



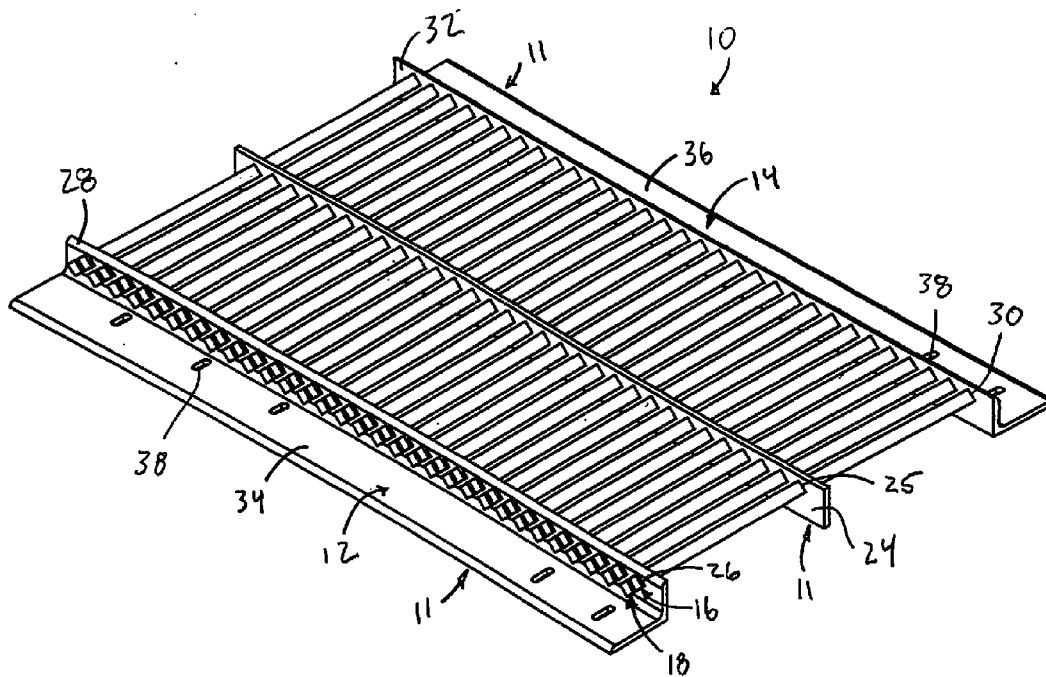
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(19) **United States**(12) **Patent Application Publication**
Kahmann et al.(10) **Pub. No.: US 2014/0123842 A1**(43) **Pub. Date: May 8, 2014**(54) **BLAST SHIELD****Publication Classification**(71) Applicant: **Meggitt (Rockmart) Inc.**, (US)(51) **Int. Cl.**
F41H 5/06 (2006.01)(72) Inventors: **Keith Alsworth Kahmann**, Ansonia, CT (US); **Michael Kittredge Costen**, Milford, CT (US)(52) **U.S. Cl.**
CPC **F41H 5/06** (2013.01)
USPC **89/36.02**(73) Assignee: **MEGGITT (ROCKMART) INC.**, Rockmart, GA (US)(57) **ABSTRACT**

A blast shield placed over a structure to be protected from the force of a blast includes a support assembly and a plurality of first deflection members secured to said support assembly. Each of said plurality of first deflection members present opposed surfaces angling away from the direction of an incoming explosive force, such that an incoming explosive force is split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force. A plurality of second deflection members presenting opposed surfaces angling away from the direction of an incoming explosive force may also be employed, whereby an incoming explosive force is further split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force.

(21) Appl. No.: **13/786,784**(22) Filed: **Mar. 6, 2013****Related U.S. Application Data**

(60) Provisional application No. 61/607,140, filed on Mar. 6, 2012.



