Jan. 10, 1967 H. J. LINGAL 3,296,952

BLAST CLOSURE

Filed June 19, 1964 2 Sheets-Sheet 1

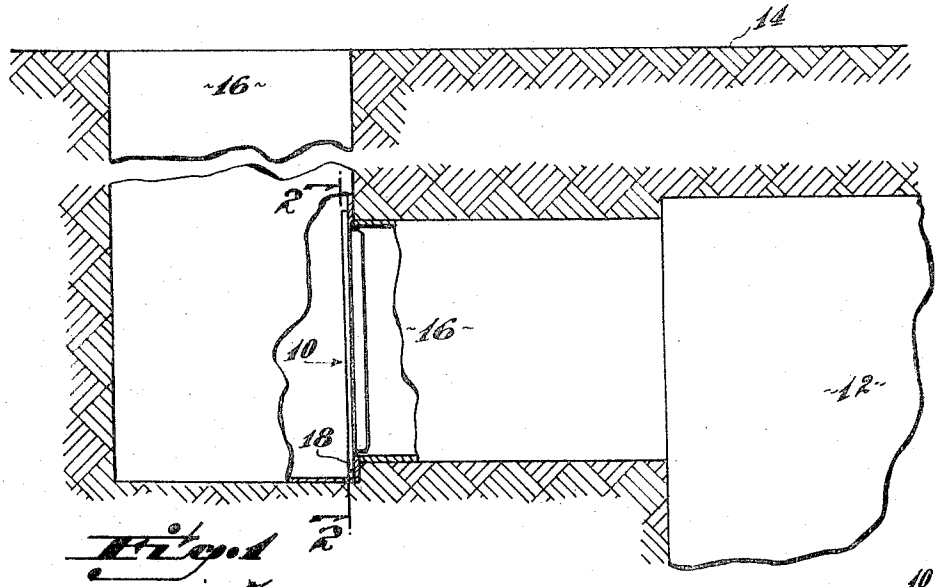


Fig. 1

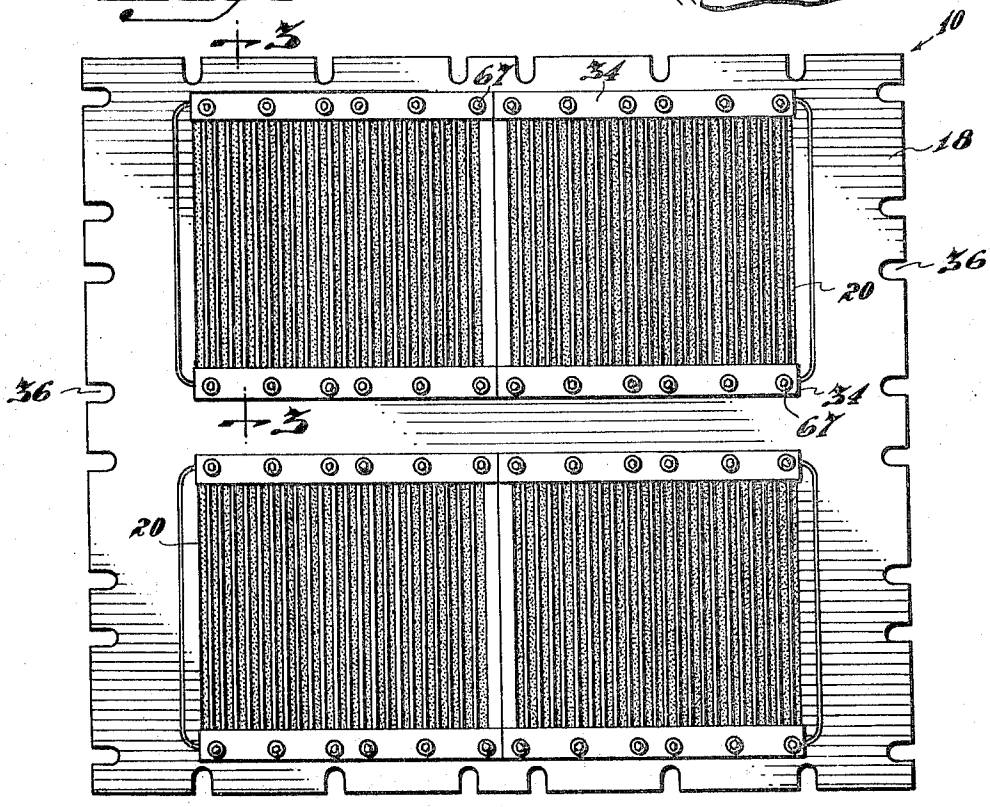


Fig. 2

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Fig. 3

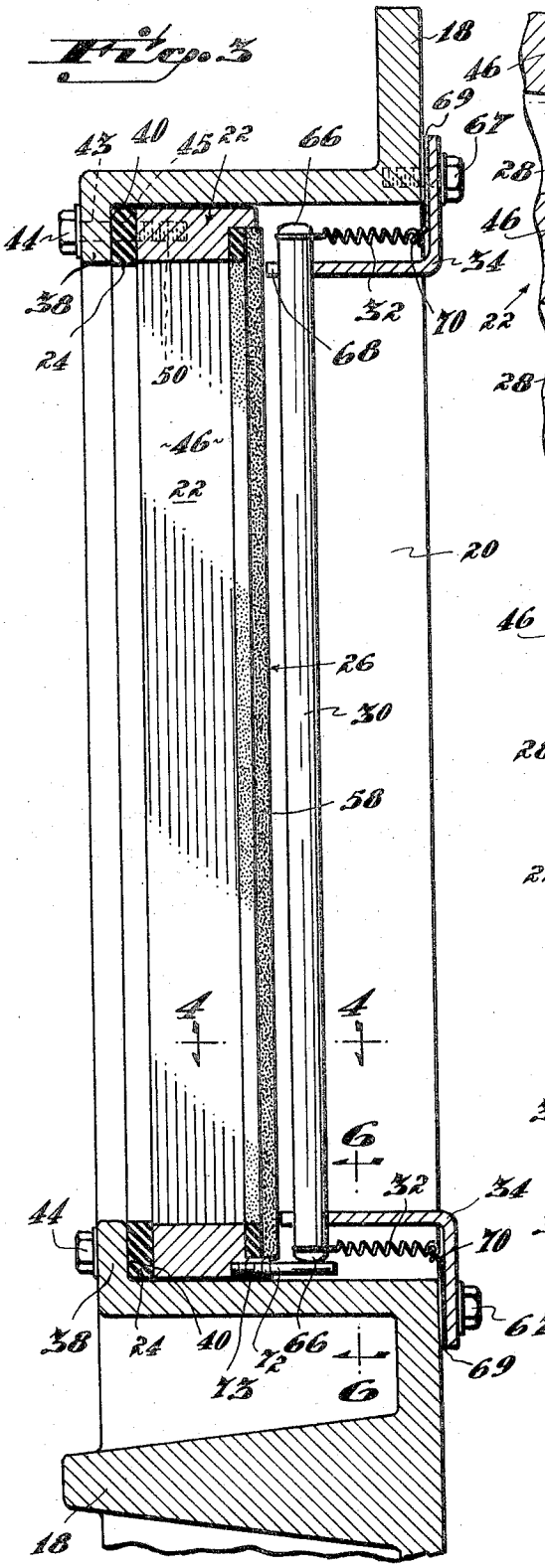


Fig. 4

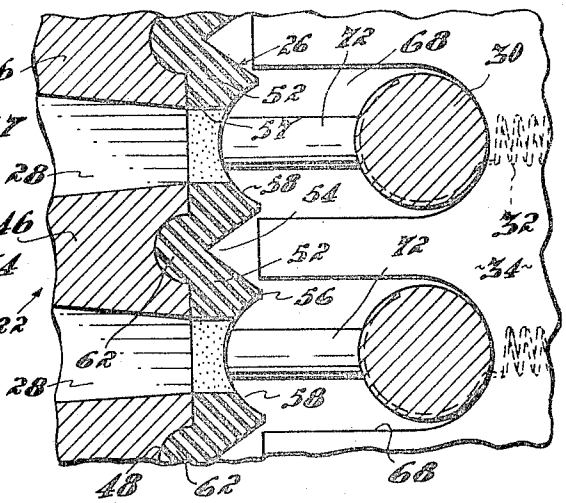


Fig. 5

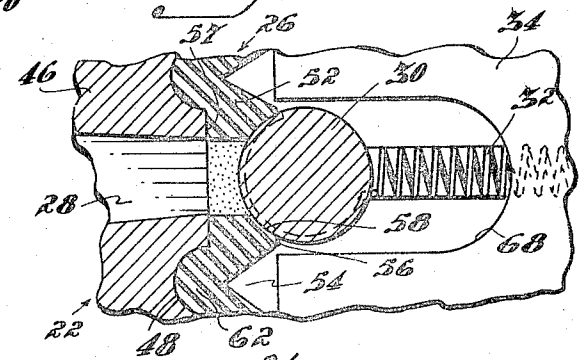
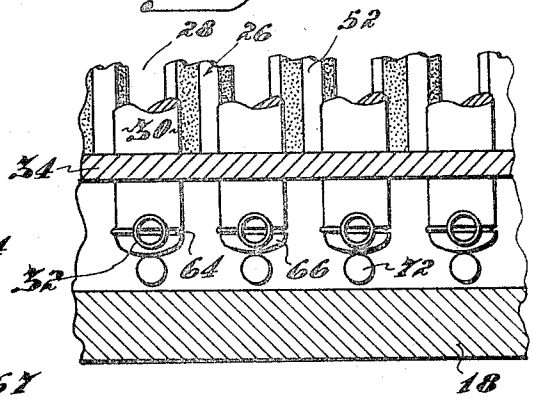


Fig. 6



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3,296,952

BLAST CLOSURE

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Filed June 19, 1964, Ser. No. 376,447
8 Claims. (Cl. 98—119)

This invention relates to a blast closure for an air duct which is actuated by a shock wave from an explosion and is impervious thereto, and more particularly, it concerns such a device wherein elastomeric grids and gaskets are employed.

