Oct. 18, 1955 T. P. MARTIN ET AL 2,721,157

EXPLOSION RESISTING WINDOW

Filed Jan. 5, 1953

Fig. 1.

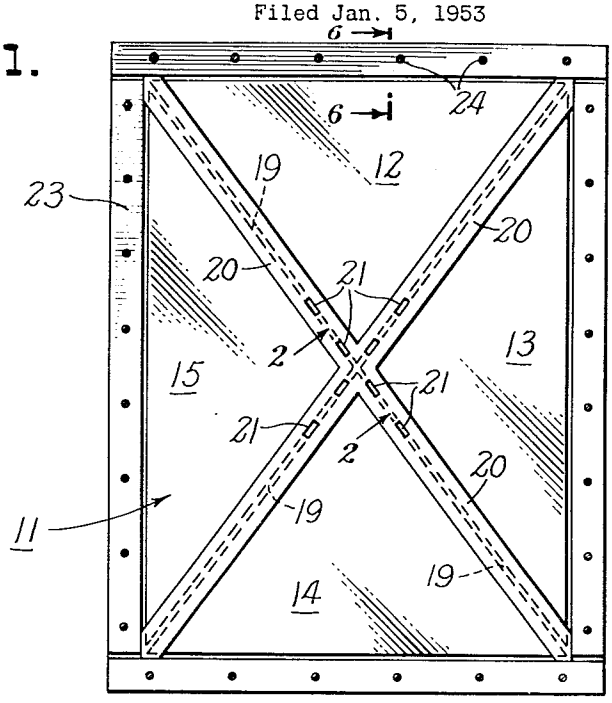


Fig. 6.

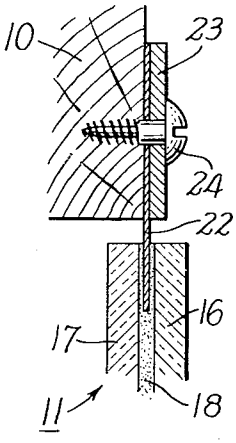


Fig. 2.

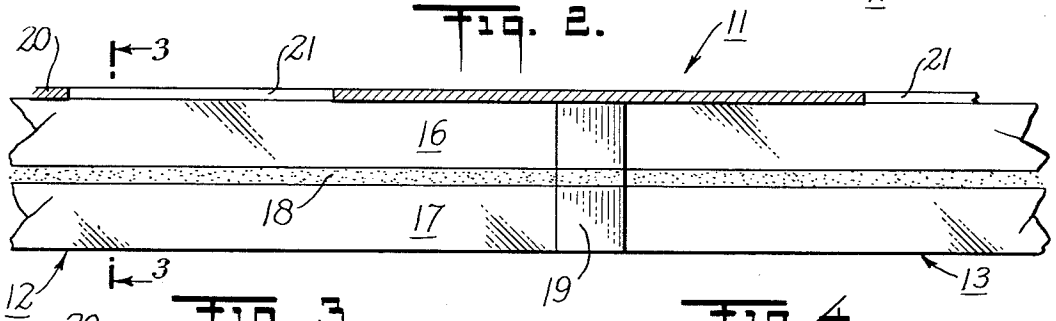


Fig. 3.

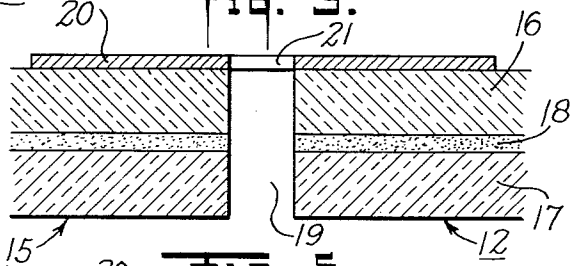


Fig. 4.

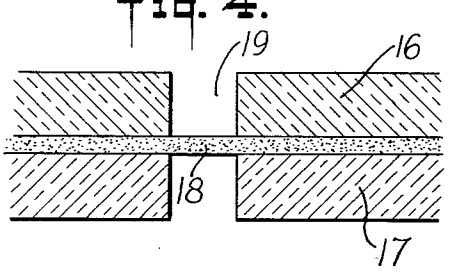
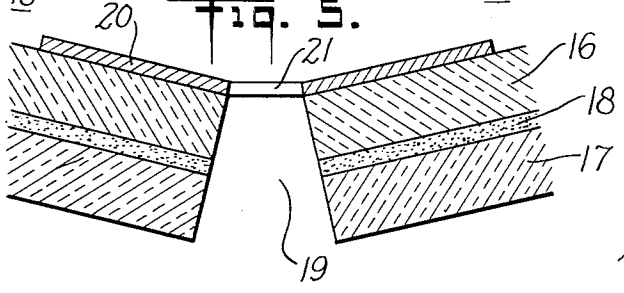


Fig. 5.



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EXPLOSION RESISTING WINDOW

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7 Claims. (Cl. 154—2.73)

This invention relates to windows and more particularly to windows of the type that are adapted to resist and/or withstand the disruptive effect of high air pressures such as explosive forces, storms and the like.