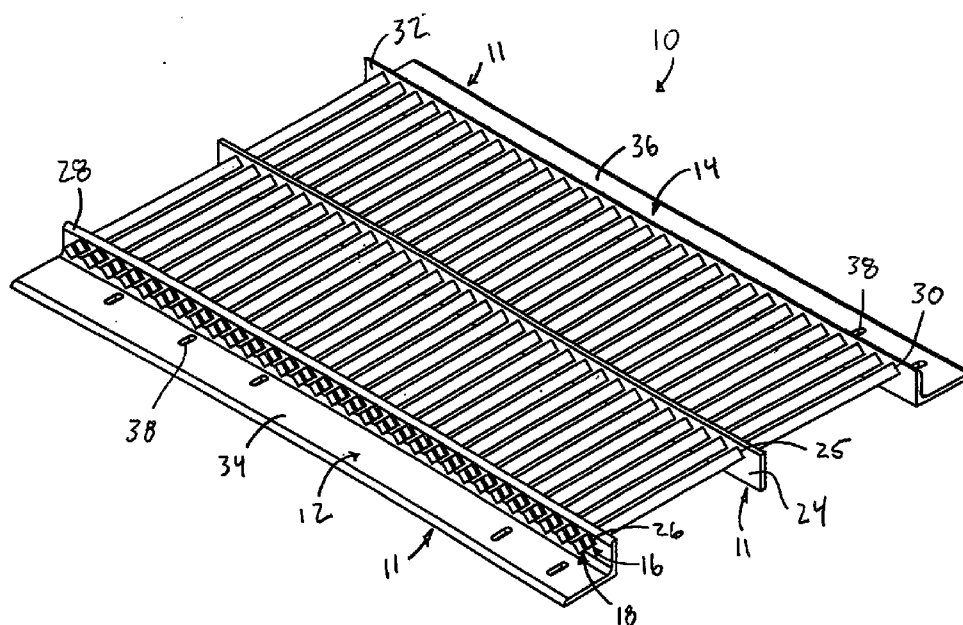


Fig. 1

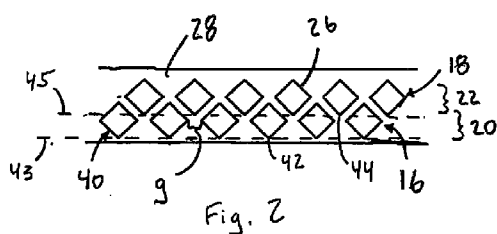


Fig. 2

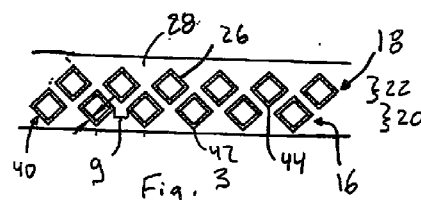


Fig. 3

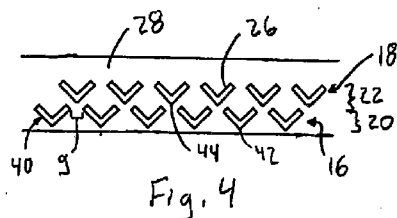


Fig. 4

BLAST SHIELD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/607,140, filed Mar. 6, 2012.

FIELD OF THE INVENTION

[0002] The present invention generally relates to shields for protecting against blasts from explosions, such as those generated by mines, improvised explosive devices (IEDs) and other munitions and explosives of concern (MEC).

BACKGROUND OF THE INVENTION

[0003] It is an unfortunate fact that many military and civilian endeavors are subject to the risks of encountering an explosion from unexploded ordnance (UXO) and other munitions and explosives of concern (MEC). In particular military operations improvised explosive devices (IEDs) also pose a significant risk. Thus, measures are taken to protect vehicles and other structures from the blast forces experienced when a UXO, IED or other MEC is detonated. For example, some vehicles are equipped with a V-hull, which is a type of vehicle armor design presenting large, solid sloped armor faces that serve to deflect an upwardly directed blast from a land mine or IED away from the vehicle.

[0004] There is a general appreciation that the effect of a blast against a vehicle or other structure can be reduced by providing a shield between the vehicle/structure and the blast source. It is further appreciated that blast forces may be reduced by employing steel plates to shield the desired structure, placing the steel plates at an angle to the direction of the blast. While surfaces normal to the source of a blast experience a high blast load, surfaces at an angle to the blast experience lower loads. This is the main concept behind the V-hull design, which, in light and medium sized vehicles, involves incorporating a generally V-shaped capsule onto the chassis of the vehicle. In general, two large plates are secured to the chassis in a V shape converging toward the ground surface on which the vehicle moves. The plates serve to deflect a blast force. These plates are solid and must be quite strong and thus quite heavy. This limits many design options, as many vehicles cannot efficiently and practically bear the additional weight. Also, to fit the V-hull under the vehicle, the vehicle must be made taller, and, particularly in military applications, this makes the vehicle a bigger target. As another disadvantage, the V-hull designs are not readily retrofit to existing vehicles.

[0005] The present invention seeks to improve the art by providing blast shield designs that do not merely reflect a blast, but also dissipate the momentum of the blast. This invention provides blast shield structures that are novel and distinctive as compared to those of the prior art.