Almost any structure constructed for sheltering people or machinery from the destructive forces of an explosion such as a nuclear explosion must be provided with an air supply. A ventilation system that utilizes ducts or similar air channeling devices to convey air from the exterior to the interior of the blast shelter is commonly employed in these shelters. Additionally, ducts are also utilized to exhaust the vitiated air.

Such air ducts tend to conduct the shock waves generated by an explosion into the shelter. Consequently, it is imperative that the duct is closed before the shock wave can reach the shelter's interior, and preferably, for simplicity, to enable the ducts to remain open until the last possible moment, the shock wave should actuate the closure means employed.

The blast closure must, of course, be able to withstand the explosive forces or shock waves and prevent them from reaching the shelter's interior. If the ducts are not closed, or if the closure means fail, the attendant results will in all probability be catastrophic, the occupants injured or killed or the machinery damaged. Not only must the closure effectively close the duct and be able to withstand great forces, but additionally, it must be operable even after remaining unused for a period of years.

It has therefore been the objective of this invention to provide a blast closure which is actuated by the shock wave from an explosion and prevents the damaging forces of the shock wave from reaching the interior of a blast shelter. Another objective has been to provide a closure having improved speed of response in relation to prior closures. Another objective has been the provision of such a closure wherein manufacturing tolerances are not critical and wherein the ability of the structure to withstand the forces is not dependent upon the sheer massiveness of the structure. Still another objective has been to provide such a structure which does not have to be periodically tested, repaired, or examined to be functional when the occasion arises.

