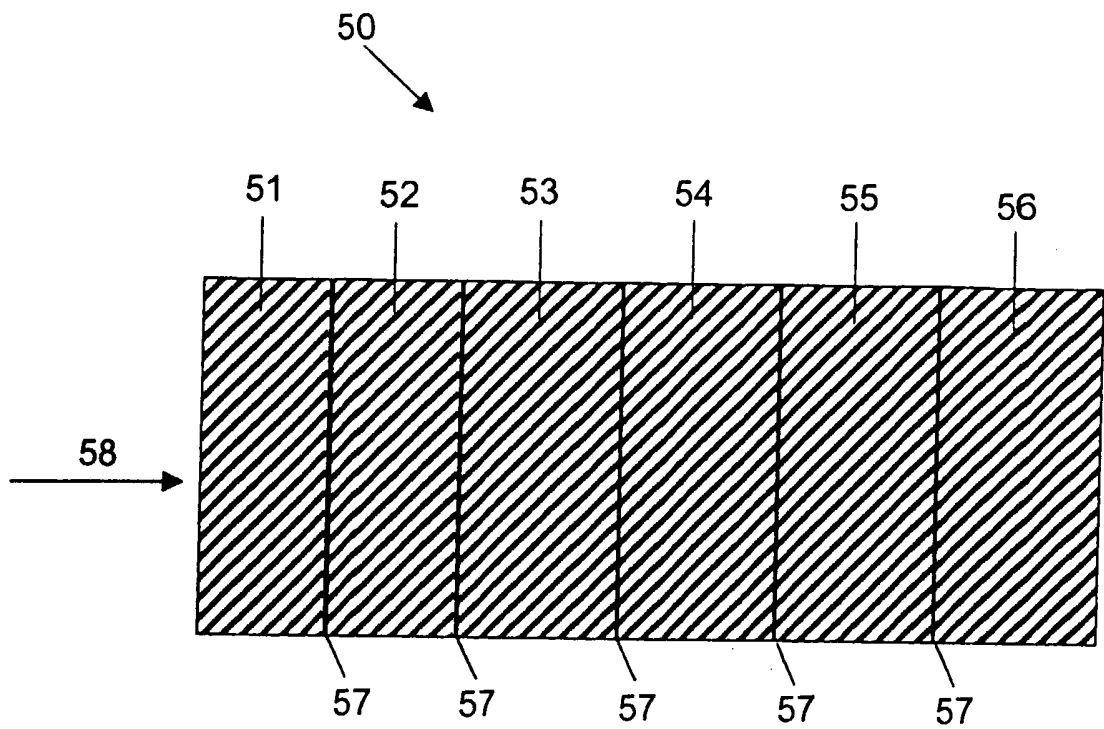


FIG. 4