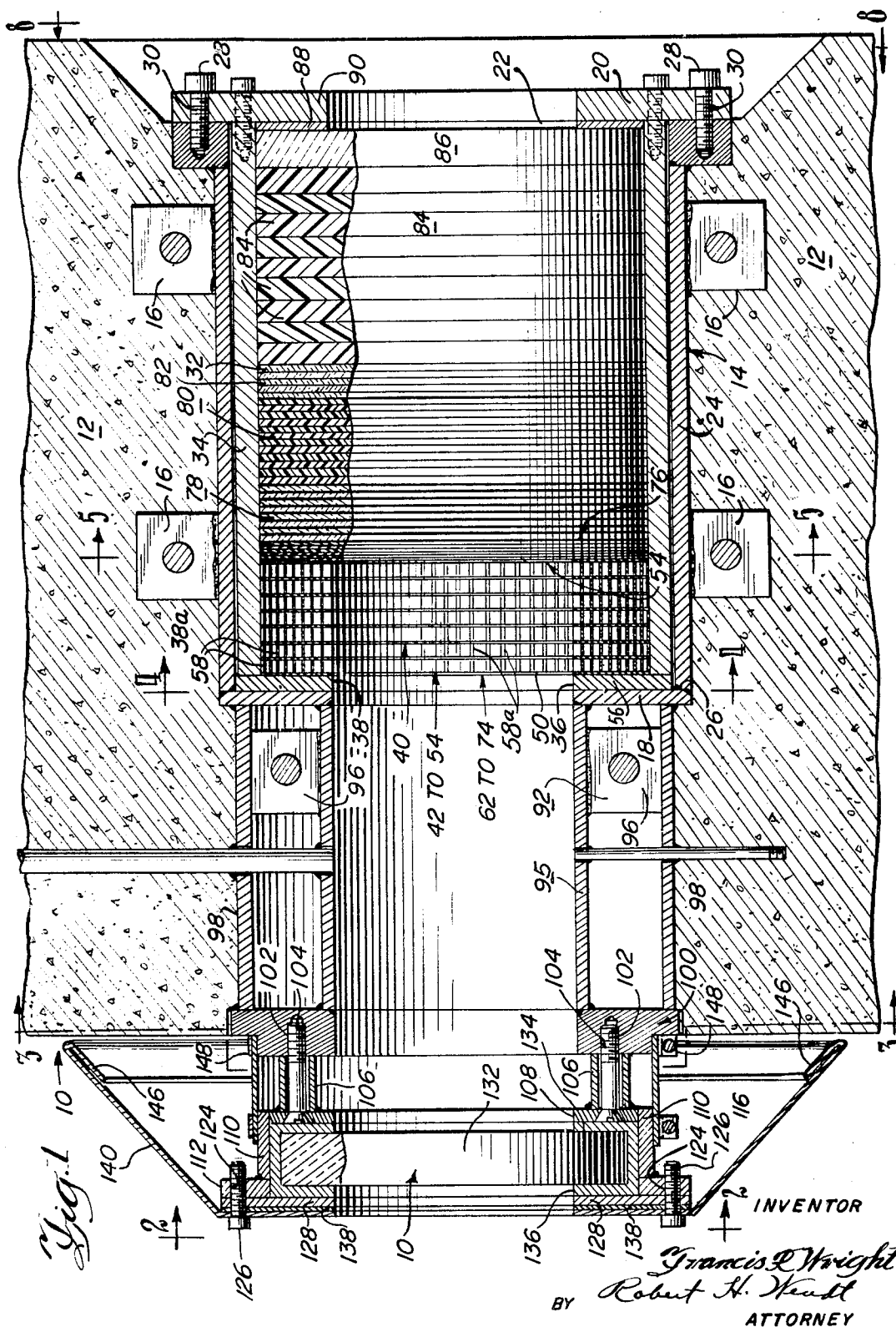


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Fig. 2

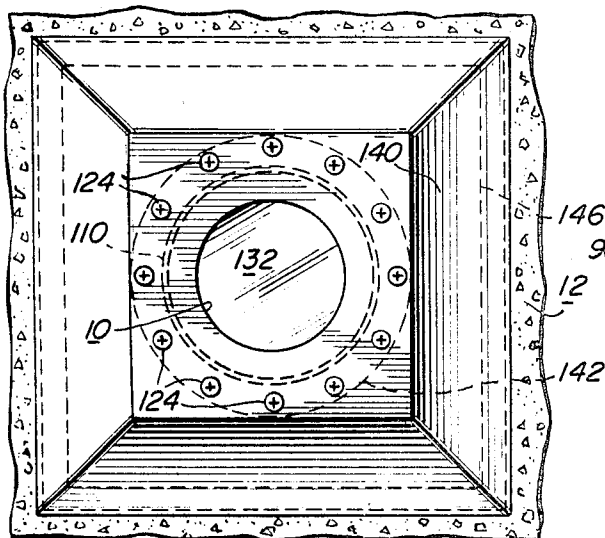


Fig. 3

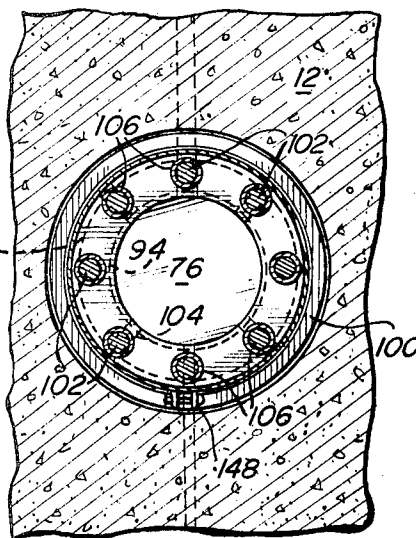


Fig. 4

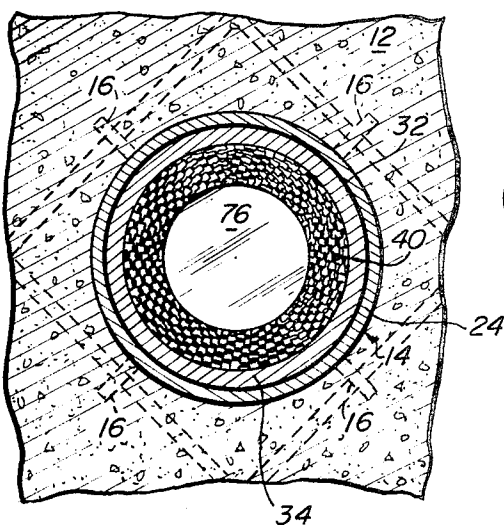
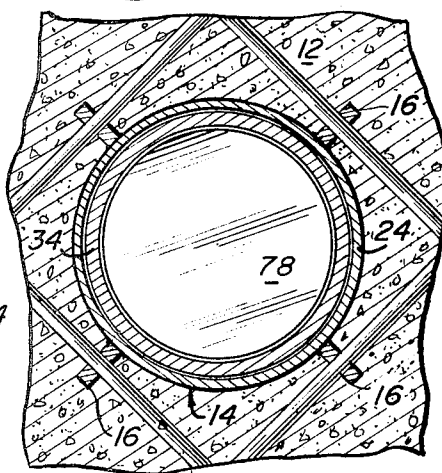


Fig. 5