It has been found that these objectives are fully met by the present invention. More specifically, it has been found that such attributes are provided by a blast closure which utilizes a frame carrying several gratings wherein elastomeric gaskets are employed between the gratings and frame. The grating is provided with a coextensive elastomeric grid over its bar elements. Air passageways between the grating bars are sealed by closure rods upon actuation by a shock wave. In closure, these rods seat against the elastomeric grid, which has a novel shape to be described.

In previous blast closures, such as that disclosed in Price Patent No. 3,015,342, issued January 2, 1962, rods for closing the air passageways have been provided for line-to-line contact with fixed bars to form a closure upon actuation by an explosion. However, in this type of blast closure manufacturing tolerances were rather critical, deformation tended to cocur after use or testing, and closure time was relatively slow.

I have found that by employing an elastomeric gasket between the frame and gratings, and further by mounting the gratings so that they can move slightly against the gasket in the direction the shock wave is traveling, the absorption of and the ability of the closure to withstand potentially destructive forces is markedly improved.

I have also found that through the use of an elastomeric grid, of a shape to be described, over the fixed grating bars against which closure rods seat to close the air passageways, closing times are shortened, critical manufacturing tolerances are minimized, and air leakage past the closure is decreased. Additionally, stresses produced by the seating of the closure rods are minimized.

It has been empirically discovered that the cross sectional shape of individual strips forming the grid is rather critical in that a specific shape provides unexpected results. It has been found that if an elastomeric grid is mounted over each grating bar and has a sectional shape including a longitudinal V-groove and concave edge surfaces on each side of the V-groove which approximate the curvature of the closure rod that engages them, the seal between the closure rods and the grid is improved and closing times are decreased.

The various features, advantages and details of my invention will be more clearly apparent to those skilled in the art from the following detailed description taken in conjunction with the drawings in which:

FIG. 1 is an elevation, partly broken away, showing the position of a blast closure in accordance with the invention in a ventilation system of a blast shelter,

FIG. 2 is a section taken along lines 2—2 of FIG. 1, showing the front of a blast closure,

FIG. 3 is a section taken along lines 3—3 of FIG. 2, particularly showing a closure rod and its relationship to the grid and grating,

FIG. 4 is a section taken along lines 4—4 of FIG. 3, particularly showing the relative positions of the closure rods and the grid when the closure rods are in their normal retracted or open position,

FIG. 5 is a view similar to FIG. 4 but it shows a closure rod engaging the grid and closing the air passageways of the grating, and

FIG. 6 is a section taken along lines 6—6 of FIG. 3, showing a plurality of closure rods held in vertical alignment by support pins.

Referring now to the drawings, FIG. 1 shows a blast closure, generally designated as **10**, in a typical environment in which such a closure may be employed; namely, this figure generally shows a blast shelter **12** especially adapted to protect people and/or machinery from a nuclear explosion. For structural reasons the shelter can conveniently be constructed below ground level **14**. Oftentimes such a shelter **12** requires an air supply and air exhaust system, and conventionally, a plurality of ducts **16** are provided to channel the air so supplied and exhausted. It is within such a duct **16** where the present invention has been devised to operate.

Referring now to FIGS. 2–6, the blast closure **10** is comprised of a frame **18** having grating receiving openings **20** in which gratings **22** are secured. The gratings **22** bear against elastomeric gaskets **24** carried by the frame **18**. To each grating **22** is secured a grid **26**, also molded from an elastomeric substance, preferably a silicone rubber. Seating against the grid **26** and closing air passageways **28** in the grating **22** and grid **26** are closure rods **30**, held in a retracted position by springs **32** and aligned with respect to the grid by alignment brackets **34**.

