

072183  
AUSTRALIA

Patents Act 1990

**NOTICE OF ENTITLEMENT**

We, Armorvision Plastics and Glass the applicant in respect of Application No. 37351/93, state the following:-

The Nominated persons are A.D.Y. Labock Coating Ltd., of Kibbutz Netzer Seneni, Post Beer Yaacob, 70395, Israel AND Shotglass Ventures L.P., of 6310 San Vicente Boulevard, Suite 500, Los Angeles, California 90048, United States of America. They are jointly entitled to the grant of the patent because they are the partners of the applicant Armorvision Plastics and Glass which partnership acquired the invention from the inventor by assignment.

The Nominated persons are entitled to claim priority from the applications listed in the declaration under Article 8 of the PCT because the Nominated persons have the consent of the applicant in respect of the applications listed in the declaration under Article 8 of the PCT to make a Co-vention application based on those applications.

DATED this 22nd day of August, 1996.

P 222

\_\_\_\_\_  
Peter H. Huntsman  
(A member of the firm of Davies Collison Cave for  
and on behalf of the applicant)



AU9337351

**(12) PATENT ABRIDGMENT**      **(11) Document No. AU-B-37351/93**  
**(19) AUSTRALIAN PATENT OFFICE**      **(10) Acceptance No. 672783**

- (54) Title  
**BULLET-RESISTANT TRANSPARENT PANEL**
- (51)<sup>5</sup> International Patent Classification(s)  
**B32B 027/08      B30B 005/00      B32B 007/12      B32B 017/10**  
**B32B 031/20      F41H 005/04**
- (21) Application No. : **37351/93**      (22) Application Date : **26.02.93**
- (87) PCT Publication Number : **WO93/16872**
- (30) Priority Data
- | (31) Number   | (32) Date       | (33) Country                       |
|---------------|-----------------|------------------------------------|
| <b>843337</b> | <b>28.02.92</b> | <b>US UNITED STATES OF AMERICA</b> |
| <b>102466</b> | <b>10.07.92</b> | <b>IL ISRAEL</b>                   |
- (43) Publication Date : **13.09.93**
- (44) Publication Date of Accepted Application : **17.10.96**
- (71) Applicant(s)  
**ARMORVISION PLASTICS AND GLASS**
- (72) Inventor(s)  
**JOSEPH LABOCK**
- (70) Nominated Person(s)  
**A.D.Y. LABOCK COATING LTD; SHOTGLASS VENTURES L.P.**
- (74) Attorney or Agent  
**DAVIES COLLISON CAVE , 1 Little Collins Street, MELBOURNE VIC 3000**
- (56) Prior Art Documents  
**US 4908083**  
**US 4594290**  
**US 4243719**
- (57)

It has been surprisingly found, as will be shown more particularly below, that when the acrylic and polycarbonate sheets are of the above thicknesses, the laminated panel exhibits unidirectional bullet-resisting characteristics. Such a panel construction thus provides protection against outsiders attacking persons inside an enclosure, such as a vehicle, a protective teller's cage, or the like; but at the same time the panel permits insiders to fire against the attacking outsiders.

(11) AU-B-37351/93  
(10) 672783

-2-

**CLAIM**

1. A transparent panel effective to block the penetration of a bullet when fired from the outer side of the panel but not when fired from the inner side of the panel, said transparent panel comprising: an outer transparent sheet of an acrylic resin having a thickness of 7.5-9 mm, and an inner transparent sheet of a polycarbonate resin having a thickness of 9.5-11 mm, said sheets being bonded together by a polyurethane transparent adhesive.



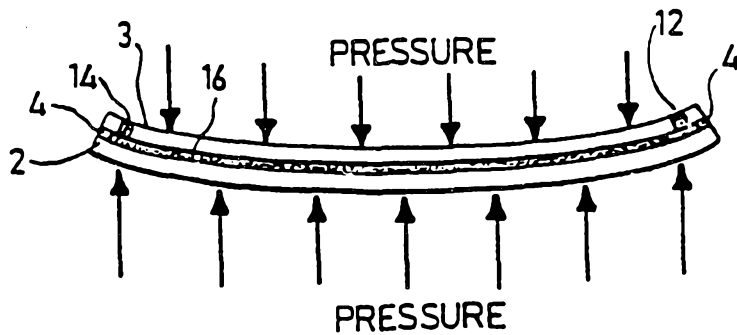
AU9337351

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>5</sup> : <b>B32B 7/12, E04B 2/02</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 93/16872</b> (43) International Publication Date: 2 September 1993 (02.09.93)</p>
<p>(21) International Application Number: PCT/US93/01757 (22) International Filing Date: 26 February 1993 (26.02.93) (30) Priority data: 07/843,337 28 February 1992 (28.02.92) US 102466 10 July 1992 (10.07.92) IL (60) Parent Application or Grant (63) Related by Continuation US 07/843,337 (CIP) Filed on 28 February 1992 (28.02.92) (71) Applicant (for all designated States except US): ARMORVISION PLASTICS AND GLASS [US/US]; 6222 Wilshire Boulevard, Suite 450, Los Angeles, CA 90048 (US).</p>	<p>(72) Inventor; and (75) Inventor/Applicant (for US only) : LABOCK, Joseph (IL/IL); 9 Hachashmonaim Street, 59 491 Bat Yam (IL). (74) Agent: GROSS, Stephen, D.; Blakley, Sokoloff, Taylor &amp; Zafman, 12400 Wilshire Boulevard, 7th Floor, Los Angeles, CA 90025 (US). (81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	

672783

(54) Title: BULLET-RESISTANT TRANSPARENT PANEL AND METHOD AND PRESS FOR MAKING SAME



(57) Abstract

A transparent panel having unidirectional bullet-resisting characteristics, comprises an outer transparent panel (2) of an acrylic resin; an inner transparent sheet (3) of a polycarbonate resin; and a transparent adhesive (16) bonding the two sheets (2, 3) together. Also described are a method of making such a panel, and presses (18, 50) useful in making such a panel.

## BULLET-RESISTANT TRANSPARENT PANEL

~~RELATED APPLICATION~~

~~This application is a continuation-in-part application to my Application Serial No. 843,337 filed February 28, 1992, which application is still pending.~~

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a bullet-resistant transparent panel, and also to a method and presses for making such a panel.