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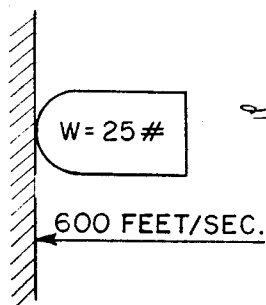
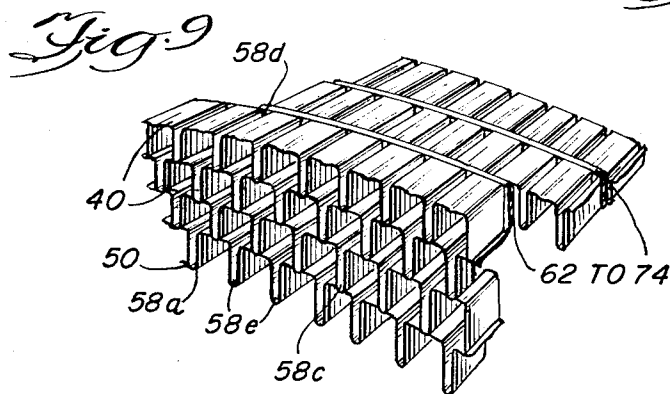
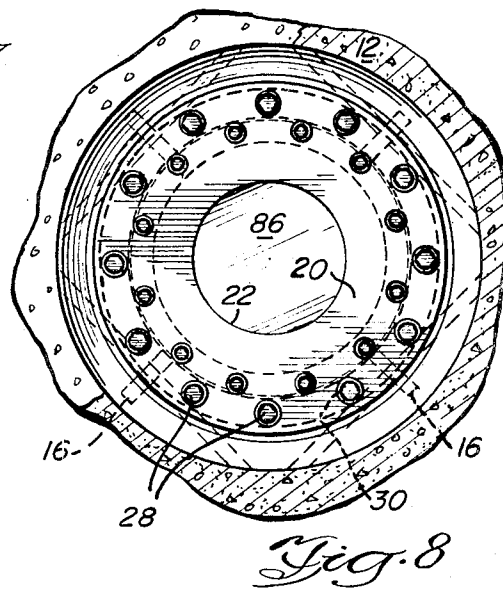
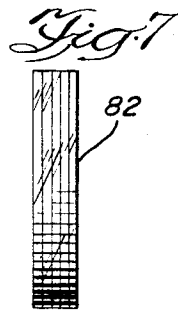
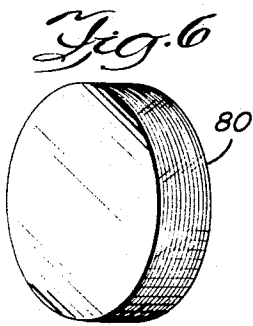
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3 Sheets-Sheet 3