SUMMARY OF THE INVENTION

[0006] In a first embodiment, the present invention provides a blast shield placed over a structure to be protected from the force of a blast. The blast shield comprises a support assembly and a plurality of first deflection members secured to said support assembly, each of said plurality of first deflection members presenting opposed surfaces angling away from the direction of an incoming explosive force, such that

an incoming explosive force is split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force.

[0007] In a second embodiment, the present invention provides a blast shield as in the first embodiment, further comprising a plurality of second deflection members presenting opposed surfaces angling away from the direction of an incoming explosive force, whereby an incoming explosive force is split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force.

[0008] In a third embodiment, the present invention provides a blast shield as in the first or second embodiment, wherein said plurality of second deflection members are positioned behind said plurality of first deflection members relative to the direction of an incoming explosive force.

[0009] In a fourth embodiment, the present invention provides a blast shield as in any of the first through third embodiments, wherein a gap is provided between neighboring ones of said plurality of first deflection members, and said plurality of second deflection members are positioned such that one of said plurality of second deflection members is aligned with each said gap, whereby an incoming explosive force is split and deflected by the opposed surfaces of said plurality of first deflection members, thereafter proceeding through said gap and encountering said plurality of second deflection members thus dissipating the momentum of the explosive force.

[0010] In a fifth embodiment, the present invention provides a blast shield as in any of the first through fourth embodiments, wherein said plurality of first deflection members define a first discontinuous blast face.

[0011] In a sixth embodiment, the present invention provides a blast shield as in any of the first through fifth embodiments, wherein said plurality of second deflection members define a second discontinuous blast face.

[0012] In a seventh embodiment, the present invention provides a blast shield as in any of the first through sixth embodiments, wherein said second discontinuous blast face is positioned closer to the surface to be protected than is said first discontinuous blast face, such that an incoming explosive force is split and deflected by said first discontinuous blast face and further split and deflected by said second discontinuous blast face.

[0013] In an eighth embodiment, the present invention provides a blast shield as in any of the first through seventh embodiments, wherein said plurality of first deflection members extend in a longitudinal direction and said plurality of second deflection members extend in a direction oblique or perpendicular to said longitudinal direction.

[0014] In a ninth embodiment, the present invention provides a blast shield as in any of the first through eighth embodiments, wherein said plurality of first deflection members may be the same or different and are selected from solid bars, hollow tubes, hollow tubes filled with a strengthening material, and v-shaped angle bars.

[0015] In a tenth embodiment, the present invention provides a blast shield as in any of the first through ninth embodiments, wherein said plurality of second deflection members may be the same or different and are selected from solid bars, hollow tubes, hollow tubes filled with a strengthening material, and v-shaped angle bars.

[0016] In an eleventh embodiment, the present invention provides a blast shield as in any of the first through tenth embodiments, wherein said support assembly comprises a first side support and an opposed second side support, said

plurality of first deflection members extending transverse to said longitudinal direction, from said first side support to said second side support.

[0017] In a twelfth embodiment, the present invention provides a blast shield as in any of the first through eleventh embodiments, wherein said opposed surfaces of said first deflection members define a v-shaped surface pointing away from the structure to be protected and toward the direction of an incoming explosive force.

[0018] In a thirteenth embodiment, the present invention provides a blast shield as in any of the first through twelfth embodiments, wherein said opposed surfaces of said first deflection members define a v-shaped surface opening in a direction toward the structure to be protected

[0019] In a fourteenth embodiment, the present invention provides a blast shield placed over a fuel tank to be protected from the force of a blast. The blast shield comprises a first side support and an opposed second side support, both extending in a longitudinal direction. A plurality of first deflection members extends transverse to the longitudinal direction, from the first side support to the second side support, each of the plurality of first deflection members presenting a v-shaped surface pointing away from the fuel tank and toward a potential incoming explosive force, such that an incoming explosive force is deflected by the V-shaped surface.

[0020] In a fifteenth embodiment, the present invention provides a blast shield as in paragraph the fourteenth embodiment, further comprising a plurality of second deflection members extending transverse to said longitudinal direction, from said first side support to said second side support, each of said plurality of second deflection members presenting a v-shaped surface pointing in the direction away from the fuel tank and toward an incoming explosive force.

[0021] In a sixteenth embodiment, the present invention provides a blast shield as in either the fourteenth or fifteenth embodiments, wherein said plurality of second deflection members are positioned behind said plurality of first deflection members relative to the direction of an incoming explosive force.