Many types of bullet-resistant transparent panels are known. One type, as described for example in US Patent 4,594,290, includes transparent sheets of acrylic and polycarbonate resins bonded together by a transparent polyurethane adhesive. The invention of the present application is directed particularly to the latter type of bullet-resistant transparent panel.

OBJECTS AND BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a transparent panel, particularly of the type described in US Patent 4,594,290, exhibiting unidirectional bullet-resisting characteristics; that



2

is intended to  
is, the panel <sup>^</sup> block the penetration of a bullet when  
fired from the outer side of the panel, but not when  
fired from the inner side of the panel.

~~Another object of the invention is to provide a  
method of making transparent panels, and a further  
object is to provide a press particularly useful for  
making such transparent panels.~~

According to the present invention, there is  
provided a transparent panel effective to block the  
penetration of a bullet when fired from the outer side  
of the panel but not when fired from the inner side of  
the panel, the transparent panel comprising: an outer  
transparent sheet of an acrylic resin having a  
thickness of 7.5-9 mm, and an inner transparent sheet  
of a polycarbonate resin having a thickness of 9.5-11  
mm, the sheets being bonded together by a polyurethane  
transparent adhesive.

It has been surprisingly found, as will be  
shown more particularly below, that when the acrylic  
and polycarbonate sheets are of the above thicknesses,  
the laminated panel exhibits unidirectional bullet-  
resisting characteristics. Such a panel construction  
thus provides protection against outsiders attacking  
persons inside an enclosure, such as a vehicle, a  
protective teller's cage, or the like; but at the same



time the panel permits insiders to fire against the attacking outsiders.

Best results were obtained when the outer acrylic resin sheet has a thickness of about 8 mm, the inner polycarbonate resin sheet has a thickness of about 10 mm, and the transparent polyurethane adhesive has a thickness of about 2 mm. Such a panel was found to exhibit the above-described unidirectional bullet-resisting characteristics with respect to bullets shot from an Uzi 9 mm full metal jacket (FMG), as will be described more particularly below.

In order to provide the panel with such unidirectional bullet-resisting characteristics with respect to the more powerful M-14, M-16 and AK-47 bullets, the panel may include a plurality of glass sheets bonded to each other and to the outer acrylic sheet. Preferably, the plurality of glass sheets include an outer glass sheet of 9-14 mm thickness, an intermediate glass sheet of 9-14 mm thickness, and an inner glass sheet of 3-6 mm thickness bonded to the outer face of the acrylic sheet.

As will be described more particularly below, a transparent panel including the polycarbonate and acrylic resin sheets described above, together with an outer glass sheet of 10 mm thickness, an intermediate

glass sheet of 10 mm thickness, and an inner glass sheet of 4 mm thickness bonded to the outer face of the acrylic sheet, exhibits the above-described unidirectional bullet-resisting characteristics with respect to M-16 and AK-47 bullets; whereas a panel as described above but including an outer glass sheet of 10 mm thickness, an intermediate glass sheet of 10 mm thickness, and an inner glass sheet of 4 mm thickness exhibits the above-described unidirectional bullet-resisting characteristics with respect to the more powerful M-14 bullet.

According to another aspect of the present invention, there is provided a method of making a transparent panel, comprising forming a sheet of an acrylic resin and a sheet of a polycarbonate resin of the same size and configuration; applying a sealing strip around the peripheral edge of one of the sheets; applying the other sheet over the one sheet with the two sheets spaced from each other by the sealing strip; drilling two holes through one of the sheets adjacent its diagonally opposite edges; applying pressure to the opposite faces of the two sheets to press them against the sealing strip; injecting under pressure an adhesive liquid through one hole of the one sheet until it exits



from the other hole thereof; and permitting the adhesive to harden to bond the two sheets together.

According to a still further aspect of the present invention, there is provided a press for laminating a plurality of sheets, comprising: a fixed frame assembly, and a movable frame assembly movable with respect to the fixed frame assembly; each of the frame assemblies including a plurality of parallel pressure bars extending transversely across the respective frame; the press further including a plurality of adjustable devices for precisely positioning the pressure bars against the opposite surfaces of the panel.

Further features and advantages of the invention will be apparent from the description below.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 illustrates a flat transparent panel constructed in accordance with the present invention;

Fig. 2 illustrates a curved transparent panel constructed in accordance with the present invention;

Fig. 3 illustrates the manner of precurving each of the resin sheets in making the curved panel of Fig. 2;

Fig. 4 illustrates the method of laminating the two resin sheets together in order to produce the curved panel of Fig. 2;

Fig. 5 illustrates a press useful in making the flat panel of Fig. 1 or the curved panel of Fig. 2;

Fig. 6 is an enlarged fragmentary view of the press of Fig. 5; and

Fig. 7 is a fragmentary view illustrating another press useful in making laminated panels in accordance with the present invention.

Fig. 8 illustrates a flat transparent panel exhibiting unidirectional bullet-resisting characteristics with respect to M-16 and AK-47 bullets; and

Fig. 9 illustrates a flat transparent panel exhibiting the above unidirectional bullet-resisting characteristics with respect to the more powerful M-14 bullets.

#### DESCRIPTION OF A PREFERRED EMBODIMENT

The bullet-resistant panel illustrated in Fig. 1 is constituted of an outer transparent sheet 2 of an

acrylic resin, an inner transparent sheet 3 of a polycarbonate resin, and a transparent polyurethane adhesive 4 between the two sheets bonding them together to form an integral panel.

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, but is also less brittle. By using the combination of the two sheets to form the panel, the outer acrylic resin sheet 2 imparts a high degree of hardness to the outer face of the panel receiving an impact, such as a bullet, rock or the like, and attenuates the force of this impact; whereas the polycarbonate resin sheet 3 on the inner face of the panel absorbs the attenuated force and supports the acrylic resin sheet 2 against breaking or shattering. The combination of the two sheets thus provides a high degree of resistance against penetration or shattering by bullets, stones, rocks or the like.

It has been surprisingly found that the panel illustrated in Fig. 1 can be provided with unidirectional bullet-resisting characteristics if the two resin sheets 2 and 3 are made of predetermined thicknesses. Thus, by making the outer acrylic resin sheet 2 of a thickness of 7.5-9 mm, and the inner

polycarbonate resin sheet 3 of a thickness of 9.5-11 mm, the panel has been found to block the penetration of a 9 mm bullet when fired from the side of the outer acrylic resin sheet, but not when fired from the side of the inner polycarbonate resin sheet.