While various window constructions have been proposed which were intended to resist the effect of high air pressures, these have been subject to various difficulties and disadvantages, such as excessive cost of manufacture, poor performance in actual service and so on.

It is an object of the present invention to provide window constructions which overcome the difficulties and disadvantages of known window constructions, which are inexpensive to manufacture and maintain and which are thoroughly reliable in performance. It is another object of the invention to provide a window construction which, when subjected to an explosive force, minimizes the tendency of the glass to shatter and fly about and which can be relatively easily repaired. Other objects of the invention will be in part obvious and in part pointed out as the specification proceeds.

In one of its broader aspects the present invention provides an explosion resistant window that yields rather than shatters when a pressure differential is suddenly applied thereto and which preferably restores itself to its original shape when the pressure differential is removed. It has been found, as described below, that by forming the window of segments or sections of glass having adjacent edges that are inter-connected by a resilient material, a yieldable pane results that has exceptionally good resistance to explosive forces.

The many objects and advantages of the present invention can best be understood and appreciated by reference to the accompanying drawing which illustrates a window construction incorporating a preferred embodiment of the present invention and wherein:

Figure 1 is an elevation of the window viewed from the side that is intended to be exposed to the high air pressure (referred to herein as the front side of the window). The window shown in Figure 1 is divided by intersecting diagonals into four triangular segments that are secured together by elastic tape, as more fully described below.

Figure 2 is a longitudinal section taken on the line 2—2 of Figure 1, i. e., along the center line of the elastic tape and particularly showing the relation between the elastic tape and the glass segments.

Figure 3 is a section taken on the line 3—3 of Figure 2, that is, through one of the slots formed in the elastic tape.

Figure 4 is a section similar to Figure 3 but showing a modification wherein the elastic tape is omitted and the plastic interlayer forms a yieldable connection between the glass segments.

Figure 5 is a section similar to those of Figures 3 and 4 but showing the manner in which the slot in the tape expands as the front of the window is subjected to high air pressure (or the rear surface of the window is subjected to reduced pressure).

Figure 6 is a fragmentary section taken on the line 6—6 of Figure 1 and particularly showing the metal border by means of which the window pane can be mounted in a frame.

Referring to the drawings and more particularly to Figure 1, the window there shown comprises a window pane 11 composed of four triangular laminated glass segments 12, 13, 14 and 15. As indicated in Figures 2 and 3, each of the triangular segments 12 to 15 is composed of two layers or lights of glass 16 and 17 having a plastic interlayer 18 therebetween. The plastic interlayer 18 may be, for example, a plasticized polyvinyl acetal. The adjacent edges of the triangular segments are slightly spaced apart to form relatively narrow channels 19 therebetween. As indicated in Figure 1, the four triangular segments of laminated glass 12 to 15 cooperate to form a rectangular window pane and the channels 19 are aligned with the diagonals of this rectangular pane.

Reverting to Figures 2 and 3 overlying the channels 19 there are strips 20 of an elastic tape that are secured in any suitable manner to the exposed surface of the light 16 of the glass segment, that is, the front surface of the window. The tape may be formed of any suitable elastic material such as, for example, vulcanized sheet rubber. The strips of elastic tape 20 are provided with spaced slits 21 which, as shown in Figures 1 to 3 of the drawings, are aligned with the channels 19 between the triangular glass segments. The slits 21 are preferably made by searing with the edge of a hot iron rather than by cutting in order to minimize their tendency to tear when pressure differentials are applied to opposite sides of the window.

One method of mounting the window pane 11 in frame 10 is shown in Figure 6 of the drawing. Referring to Figure 6, embedded in the plastic interlayer 18 at the peripheral portion of the window pane there is a thin flexible metal strip or ribbon 22 that extends beyond the perimeter of the window pane and provides a rim or border by means of which the window pane can be mounted in its frame. The extending portion of the metal strip 22 is positioned against the window frame 10 and held in place by a retaining plate 23 and screws 24. It should be noted that the perimeter of the window pane 11 is spaced somewhat from the frame 10 to permit inward flexing of the segments 12 to 15 of the window pane when they are subjected to external air pressure.

The manner in which the present window operates when subjected to a sudden differential pressure should be largely apparent from the foregoing description. Since the window is formed of separate segments that are interconnected by a flexible tape or band, the segments can flex inwardly around axes substantially coincident with the perimeter of the window pane. The slits 21 in the tape 19 provide openings through which air can flow to relieve partially the pressure difference across the window pane. Moreover, as shown in Figure 5 of the drawings, when the segments flex inwardly the slits 21 are stretched, and hence as the segments flex inwardly the total area of the openings available for air flow through the tape 19 increases correspondingly.

It has been found by tests that windows constructed as described above are able to withstand substantial dif-

ferential pressures without failure. In one series of tests a window was constructed as shown in the drawings of the present application and having the following dimensions:

Size of window pane	14" x 19"
Thickness of lights of glass	7/64"
Thickness of interlayer	.03"
Spacing between segments	1/8"
Width of elastic tape	7/8"
Length of slits	1/2"
Distance between slits	1"
Number of slits	8 arranged as in Fig. 1.