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IMPACT-PROOF OBSERVATION WINDOW

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9 Claims. (Cl. 52-232)

ABSTRACT OF THE DISCLOSURE

An impact-proof window comprising, a steel housing, an annular steel closure at each end of said housing, one of said members being removably secured to said housing, a plurality of spaced stacks of acrylic plastic plates disposed within said housing, said stacks of acrylic plastic plates being in alternate relation with stacks of safety glass, a stack of alternating steel annular discs and annular crushable aluminum honeycomb material disposed within said housing between the inner end member and the alternating stacks of acrylic plastic plates and safety glass plates, a high velocity impact on the outer end of said housing causing crushing of said honeycomb material and exhaust of air through a central opening at the inner end of said housing.

The present invention relates to impact-proof observation windows, and is particularly concerned with the provision of an improved window adapted to be mounted in the wall of a reinforced concrete bunker for protecting the observers during the blast off of missiles from an adjacent pad.

One of the objects of the invention is the provision of an impact-proof observation window which includes a structure that is adapted to meet the rigid requirements of an observation window for observing the simulated blast off, or actual blast off, of missiles from a rocket test stand or launching pad, located at close proximity to said facility, without injury to the observer by any missile part, up to a 25 pound piece thereof, moving at a velocity of 600 feet per second, without any substantial penetration of the window.

Another object is the provision of such an impact-proof observation window which utilizes the cushioning effect of a multiplicity of layers of honeycomb aluminum, which may be crushed in the impact, expelling the air into an adjacent air chamber, from which the air is vented by a multiplicity of layers of coated fabric, engaging adjacent metal parts to provide an air pressure vent.

Another object is the provision of an impact-proof observation window which is mounted in a replaceable unit so that it may be tested, or used, and replaced whenever necessary after test or use.

Another object is the provision of an improved impact-proof observation window, which utilizes a plurality of successive layers of acrylic plastic, and layers of safety glass, and layers of crushable aluminum honeycomb, carried by steel rings arranged to vent the air in the honeycomb cells, into central openings in the rings, which also serve as window openings and communicate with a blast vented space for discharging the air after its expulsion from the honeycomb cells.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts, throughout the several views.

Referring to the drawings, of which there are three sheets;

FIG. 1 is a diametrical, longitudinal, sectional view of the impact-proof observation window;

FIG. 2 is an end elevational view, taken on the plane,

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of the line 2—2, of FIG. 1, looking in the direction of the arrows;

FIG. 3 is a vertical sectional view, taken on the plane of the line 3—3, of FIG. 1, looking in the direction of the arrows;

FIG. 4 is a vertical sectional view, taken on the plane of the line 4—4, of FIG. 1, looking in the direction of the arrows;

FIG. 5 is a vertical sectional view, taken on the plane, of the line 5—5, of FIG. 1, looking in the direction of the arrows;

FIG. 6 is a perspective view of the composite plastic discs 80;

FIG. 7 is an edge elevational view of the safety glass discs 82;

FIG. 8 is a fragmentary end elevational view, taken on the plane of the line 8—8, in FIG. 1, looking in the direction of the arrows;

FIG. 9 is a perspective of a fragment of a honeycomb ring 40; and

FIG. 10 is a diagrammatic view showing the relations of the parts, involved in the calculations, see column 4, lines 5-15.