Table 1 below summarizes the results of a number of tests that were conducted on laminations of polycarbonate and acrylic sheets of different thicknesses when impacted by a bullet shot from an Uzi 9 mm full metal jacket (FMG); velocity 359.6 m/sec; distance of 3 meters; temperature of 17-25°C at time of test:

TABLE 1

<u>ACRYLIC</u>	<u>POLYCAR-</u> <u>BONATE</u>	<u>RESULTS</u>	
		<u>Shot from</u> <u>Acrylic Side</u>	<u>Shot from</u> <u>Polycarbonate Side</u>
1. 8 mm	6 mm	Passed through	Passed through
2. 8 mm	8 mm	Blocked but produced a "mushroom" deform- ation in the poly- carbonate side	Passed through
3. 8 mm	10 mm	Blocked	Passed through
4. 8 mm	12 mm	Blocked	Blocked
5. 6 mm	10 mm	Passed through	Passed through
6. 10 mm	10 mm	Blocked	Blocked

The polycarbonate sheet was that supplied by Tsutsunaka of Japan under the trademark Sunloid PC; and the acrylic sheet was a cast acrylic sheet supplied by Mitsubishi of Japan, the polycarbonate and acrylic sheets having the properties as set forth in the following Table 2:

TABLE 2

<u>Properties</u>	<u>Polycarbonate</u>	<u>Acrylic</u>
Specific gravity	1.2	1.20
Rockwell hardness	R119	R124
Tensile strength	650 kgf/cm <sup>2</sup>	720-770 kgf/cm <sup>2</sup>
Elongation	85%	4-7%
Compressive strength	830 kgf/cm <sup>2</sup>	160-250 kgf/cm <sup>2</sup>
Flexural strength	950 kgf/cm <sup>2</sup>	1100-1200 kgf/cm <sup>2</sup>
Flexural modulus	24000 kgf/cm <sup>2</sup>	30000-31000 kgf/cm <sup>2</sup>
Izod impact strength	80 kgf·cm/cm	2-3 kgf·cm/cm
Heat deflection temperature	135°C	87-100°C
Coefficient of linear thermal expansion	7.0 cm/cm°Cx10 <sup>-5</sup>	7-8 cm/cm°Cx10 <sup>-5</sup>
Total light transmittance	87%	92%

The adhesive used was a clear liquid polyurethane adhesive as commonly available for bonding polycarbonate to itself, glass or metal; it had an elongation of about 300%, and was applied at a thickness of 2 mm.

As can be seen from the above, best results were obtained when the outer acrylic sheet is about 8 mm, the inner polycarbonate resin sheet 3 is about 10 mm, and the transparent adhesive layer 4 in between is transparent polyurethane adhesive having a thickness of about 2 mm. Preferably, each of the two sheets 2, 3 includes a scratch-resistant coating (many of which are

known) on the face thereof not bonded to the other sheet.

Fig. 1 illustrates the transparent panel of a flat configuration, such as may be used for side windows on a vehicle, building windows, windows for protective cages, and the like. Fig. 2 illustrates the panel of the same construction as that illustrated in Fig. 1, but of a curved configuration, such as may be used for the front and/or back windshields of a vehicle.

Figs. 3 and 4 illustrate a method, and Fig. 5 illustrates a press useful in the method, for making the curved panel of Fig. 2, but it will be appreciated that the method and press could also be used for making the flat panel of Fig. 1.

Thus each of the two resin sheets 2, 3 for making the panel is first cut according to the size and configuration of the panel to be produced, and is then precurved according to the curvature of the panel to be produced. Fig. 3 illustrates how each of the two resin sheets 2, 3 is precurved according to the curvature, e.g., of a windshield to be applied to a vehicle.

Thus, as shown in Fig. 3, a sheet of acrylic resin 2, having dimensions slightly larger than those of the windshield is supported on an actual glass

windshield having the desired curvature (and serving as the reference model), and is heated to a temperature of about 140°C. This temperature is sufficiently high to soften the acrylic resin, but not the glass windshield 10. Accordingly, the acrylic resin sheet will assume the curvature of the glass windshield 10.

A sheet 3 of polycarbonate resin, also having dimensions slightly larger than those of the windshield 10, is supported on the windshield and is heated to a temperature of about 150°C. This temperature is sufficient to soften the polycarbonate resin sheet 3, but not the glass windshield 10, so that the polycarbonate resin sheet 3 thus also assumes the curvature of the glass windshield.

The curved acrylic resin sheet 2 is then supported with its concave face facing upwardly. A preformed sealing strip 4 is applied around the peripheral edge of the acrylic resin sheet 2. The polycarbonate resin sheet 3 is then applied over the sealing strip 4 so as to be spaced from the acrylic resin sheet 2 by the thickness of the sealing strip, 2 mm in this case. Two holes 12, 14 are drilled through the polycarbonate resin sheet 3 adjacent to two diagonal corners of the sheet (e.g., see Fig. 1). Pressure is then applied (Fig. 4) to the opposite faces





of the two sheets to press them against the sealing strip 4, while an adhesive liquid 16 is injected under pressure through one hole (e.g., 12) until it is seen exiting from the other hole (e.g., 14), thereby assuring that the complete space between the two sheets 2, 3 is filled with the adhesive 16. The adhesive is then permitted to harden to bond the two sheets together.

The press illustrated in Figs. 5 and 6, and therein designated 18, is used for applying the pressure to the two sheets at the time of injection of the adhesive liquid 16 between the two sheets, to prevent distortion of the two sheets by the pressure of the injected liquid. Press 18 illustrated in Fig. 5 comprises a fixed frame assembly, generally designated 20, and a movable frame assembly, generally designated 30, movable to an open position or to a closed position with respect to the fixed assembly 20. Both assemblies are of rectangular configuration of a size at least as large as, but preferably larger than, the largest panel to be produced.

The fixed frame assembly 20 comprises four vertical bars 21, one at each of the four corners of the frame assembly, joined together by four lower horizontal bars 22 braced by a diagonal bar 23, and



four upper bars 24 which may be similarly braced by a diagonal bar (not shown). The fixed frame assembly 20 further includes a plurality of parallel pressure bars 25 extending transversely across the assembly for contacting the lower surface of the sheets to be bonded together and occupying the complete area of such sheets. Each of the pressure bars 25 includes an outliner 26 (Fig. 6) of rubber or other resilient cushioning material which directly contacts the lower surface of the acrylic sheet to the polycarbonate sheet.