This window was tested by making the window pane one wall of a closed chamber and then suddenly reducing the pressure within the chamber to produce a differential pressure across the window pane. The window was tested by suddenly establishing a pressure difference of 10 lbs./in.^{2} across the window pane, and it was found that after five successive tests at this differential pressure the window still remained essentially intact.

Referring now to Figure 4 of the drawing, this figure shows a modification wherein the elastic tape **20** is omitted and the plastic interlayer **18** extends across the channels **19** to provide a yieldable connection between the glass segments. It will be evident that the portions of interlayer **18** extending across the channels **19** may, if desired, be provided with slits similar to the slits **21** of the embodiment of Figure 1.

From the foregoing description it should be apparent that the present window is capable of achieving the several objects set forth at the beginning of the present specification. By utilizing the independent segments of laminated glass interconnected by a yieldable and preferably resilient material, shattering of the window and flying glass are substantially prevented; in the event that the window fails, it will fail by tearing of the yieldable material. The window exhibits a considerable resistance to relatively high pressures and even if failure occurs the window can be readily repaired by applying new elastic tape thereto.

It is of course to be understood that the foregoing description is illustrative only and that numerous changes can be made within the scope of the present invention and without departing from the spirit thereof. For example, it is not essential that the particular pattern of Figure 1 be used wherein the window pane is divided into four triangular segments having edges aligned with the diagonals of the window pane. It is evident that a variety of other patterns can be used so long as the individual segments cooperate to define a window pane of the desired configuration. Moreover, it is not essential that the window pane be mounted in the manner shown in Figure 6. For example, the pane **11** can be mounted by so forming the pane that the elastic interlayer **18** extends beyond the perimeter of the glass to form a means whereby the laminated segments can be mounted in flexible relation to the frame **10**. If the window pane is mounted in this way by means of an extension of the plastic interlayer, it is usually desirable to make the extending portion of the plastic interlayer somewhat thicker than the portion of the interlayer that lies between the glass lights **16** and **17**.

It has been pointed out above that the yieldable material interconnecting the glass segments can be a vulcanized rubber tape or a portion of the plastic interlayer of the laminated segments. Where a separate tape is used, this tape may alternatively be made of a resilient plastic, or of any other flexible material that can be bonded or adhered to glass and also is yieldable under pressure. The tape need not necessarily be applied to the surfaces of the glass segments, but can also be adhered to the adjacent edges of the segments, or laminated with the assembly rather than adhered by means of an adhesive.

While it is preferable for the reasons given above to provide the yieldable connecting material with slits **21**, these slits can be omitted for economy of manufacture and also for use in places like chemical laboratories where obnoxious odors are likely to escape unless the window provides a completely sealed closure. Other modifications within the scope of the invention will be apparent to those skilled in the art.

We claim:

1. An explosion-resistant window comprising a plurality of coplanar segments of laminated glass that cooperate to form a window pane, one edge of each of said segments forming a portion of the perimeter of said window pane and each segment having two other edges being adjacent to but slightly spaced from the corresponding edges of other segments of said pane and a yieldable elastic material connected to each segment along the entire length of each of the said other two edges of the segment and connecting adjacent segments to secure said segments together and to cooperate with said segments to provide a substantially impermeable window pane when the segments are coplanar.

2. An explosion-resistant window comprising four coplanar triangular segments of laminated glass that cooperate to form a rectangular window pane, one edge of each of said segments forming a side of said window pane and the other two edges of each segment being adjacent to but slightly spaced from corresponding edges of other segments of said pane and a yieldable elastic material connected to each segment along the entire length of each of said other two edges of the segment and connecting adjacent segments to secure said segments together and to cooperate with said segments to provide a substantially impermeable window pane when the segments are coplanar.

3. The window of claim 2 wherein said adjacent edges are aligned with the diagonals of said rectangular window pane.

4. An explosion-resistant window comprising four coplanar triangular segments of laminated glass that cooperate to form a rectangular window pane, one edge of each of said segments forming a side of said window pane and the other two edges of each segment being adjacent to but slightly spaced from corresponding edges of other segments of said pane and elastic tape connected to one surface of each segment along the entire length of each of said other two edges of the segment and connecting adjacent segments to secure said segments together and to cooperate with said segments to provide a substantially impermeable window pane when the segments are coplanar.

5. The window of claim 4 wherein the elastic tape is vulcanized rubber tape.

6. The window of claim 4 wherein said tape is provided with spaced slits aligned with spaces between said adjacent edges of said segments.

7. An explosion-resistant window comprising four coplanar triangular segments of laminated glass that cooperate to form a rectangular window pane, each of said glass segments comprising layers of glass with a plastic interlayer therebetween, one edge of each of said segments forming a side of said window pane and the other two edges of each segment being adjacent to but slightly spaced from corresponding edges of other segments of said pane, the plastic interlayer of each segment extending beyond adjacent edges and integral with the plastic interlayer of other segments to form a single continuous plastic interlayer sheet to provide a substantially impermeable window pane when the segments are coplanar.

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