The frame **18** can conveniently be cast from aluminum or iron. Its rectangular dimensions should generally correspond to that of the duct **16** in which it is to be

employed. The peripheral edges of the frame are notched as at **36** so that the frame **18** may be bolted to the walls of the duct. The frame **18** has a plurality of grating receiving openings **20** which are generally rectangular in area and in which the gratings **22** are secured. On the downward side **37** of these openings (i.e., in the direction toward the shelter) there are formed in-turned peripheral flanges **38**. On the forward (or upstream) side **40** of the flanges **38** are fitted gaskets **24** which are generally rectangular in shape, corresponding to the outline of opening **20**. These gaskets **24** are made from an elastomeric material and preferably from a silicone rubber which has a high thermal stability and high imperviousness to contaminated air. Bolts **44** pass slidably through holes **43** in the frame, through the holes **45** of the gaskets **24**, and are threaded into the grating **22**. The gaskets **24** are under slight compression between the frame and grating.

The grating **22** is rectangular in area and can be cast integrally from aluminum or iron. It consists of parallel spaced bars **46** joined at their ends, between which are air passageways **28**. Each bar **46** has a longitudinal semi-circular groove **48** in its front or upstream surface for securing the grid **26**. Because the bolts **44** are slidable in the holes **43**, the grating **22** is free to move toward the flange **38** when sufficient forces are exerted on the grating **22** to compress the gaskets **24**.

The grid **26** is secured to the grating as by means of an adhesive such as Dow Corning Selastic RTV–140. Like the gasket **24**, the grid is molded from an elastomeric material such as silicone rubber. The grid is coextensive with the surfaces of the grating **22**; that is, the grid has spaced parallel strips **52** that facially engage the bars **46**. The strips **52** are connected at their extremities, as are the bars **46**. The top of each strip has a longitudinal V-shaped groove **54** therein which in part accounts for the improved seating of a cooperating closure rod **30**. The upstream edges **56** of the strips, each above an upstream edge **57** of a bar **46**, are concave so that the adjacent edges of adjacent strips provide a circumferential seat **58** for receiving a closure rod **30**. Such a circumferential seat also defines a passageway **28**. The circumferential seat **58** so formed extends along the entire length of the grid **26**, thereby providing a seat for a closure rod along the rod's **30** entire length. Immediately downstream from the vertex of the V-shaped notch **54** is a semi-circular rib **62** in the strip **52** which engages the groove **48** of the grating **22** and helps to secure and to maintain the position of the grid **26**.

Immediately in front of the circumferential seats **58**, but spaced far enough away so that the air flowing through the passageways **28** and between the strips **52** is not unduly restricted, are the closure rods **30**. These rods are made from anodized aluminum which has been coated with nickel or cobalt acetate to prevent the rods from adhering to the seats **58**. The radius of the rods is longitudinally constant and should be slightly less than the radius of the circumferential seat **58** formed by the adjacent rounded edges of adjacent strips so that the rods do not stick to the seats after exposure to a blast. Circumferential grooves **64** are cut in the rods adjacent their slightly rounded or tapered ends **66**.

Alignment brackets **34** are secured to the front of the frame **18** by bolts **67** and have U-shaped notches **68** that each surround a closure rod. The closure rods are aligned by these notches in a spaced parallel relationship and are positioned immediately in front of the air passageway **28** and the seat **58**.

Coil springs **32** encircle each end of the rods **30** and rest in the grooves **64**. The other ends of the springs are secured by circular strips **69** held by the countersink head screws, not shown, having a tab portion **70** which has a hole, not shown, through which the spring is hooked. The springs **32** are resilient enough to hold the rods away from the seats during normal conditions but permit the rods to engage the seats when a predetermined force strikes the rods, the resiliency of the springs determining the magnitude of the shock wave necessary to actuate the closure.

Vertical alignment pins **72** are seated in the gratings **22** immediately below the bottom end of the rods **30**. These pins may conveniently be screwed into threaded holes **73** in the grating. An end of each rod rests on one of these pins and the rods are thereby held in vertical alignment. The pins **72** are preferably cylindrical to provide a minimum of frictional interference between the rods and the pins, while at the same time preventing the accumulation of dust or other foreign matter which might interfere with or prevent the free movement of its rods **30**. Of course it will be appreciated that fins projecting from the bottom of the grating receiving opening and having a narrow upper edge could be used in place of the pins.