Each of the pressure bars 25 is mounted to the fixed frame assembly 20 by a cylinder-piston device 27 at each of the opposite ends of the pressure bar. The piston-cylinder devices permit each pressure bar to be located at a precise vertical position according to the curvature of the sheets to be bonded together. The movable frame assembly 30 includes a rectangular frame of two horizontal bars 31 and four vertical bars 32 at the four corners telescopingly receivable within the vertical bars 21 of the fixed frame assembly 20, to permit the movable frame assembly 30 to be moved to an open position away from the fixed frame assembly, or to a closed position towards the fixed frame assembly. The movement of the movable frame assembly 30 is effected



by four cylinder-piston devices 33 at the four corners of the press, each coupling one of the fixed vertical bars 21 to one of the movable vertical bars 32.

The movable frame assembly 30 further includes a plurality of parallel, horizontal pressure bars 35 extending transversely of the assembly, one for and aligned with one of the pressure bars 25 of the fixed frame assembly 20. Each of the pressure bars 35 is also mounted by a pair of cylinder-piston devices 36, permitting each such bar to be moved to a preselected vertical position, according to the curvature of the panel to be produced. The cylinder-piston devices 36 are mounted to an upper framework including four further horizontal bars 37.

As indicated earlier, the two groups of pressure bars 25 and 35 are each individually movable by their respective cylinder-piston devices 27 and 36 to appropriate vertical positions in accordance with the curvature of the panel to be produced. The pressure bars 25, 35 are moved to their respective vertical positions by a plurality of handles 40, one controlling all the cylinder-piston devices of one pressure bar 25 in the fixed frame assembly 20, and the aligned pressure bar 35 in the movable frame assembly 30. When the movable frame assembly 30 is moved to its closed



position with respect to the fixed frame assembly 20, handles 40 are manually actuated to permit the pressure bars to be freely moved by their respective cylinder-piston devices 27, 36 until they contact the surface of the panel. The pressure bars are thus moved to their respective vertical positions according to the curvature of the panel. They are then fixed in those positions by further handles 42, one for each pair of aligned pressure bars 25, 35. When handles 42 are moved to their closed positions, they block the flow of the fluid to the respective cylinder-piston devices 27, 36, to thereby fix the pressure bars in position.

It will thus be seen that after the precurved polycarbonate resin sheet has been placed over the sealing strip 4 applied around the outer periphery of the acrylic resin sheet, the two sheets are then applied between the pressure bars 25 of the fixed frame assembly 20 and the pressure bars 35 in the movable frame assembly 30. The movable frame assembly 30 is then moved to its closed position, and handles 40 are actuated to move the two groups of pressure bars 25, 35 into contact with the two sheets of the panel such that the bars assume their respective vertical positions according to the curvature of the two sheets. The handles 42 are then actuated to block the flow of fluid



from the cylinder-piston devices 27, 36, thereby fixing the pressure bars in their respective vertical positions according to the curvature of the two sheets.

The transparent liquid adhesive is then injected via one hole (e.g., 12) in the polycarbonate resin sheet 3 under high pressure to fill the space between the two sheets with the transparent adhesive, as shown at 16 in Fig. 4. The pressure injection of liquid adhesive continues until the adhesive begins to exit from the other hole 14 at a diagonally-opposed corner from opening 12, indicating that the complete space between the two sheets has been filled with the transparent adhesive. The two holes 12, 14 are located so as to be outside of the area covered by the pressure bars 25, 35, and thereby easily accessible for injecting the liquid adhesive. During this injection of the transparent adhesive, the two groups of pressure bars 25, 26 of the press illustrated in Fig. 5 are fixed in their respective vertical positions and prevent any distortion or displacement of the two sheets despite the high pressure of injection of the liquid adhesive.

After the complete space between the two sheets 2, 3 has been filled with the transparent adhesive, the two holes 12, 14 may be plugged, and the adhesive is



permitted to harden to thereby firmly bond the two sheets together to produce the laminated assembly.

The liquid adhesive 16 is preferably one of the commercially-available cold-applied, transparent, polyurethane adhesives. The sealing strip 4 is preferably a transparent silicon tape of 2 mm thickness having a transparent polyurethane adhesive layer applied to its opposite faces. As one example, the adhesive may be formulation 1908E.P supplied by Engineering Chemicals B.V., Steenberg, Netherlands, and may be injected at a pressure of about 1.5 to 2 atmospheres, although this pressure may be increased up to about 7 atmospheres in order to decrease the injection time.

Since the laminated panel is made of plastic sheets, the margins of the sheets may be trimmed or planed to fit the frame (e.g., windshield frame) in which they are to be applied.

Figure 7 illustrates another form of press which may be used when applying the cold liquid adhesive to the two sheets. The press illustrated in Fig. 7, generally designated 50, also includes a lower fixed frame assembly 60, and an upper movable assembly 70 which is movable to either an open or a closed position with respect to the fixed frame assembly. The

opening and closing of the movable frame assembly 70 may also be effected by telescoping vertical bars 61, 71 at each of the four corners of the two assemblies and actuated by a cylinder-piston device (not shown) at each of these corners.

The fixed frame assembly 60 also includes a plurality of pressure bars 65 extending transversely of the assembly and each adjustable to a selected vertical position according to the curvature of the panel to be produced.

In the press illustrated in Fig. 7, however, each of the pressure bars 65 is lined with an inflatable flat boot 66, e.g., of rubber or the like. The boots 66 directly contact the lower surface of the acrylic sheet used in producing the laminated panel, and apply the pressure during the application of the liquid adhesive between the two sheets.

Press 50 illustrated in Fig. 7 also provides another arrangement for adjusting the vertical positions of the pressure bars 65 to conform to the curvature (or flatness) of the laminated panel to be produced. In this case, each of the pressure bars 65 is vertically adjustable by a pair of screw-threaded adjustment devices 67 securing the opposite ends of each pressure bar 65 to the lower frame assembly 60.



The pressure bars in the movable assembly 70, and therein designated 75, are similarly constructed and mounted as the pressure bars 65 in the fixed frame assembly 60. Thus, each pressure bar 75 in the movable frame assembly includes an inflatable flat boot 76 which directly contacts the outer surface of the polycarbonate sheet used in producing the laminated panel and applies pressure to that surface during the time of the injection of the transparent adhesive. Each of the pressure bars 75 in the movable frame assembly 70 is also mounted for vertical movement by a pair of screw-and-nut devices, shown at 77, secured to the opposite ends of each pressure bar.