Referring to FIG. 1, the present impact-proof observation window is indicated in its entirety by the numeral 10, and it is adapted to be mounted in a concrete reinforced bunker 12, which is adapted to house and protect observers in the bunker 12 from missiles or parts thereof, while observing the blast off of rockets, or other missiles at close range with comparative safety.

As a basis for the performance of this observation window, it was calculated that a 25 lb. missile or part thereof might travel at a velocity of 600 ft. per second, having an energy of 140,625 ft. lbs. to be dissipated by the impact on the window and stopped without substantial penetration and with safety to the observers.

The window 10 may be housed in a first thick cylindrical steel casing 14, provided with anchors 16, embedded in the concrete, said casing 14 being provided with an annular steel member at each end 18, 20, secured to the ends of the cylinder and providing a window opening 22 at each end (FIG. 1, FIG. 8).

The annular steel member 18, at the inner end of the cylinder is welded to the cylinder at 26, and the one 20, at the other end, is removably secured by bolts 28, threaded in bores 30, to secure it to the cylinder, so that the unit 32, may be removed and replaced.

The impact resistant unit 32, is housed in a second steel inner casing 34, of cylindrical shape and having a $\frac{3}{32}$ inch clearance and slidably engaged in the first casing 14. Inner casing 34 has an inner annular end wall 36 (FIG. 1), having an opening 38, registering with that opening 22 in the adjacent annular member 20.

A composite, absorbent ring assembly 40, includes a multiplicity (7) of steel rings 42 to 54, inclusive, each ring having the same size inner opening 38, and the same circular periphery 38a, sliding into the second cylindrical casing 34. The steel rings 42-54, are spaced from each other by a multiplicity of aluminum honeycomb rings 58, of the same size as the steel rings 42-54, and having the same size hole 38, and the aluminum rings are arranged alternately with the steel rings and each aluminum ring is caused to adhere to the steel ring behind it by a layer of epoxy but the forward side of each aluminum ring 58 is free from the next steel plate.

The composite ring assembly 40, of steel rings and aluminum rings 58, is stacked against the end annular wall 36, which gives the ring assembly 40, support over an annular area against forces exerted on it from the front of the window 10, and the apertures in the ring assembly 40, provide a window opening and a discharge path for

air from the aluminum rings which become crushed by the impact.

Each aluminum ring 58 comprises a multiplicity of cells $\frac{1}{2}$ inch more or less in length as the cells extend transversely to the disc which is $\frac{1}{2}$ inch thick. Each of the cells is indicated at 58a (FIG. 1, FIG. 9), with walls and open ends 58c and 58d, and the walls are welded to the adjacent walls by pressure at 58e, and one end of all the cells is closed by a layer of epoxy, causing the honeycomb disc to adhere to the adjacent steel disc on that side. When impact occurs, the aluminum cells are crushed to absorb the impact, driving the air in the cells to the central blast area in the steel annular discs, and to the air blast chamber.

The alternate honeycomb rings 58, are each indicated by numbers 62 to 74, and they are all supported against the annular end wall 56, of the inner casing 34, and the aperture 38 in the steel rings, 42-54, and aluminum rings, 62-74, registers with the inside of the blast chamber further to be described.

Proceeding toward the right end of the window, the assembly includes a stack of steel annular discs, such as 16 gauge galvanized steel, including 6 layers of the same steel discs, indicated at 76, and these support a thick two inch layer 78, of safety glass. All safety glass is made up of $\frac{1}{4}$ inch thick glass, laminated together with polyvinyl butyral interlayers.

Proceeding toward the right in window 10, twelve layers of $\frac{1}{4}$ inch acrylic plastic discs 80, lie against the safety glass 78, and the window next includes a $\frac{1}{4}$ inch layer 82, of safety glass as described above.

The window next includes an assembly of nine layers 84, of acrylic plastic discs, eight being $\frac{3}{4}$ inch thick and the last one 1 inch thick. The final layer 86, comprises a disc of safety glass $\frac{1}{4}$ inches thick lying against an annular disc 88, of $\frac{1}{4}$ inch thick impact absorbent sponge neoprene, which engages the annular end wall 90 of the inner casing 34.

Referring now to the other or left end of the window assembly 10, the outer casing 14 supports a thick steel cylinder 92, having an inner cylindrical wall, registering with the window opening 38, and forming an air blast chamber 95, anchored in the concrete by anchors 96 and provided with an outer strap 98.

The inner wall and the outer strap 98, are welded to an annular end wall 100, which forms the end of the air blast chamber 95, and is provided a plurality of threaded bores 102, for receiving the threaded ends of screw bolts 104, carrying spacer tubes 106.