In operation the rods **30** are normally held away from the seats **58** by the springs **32**. However, when an explosion occurs and a shock wave travels into the duct **16** and strikes the rods **30**, the latter engages the seats **58** thereby closing the passageways **28**. After the shock wave has dissipated, the springs **32** pull the rods **30** away from the seats **58** and air may again pass through the passageways **28**.

From the above disclosure of the general principles of the present invention and the preceding description of the preferred embodiment, those skilled in the art will readily comprehend various modifications of which the invention is susceptible within the scope of the following claims.

Having thus described my invention, I claim:

1. A blast closure comprising,
a frame having at least one grating receiving opening,
at least one grating having spaced bars with air passageways therebetween, each grating positioned within a grating receiving opening,
means elastically securing each grating to said frame in said opening, said means allowing unidirectional movement of each grating,
an elastomeric grid secured to each grating, said grid having spaced strips coextensive with and engaging said bars,
a plurality of spaced closure rods engageable with the edges of adjacent strips, said rods providing a closure of the air passageways between said bars,
aligning means secured to said frame for maintaining the spaced relationship of said rods,
yieldable means connected to said rods and to said frame for holding said rods away from said grid, and
means secured to said grating for maintaining the vertical alignment of said rods.

2. A blast closure comprising,
a frame having at least one grating receiving opening,
at least one grating having spaced bars with air passageways therebetween, each grating positioned within a grating receiving opening,
means elastically securing each grating to said frame, said means allowing unidirectional movement of said grating,
a plurality of elastomeric strips coextensive with and secured to said bars,
longitudinal V-shaped grooves in the respective upper surfaces of said strips,
a plurality of spaced closure rods engageable with the edges of adjacent strips for providing a closure of the air passageways between said bars,
aligning means secured to said frame for maintaining the spaced relationship of said rods,
blast yieldable means connected to said rods and to said frame for holding said rods away from said grid, and

means secured to said grating and engaging said closure rods for maintaining the vertical alignment of said rods.

3. A blast closure comprising,
a frame having at least one grating receiving opening,
a peripheral flange encircling each opening,
an elastomeric gasket engaging each flange,
at least one grating having spaced bars with air passageways therebetween, said grating positioned within a grating receiving opening and engaging an elastomeric gasket,
means securing each grating to said frame, said means allowing unidirectional movement of each grating,
a plurality of elastomeric strips coextensive with and secured to said bars,
longitudinal V-shaped notches in the upper surfaces of said strips,
said strips having curved upper edges,
a plurality of spaced closure rods engageable with the curved edges of adjacent strips for providing a closure of the air passageways between said bars,
aligning means secured to said frame for maintaining the spaced relationship of said rods,
means connected to said rods and to said frame for holding said rods away from said grid, and
means secured to said grating and engaging said closure rods for maintaining the vertical alignment of said rods.

4. A blast closure comprising,
a frame having at least one grating receiving opening,
a peripheral flange encircling each opening,
an elastomeric gasket engaging each flange,
at least one grating having parallel spaced bars with air passageways therebetween, said grating positioned within a grating receiving opening and engaging an elastomeric gasket,
a longitudinal groove in each of said bars,
means securing each grating to a flange, said means allowing unidirectional movement of said grating,
a plurality of elastomeric strips coextensive with said bars,
a longitudinal rib in each of said strips for engaging each of said grooves,
longitudinal V-shaped grooves in the upper surfaces of said strips,
said strips having curved upper edges,
a plurality of spaced parallel closure rods engageable with the adjacent curved edges of adjacent strips for providing a closure of the air passageways between said bars,
a bracket having U-shaped notches for maintaining the parallel relationship of said bars and secured to said frame,
springs connected to each end of said bars and to said frame for holding said bars away from said grid, and
pins engaging said grating, said pins providing a surface for said closure rods to rest on.