The press illustrated in Fig. 7 is particularly useful for producing a run of laminated panels all of the same configuration. Thus, when each of the pressure bars 65, 75 is preset in its proper vertical position, according to the curvature (or flatness) of the laminated panel to be produced, the same setup may be used for producing the run of laminated panels. The method of producing the laminated panels is the same as described above with respect to the press of Figs. 5 and 6, except that after the upper frame assembly 70 has been moved to its closed position, the boots 66 and 76 carried by the pressure bars 65 and 75 are inflated





to firmly contact the opposite faces of the sheets being laminated and to prevent their distortion by the high pressure of injection of the transparent adhesive.

Figs. 8 and 9 illustrate transparent panels constructed in accordance with the present invention but exhibiting the above-described unidirectional bullet-resisting characteristics with respect to more powerful bullets than the above-described Uzi bullets.

Thus, Fig. 8 illustrates a panel, generally designated 100, particularly for exhibiting the above-described unidirectional bullet-resisting characteristics with respect to M-16 and K-47 bullets. Such a panel includes an inner sheet 101 of polycarbonate resin having a thickness of 10 mm; an outer (with respect to sheet 101) transparent sheet 102 of an acrylic resin having a thickness of 8 mm and bonded to the polycarbonate sheet 101 by a transparent polyurethane adhesive 102a; and three glass sheets 103, 104 and 105 bonded to the outer face of the acrylic sheet 102. Thus, the innermost glass sheet 103 is of 4 mm and is bonded to the outer face of the acrylic sheet by the same transparent polyurethane adhesive 103a as adhesive 102a; the intermediate glass sheet 104 is of 10 mm and is bonded to the inner glass sheet 103 by a transparent adhesive 104a called P.V.B. in the trade



and conventionally used in laminating glass sheets together; and an outer glass sheet 105, also of 10 mm, bonded to the intermediate glass sheet 104 by the same adhesive 105a as used in laminating glass sheets.

Panel 100, of overall thickness of 41.6 mm, has a weight of 80 Kg per square meter.

Panel 100 as illustrated in Fig. 8 was found to exhibit the above-described unidirectional bullet-resisting characteristics with respect to M-16 bullets of 5.56 calibre, having a velocity of 1,000 m/second, and a striking energy of 1,700 joule, when shot from a distance of 10 meters, at a temperature of 17-25°C. The same result was found respect to AK-47 bullets of 7.62 (39) calibre having a velocity of 780 m/second, and a striking energy of 2,200 joule, also when shot at a distance of 10 meters and at a temperature of 17-25°C. The above-described unidirectional bullet-resisting characteristics means that such a bullet did not penetrate the panel when shot from the outer side of the panel (i.e., from glass sheet 105 side), but did penetrate the panel when the bullet was shot from the inner side (i.e., the polycarbonate sheet 201 side).

However, with respect to the more powerful M-14 bullets, the panel illustrated in Fig. 8 permitted



bullet penetration when the bullet was shot from either side.

The panel illustrated in Fig. 9, and therein designated 200, however, exhibited unidirectional bullet-resisting characteristics with respect to the more powerful M-14 bullet. Panel 200 illustrated in Fig. 9 includes the same five sheets 201-205, corresponding respectively to sheets 101-105 as in Fig. 8 (and the same adhesives 202a-205a as adhesives 102a-105a in Fig. 8), except that the outer glass panel 205 and the intermediate glass panel 204 were each 12 mm in thickness instead of 10 mm in thickness. Such a construction, having an overall thickness of 45.6 mm and a weight of 90 Kg/meter-square, was found to block the penetration of M-14 bullets of 7.62 (51) calibre, having a velocity of 845 m/second, and a striking energy of 3,373 joule, when shot at a distance of 10 meters, and at a temperature of 17-25°C, when shot from the outer glass sheet 205 side, but to permit the penetration of such a bullet when shot from the inner polycarbonate sheet 101 side.

While the invention has been described with respect to two preferred embodiments, it will be appreciated that many other variations, modifications and applications of the invention may be made.

WHAT IS CLAIMED IS:

1. A transparent panel effective to block the penetration of a bullet when fired from the outer side of the panel but not when fired from the inner side of the panel, said transparent panel comprising: an outer transparent sheet of an acrylic resin having a thickness of 7.5-9 mm, and an inner transparent sheet of a polycarbonate resin having a thickness of 9.5-11 mm, said sheets being bonded together by a polyurethane transparent adhesive.

2. The panel according to Claim 1, wherein said outer acrylic resin sheet has a thickness of about 8 mm, and said inner polycarbonate resin sheet has a thickness of about 10 mm.

3. The panel according to Claim 1, wherein said transparent polyurethane adhesive has a thickness of about 2 mm.

4. The transparent panel according to Claim 1, wherein each of said sheets includes a scratch-resistant coating on the face thereof not bonded to the other sheet.

5. The transparent panel according to Claim 1, wherein both said sheets are of curved configuration.



6. The panel according to any one of Claims 1-5, further including a plurality of glass sheets bonded to each other and to said outer acrylic sheet.

7. The panel according to Claim 6, wherein said plurality of glass sheets include:  
an outer glass sheet of 9-14 mm thickness;  
5 an intermediate glass sheet of 9-14 mm thickness; and  
an inner glass sheet of 3-6 mm thickness bonded to the outer face of said acrylic sheet.

8. The panel according to Claim 7, wherein:  
said outer glass sheet is of 10 mm thickness;  
said intermediate glass sheet is of 10 mm thickness; and  
10 said inner glass sheet is of 4 mm thickness.

9. The panel according to Claim 7, wherein:  
said outer glass sheet is of 12 mm thickness;  
said intermediate glass sheet is of 12 mm thickness; and  
said inner glass sheet is of 4 mm thickness.

15 10. A transparent panel substantially as herein described with reference to the accompanying drawings.

DATED this 22nd day of August, 1996.