The spacers 106 are welded to annular frame member 108, which carries cylindrical frame member 110, which is welded to annular member 112 having a multiplicity of threaded bores 124 for receiving screw bolts 126, passing through another annular member 128 forming a circular window frame for a circular disc of safety glass, which may be two inches thick and is mounted in $\frac{1}{4}$ inch shock absorbing neoprene sponge, at its edge 132, its front 134, and its rear at 136, forming a safety eyepiece for the observer.

The bolts 126, which also pass through the facing flange 138, of a frustum shell protector shield 140, which is mounted against a $\frac{1}{8}$ inch neoprene ring, and extends forward away from the observer, and may have a U-bend at its forward edge, and a double thickness at 146. The shield deflects the blast from the air blast chamber forwardly away from the observer.

The spacers 104 support a circumferential wrapping of neoprene banding with its edges engaging the surfaces of annular members 100, and 108, and the neoprene band serving as a blast vent and secured by metal clamping bands 148.

The air blast chamber 95, may have a plurality of stainless steel pipes welded to cylinders 92, and strap 98, and passing through the concrete to serve as conduits for conditioned air, to prevent fogging of the window.

The present impact-proof observation window may extend through a 42 inch concrete bunker wall, and it is adapted to resist the impact of a missile of a weight of 25 lbs., travelling at 600 feet per second, with minimum penetration.

The following are calculations relating to the kinetic energy, illustrated in the diagram of FIG. 10, involved.

Kinetic energy -----	E_k
Mass -----	Weight/32 ft./sec. ² .
V -----	600 ft./sec.
	$\frac{1}{2} MV^2$.
	$\frac{1}{2} \cdot 2\frac{25}{32} \cdot (600)^2$.
E_k -----	$25 \times 360,000/64$.
	140,625 ft.-pounds.

While I have illustrated and described a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of the invention and construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

What I claim as new, and desire to secure by U.S. Letters Patent is:

1. An impact-proof window comprising an elongated cylindrical steel housing having an outer and inner end, an annular steel closure member at each end of said housing, at least one of said members being removably secured to said housing, a plurality of spaced stacks of safety glass plates disposed within said housing, a plurality of spaced stacks of acrylic plastic plates disposed within said housing, said stacks of acrylic plastic plates being in alternate relation, with said stacks of safety glass, a stack of alternating steel annular discs and annular crushable aluminum honeycomb material disposed within said housing between said inner end member and the alternating discs of acrylic plastic plates and safety glass plates, a high velocity impact on the outer end of said housing causing crushing of said honeycomb material and exhaust of air therein through a central opening at the inner end of said housing.

2. A window, according to claim 1, in which the aluminum honeycomb has one side adhered to the adjacent steel disc by epoxy, and the other side of each cell of aluminum is open, toward the adjacent steel disc for escape of air when the aluminum is crushed by impact.

3. A window, according to claim 1, in which the unit is mounted in a separate removable cylindrical housing, for replacement after impact.

4. A window according to claim 1, in which there is a cylinder forming a steel member secured to the rear end of the first steel housing, and having a cylindrical air chamber, adapted to receive air from the aluminum cells in front of said air chamber, and having a blast vent at the other end of said air chamber.

5. A window according to claim 1 in which the blast vent is between two annular steel discs held in spaced relation to the air chamber and having a plurality of wrappings of coated fabric with its edges engaging both steel annular discs, and held there by a clamping steel band.

6. A window according to claim 5 in which there are a plurality of layers of circular discs of safety glass clamped on all sides by neoprene, to provide a non-shatterable stage near the observer, to protect the observer.

7. A window according to claim 6, in which the final steel annular disc outside the safety glass, carries the inner flange of a conical metal shield deflecting backward from the observer, the air blast from the air chamber.

8. An impact observation window, comprising a cylindrical steel casing having an annular wall at each end, forming a window opening, a multiplicity of spaced annular steel members supported against one of said end walls, a plurality of crushable annular aluminum honeycomb members, located between said steel members, a

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thick layer of safety glass of circular shape, covering said window opening and steel members, a multiplicity of layers, comprising circular discs of acrylic plastic lying one side of against said safety glass, and a multiplicity of circular layers of safety glass lying against the opposite side of said acrylic plastic, and forming part of said window.

9. An impact observation window, according to claim 8, in which there are included a multiplicity of circular layers of thicker acrylic plastic lying against the last mentioned safety glass, and against each other, forming part of said window.

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