5. A blast closure comprising,
a frame having at least one grating receiving opening,
a peripheral flange encircling one end of each opening,
an elastomeric gasket engaging each flange,
at least one grating having parallel spaced bars with air passageways therebetween, said grating positioned within a grating receiving opening and engaging an elastomeric gasket,
bolts securing said grating to a flange, said bolts threadably engaging said flange only for allowing unidirectional movement of said grating,
an elastomeric grid adhesively secured to each grating, said grid having spaced parallel strips coextensive with and engaging said bars,
longitudinal V-shaped grooves in the upper surface of each strip,
said strips having concave upper edges, the adjacent upper curved edges of adjacent strips forming a plurality of circumferential seats,
a plurality of spaced parallel closure rods engageable with said circumferential seats for providing a closure of said air passageways,
said rods having a radius less than the radius of said circumferential seat,
aligning means secured to said frame maintaining the parallel relationship of said rods,
means connected to each end of said bars and to said aligning means for holding said rods away from said grid, and
means secured to said grating for maintaining the vertical alignment of said rods.

6. A blast closure comprising,
a frame having a plurality of grating receiving openings,
a peripheral flange encircling one end of each of said grating receiving openings,
an elastomeric gasket engaging each of said flanges,
a plurality of gratings having parallel spaced bars,
air passageways between said bars,
said gratings each positioned within a grating receiving opening and engaging an elastomeric gasket,
bolts securing said gratings to said flange, said bolts threadably engaging said flange only for allowing unidirectional movement of said grating,
an elastomeric grid secured to each grating, said grid having spaced parallel strips coextensive with and engaging the bars of said grid,
a plurality of spaced parallel aluminum closure rods engageable with the adjacent edges of adjacent strips, said rods providing a closure of the air passageways between said bars,
said rods having a coating for providing a surface that is relatively non-adherent to said elastomeric grid,
aligning means secured to said frame for maintaining the parallel relationship of said rods,
means connected to each end of said rods and to said frame for holding said rods away from said grid, and
means secured to said grating for maintaining the vertical alignment of said rods.

7. A blast closure comprising,
a frame having a plurality of grating receiving openings,
a peripheral flange encircling one end of each of said grating receiving openings,
an elastomeric gasket engaging each of said flanges,
a plurality of gratings having parallel spaced bars,
air passageways between said bars,
said gratings each positioned within a grating receiving opening and engaging an elastomeric gasket,
bolts securing said gratings to said frame, said bolts threadably engaging said flange only for allowing unidirectional movement of said grating,
an elastomeric grid secured to each grating, said grid having spaced parallel strips coextensive with and engaging the bars of said grating, the adjacent edges of adjacent strips forming a circumferential seat defining an air passageway,
a plurality of spaced parallel aluminum closure rods, said rods engageable with said circumferential seat for providing a closure of the air passageway defined by said seat,
aligning means secured to said frame for maintaining the parallel relatioinship of said rods,
means connected to each end of said rods and to said frame for holding said rods away from said grid, and
means secured to said grating for maintaining the vertical alignment of said rods.

8. A blast closure comprising,
a frame having a plurality of grating receiving openings,

a peripheral flange encircling one end of each of said grating receiving openings,
an elastomeric gasket engaging each of said flanges,
a plurality of gratings having parallel spaced bars,
air passageways between said bars,
said gratings each positioned within a grating receiving opening and engaging an elastomeric gasket,
bolts securing said gratings to said flange, said bolts threadably engaging said flange only for allowing unidirectional movement of said grating,
an elastomeric grid secured to each grating, said grid having spaced parallel strips coextensive with an engaging the bars of said grid, the adjacent edges of adjacent strips being rounded so as to form a circumferential seat that defines an air passageway,
a V-shaped groove in the upper surface of each strip,
a plurality of spaced parallel aluminum closure rods engageable with the circumferential seat, said rods providing a closure of the air passageways defined by said seat,
said rods having a coating for providing a surface

that is relatively non-adherent to said elastomeric grid,
aligning means secured to said frame maintaining the parallel relationship of said rods,
means connected to each end of said rods and to said frame for holding said rods away from said grid, and
means secured to said grating for maintaining the vertical alignment of said rods.

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