20

ARMORVISION PLASTICS AND GLASS

By its Patent Attorneys

DAVIES COLLISON CAVE



37351/93

1/4

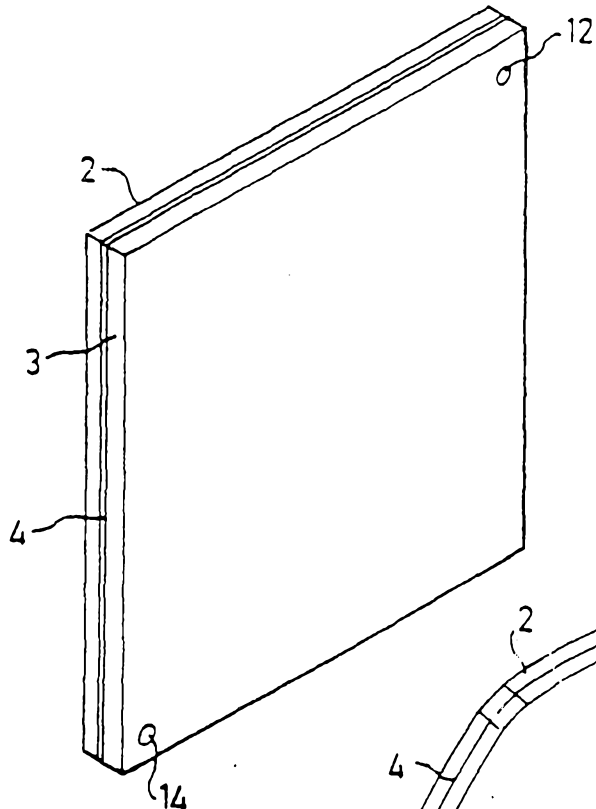


FIG 1

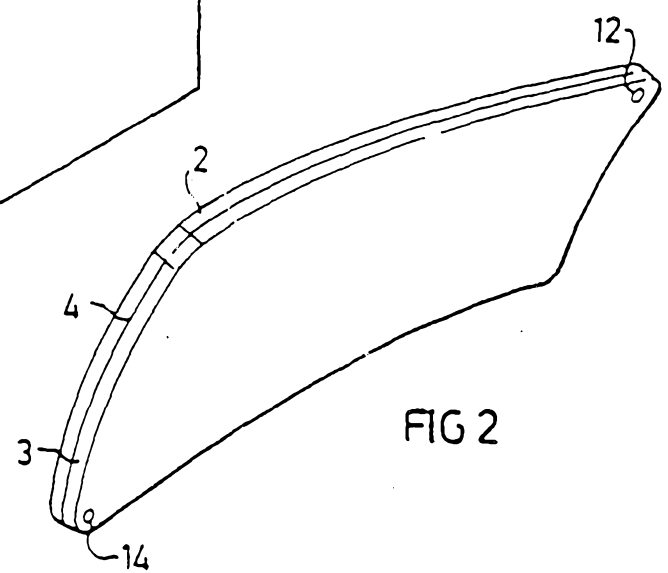


FIG 2

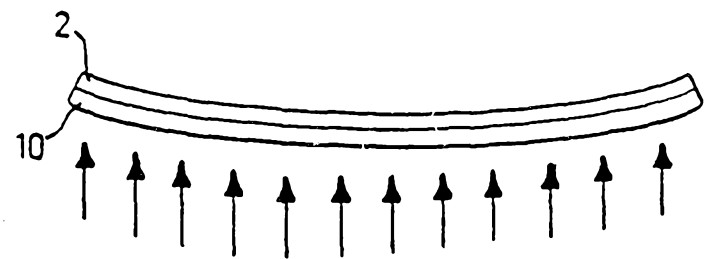


FIG 3

HEAT

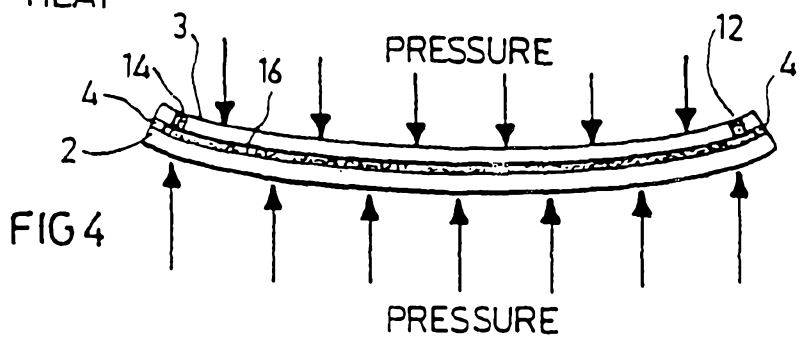
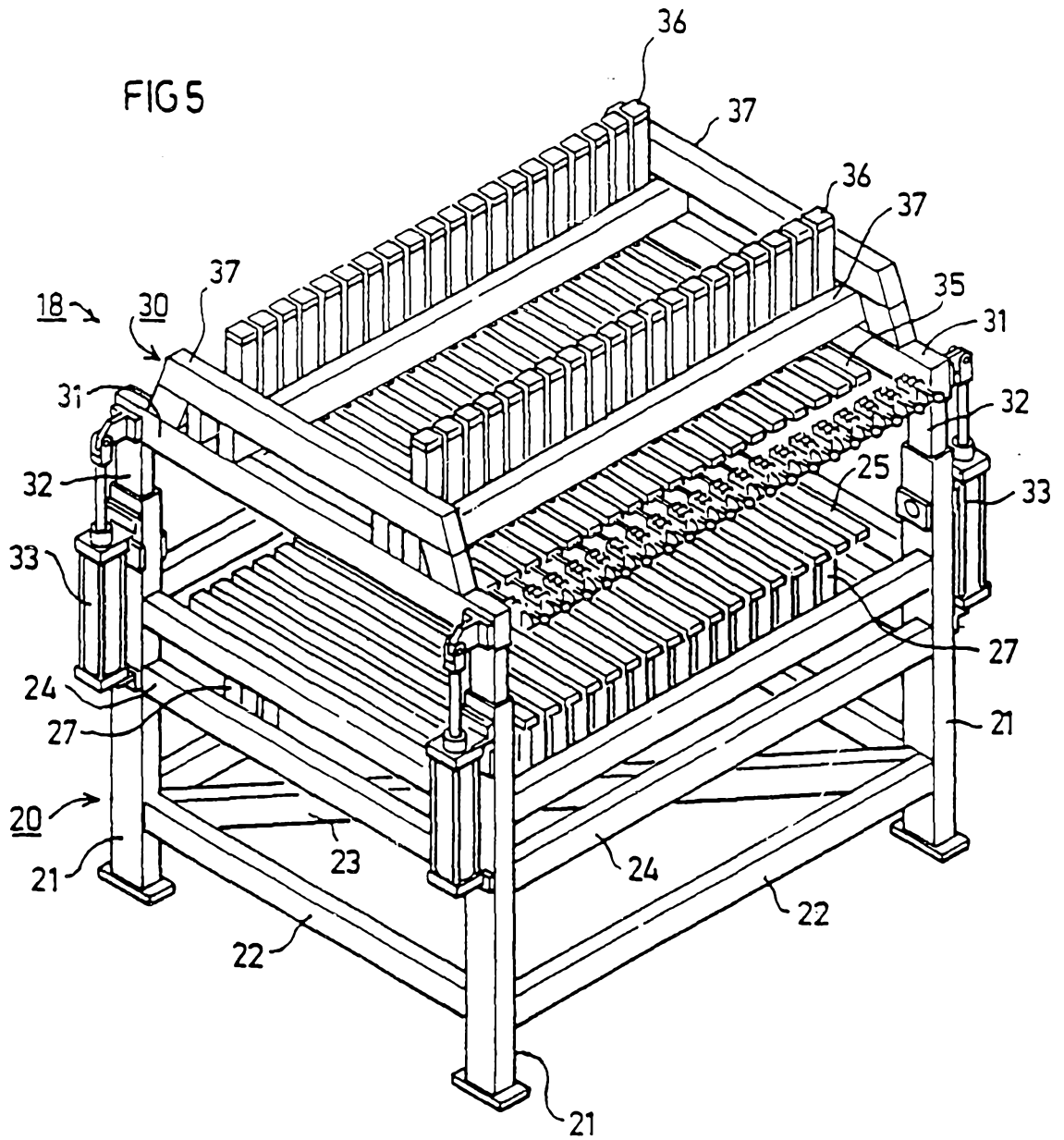
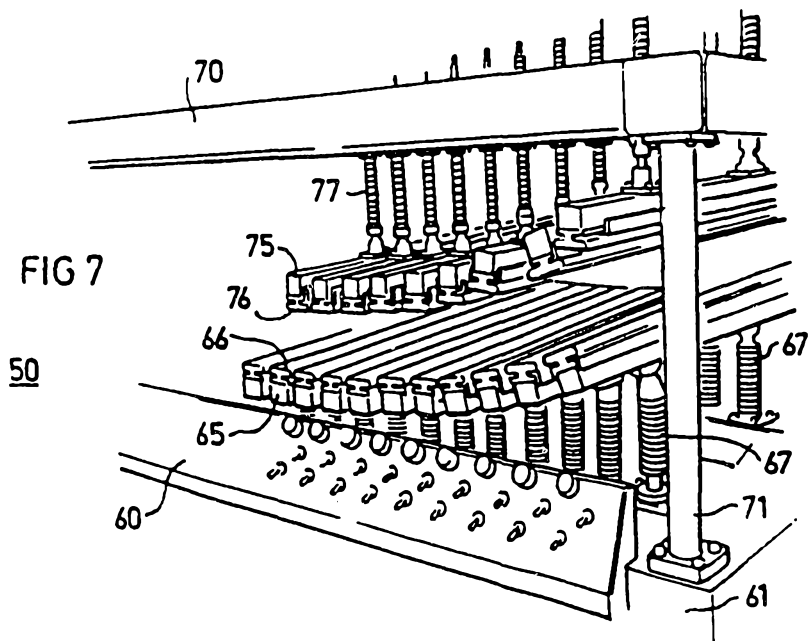
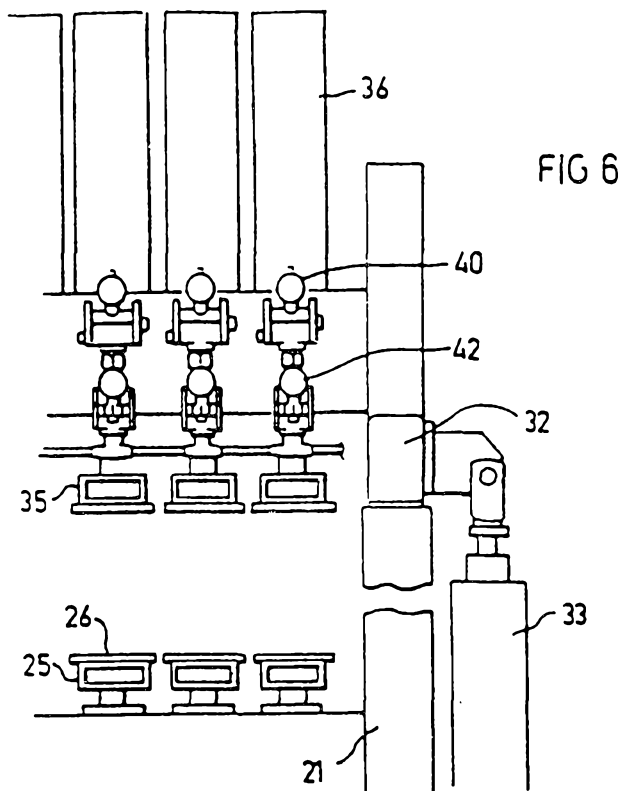


FIG 4

PRESSURE







414

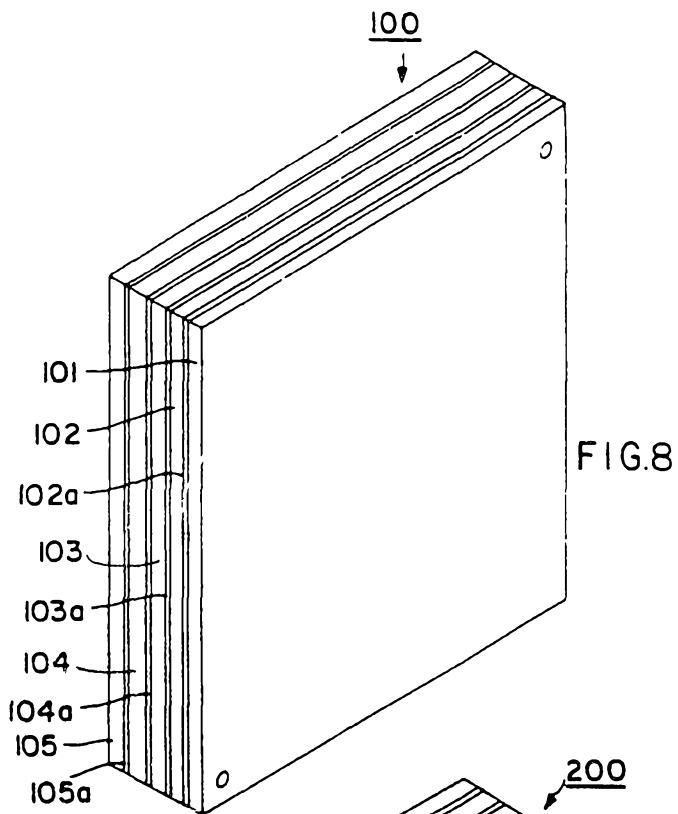


FIG. 8

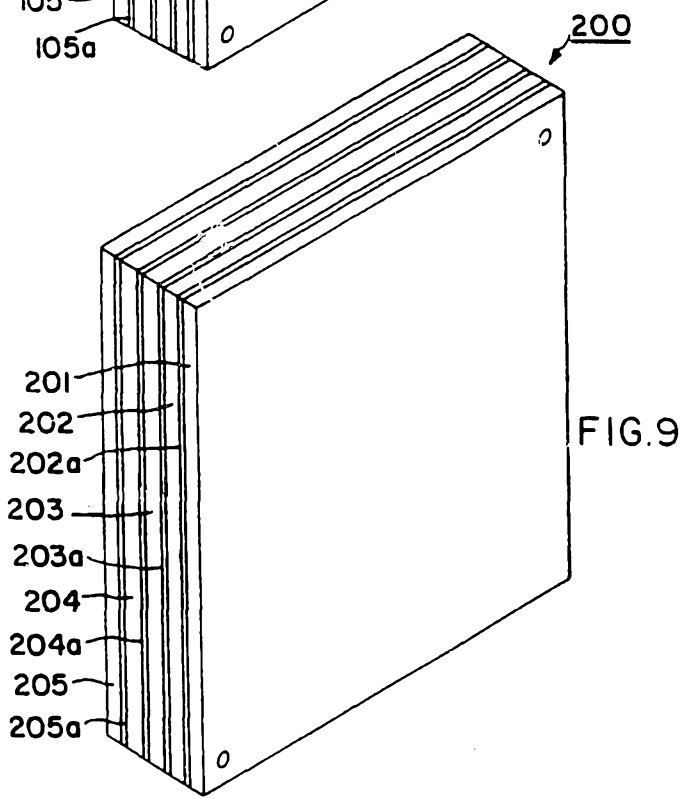


FIG. 9

BR  
S  
N

# INTERNATIONAL SEARCH REPORT

PCT/US93/01757

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : B32B 7/12; E04B 2/02

US CL : Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 100/237,258A; 109/5; 156/104,109,228,581

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS.

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US, A, 4,686,932 (PETTINGELL) 18 August 1987, See fig. 2.	<u>19</u> 14,15,17,18, 20,22,23
X Y	US, A, 2,983,635 (RICHARDSON) 09 May 1961, See fig. 1.	<u>19,22,23</u> 14,17,18,20, 22,23
X Y	US, A, 2,137,505 (OSGOOD) 22 November 1938, See fig. 2.	<u>19</u> 14,16,21
Y	US, A, 4,594,290 (FISCHER ET AL.) 10 June 1986, See page 6, lines 30-45.	10-18
Y	US, A, 4,299,639 (BAYER) 10 November 1981, See figs. 1 and 2.	10-18

Further documents are listed in the continuation of Box C.  See patent family annex.

<p>* Special categories of cited documents:</p> <p>*A* document defining the general state of the art which is not considered to be part of particular relevance</p> <p>*E* earlier document published on or after the international filing date</p> <p>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p>	<p>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>*&amp;* document member of the same patent family</p>
---	---

Date of the actual completion of the international search	Date of mailing of the international search report
20 MAY 1993	28 JUN 1993

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer <i>my means</i> LOYD A. GALL Telephone No. (703) 308-2168
---	--

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US93/01757

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,090,078 (ACKLES) 21 May 1963, See page 3, lines 67-71.	10-18
Y	JP, A, 49-104909 (MITSUBISHI) 04 October 1974, See fig. 2.	10-18
Y	US, A, 4,838,974 (NIED ET AL.) 13 June 1989, See fig. 2.	13
Y	US, A, 3,046,169 (RICHARDSON) 24 July 1962, See figs. 6 and 7.	14,15,17,19, 20,22
Y	UK, A, 858,578 (FORD MOTOR COMPANY) 11 January 1961, See fig. 1.	16,21
A	US, A, 3,029,730 (PARRISH ET AL.) 17 April 1962, See fig. 2.	10-18
A	US, A, 5,008,049 (ROSE ET AL.) 16 April 1991, See fig. 1B.	10-18
A	DE, A, 3,016,061 (SIEMENS) 29 October 1981, See fig. 1.	10-18
A	US, A, 1,809,769 (WETZLER) 09 June 1931, See fig. 1.	16,21

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US93/01757

## A. CLASSIFICATION OF SUBJECT MATTER:

US CL :

89/36.02; 109/10,49.5,80; 156/102,305,580; 264/261; 428/335,412,424.4,811

## BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

Claims 1-9 are drawn to a transparent panel, classified in class 428, subclass 335.

Claims 10-18 are drawn to a method of making a transparent panel, classified in class 156, subclass 102.

Claims 19-23 are drawn to a press for laminating a plurality of sheets, classified in class 156, subclass 580.

The inventions are distinct, each from the other because of the following reasons:

Inventions Group II and Group I are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (M.P.E.P. § 806.05(f)). In the instant case the product as claimed can be made by a materially different process such as by preforming the holes along the diagonally opposite edges of the sheet.

Inventions Group III and Group I are related as apparatus and product made. The inventions in this relationship are distinct if either or both of the following can be shown: (1) that the apparatus as claimed is not an obvious apparatus for making the product and the apparatus can be used for making a different product or (2) that the product as claimed can be made by another and materially different apparatus (M.P.E.P. § 806.05(g)). In this case the apparatus as claimed is not an obvious apparatus for making the product and the apparatus as claimed can be used to make a different product such as a panel comprising two sheets of acrylic resin.

Inventions Group II and Group III are patentably distinct inventions.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.