[0022] In a seventeenth embodiment, the present invention provides a blast shield as in any of the fourteenth through sixteenth wherein a gap is provided between each of said plurality of first deflection members, and said plurality of second deflection members are positioned such that one of said plurality of second deflection members is aligned with each said gap.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a perspective view of an embodiment of a blast shield in accordance with this invention;

[0024] FIG. 2 is a schematic view of the arrangement of deflection members of the blast shield of this invention, the deflection members being shown as solid square rods;

[0025] FIG. 3 is a schematic view of the arrangement of deflection members of the blast shield of this invention, the deflection members being shown as hollow square tubes; and

[0026] FIG. 4 is a schematic view of the arrangement of deflection members of the blast shield of this invention, the deflection members being shown as angle bars.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0027] Referring now to FIG. 1, a blast shield in accordance with this invention is shown and designated by the numeral 10. The blast shield 10 includes a support assembly 11, including a first side support 12 and an opposed second side support 14 and a one or more optional intermediate supports such as intermediate support 24. The first side support 12 and the second side support 14 extend in a longitudinal direction, and a multitude of deflection members extend transversely between them. More particular, a plurality of first deflection members 16 extend transversely from a sidewall (or web) 28 of the first side support 12 to a sidewall (or web) 32 of the second side support 14, and a plurality of second deflection members 18 extend perpendicularly from the sidewall 28 of the first side support 12 to the sidewall 32 of the second side support 14. The deflection members 16, 18 may instead extend obliquely to the first and second side supports 12, 14. The plurality of first deflection members are formed in a first row 20, while the plurality of second deflection members 18 are formed in a second row 22. It should be appreciated, however, that benefits of this invention can be experienced by the use of only one row. Two rows are shown here simply as a particularly desired option. It should similarly be appreciated that additional rows of a plurality of deflection members could also be employed. It should also be appreciated that the second row may extend obliquely or perpendicularly to the first row, and is not limited to the parallel relationship shown in the specific embodiments of the Figures.

[0028] It should be appreciated that while a generally rectangular blast shield 10 is shown herein, other structures may be practiced, and the support assembly 11 may take various shapes. For example, a circular support member could be provided, with deflection members extending across the general circular shape.

[0029] Although the present invention is not limited to or by this particular structure, in particular embodiments such as that shown for the blast shield 10 of FIG. 1, the deflection members 16, 18 partially extend through apertures 26 in a sidewall 28 of the first side support 12, and, similarly, extend through apertures 30 in a sidewall 32 of the second side support 14. The deflection members 16, 18 are welded to the first side support 12 and second side support 14 at those respective apertures 26, 30. It will be appreciated that this construct will be very strong, particularly as compared to simply welding the deflection members 16, 18 to the face of the sidewalls 28, 32. Although the deflection members 16, 18 can be secured in other ways, it is noted that by securing them after extending through apertures, such as 26, 30, explosive forces against the deflection members 16, 18 will be significantly borne by the first and second side supports 12, 14. Securing them in other ways, such as by welding to a face of the side supports 12, 14, may not allow the side supports 12, 14 to bear as much of the explosive force or transfer explosive force to the side supports.

[0030] In some embodiments, particularly where the distance between the first side support 12 and the second side support 14 is particularly large, the support assembly 11 may include an intermediate support 24. In this embodiment, the intermediate support 24 is positioned to extend longitudinally between the first side support and second side support 14, generally parallel to them, though it may extend obliquely. In some embodiments, to improve the strength of such a structure, the intermediate support 24 includes apertures 25 like

those at **26** and **30**, and the deflection members **16**, **18** extend through the apertures **25**. In other embodiments, the deflection members are spot welded at the apertures **25**. In some embodiments, multiple intermediate supports are employed, spaced to be positioned at intervals between the first and second side supports. The side supports and, in some embodiments, the intermediate support(s) are secured to structures in order to place the deflection members between an item to be protected and a potential incoming blast force.

[0031] In the particular embodiment of FIG. 1, the blast shield **10** is intended for mounting to the underside of a military vehicle to protect the fuel tank and other structures, including the personnel that might be inside the vehicle. The first and second side supports **12**, **14** therefore each respectively include a mounting flange. The first side support **12** includes a mounting flange **34** extending from the side wall **28**, and the second side support **14** includes a mounting flange **36** extending from the sidewall **32**. The first and second side supports **12**, **14** are preferably formed as one piece, thereby improving the strength thereof. In this particular embodiment, the first and second side supports **12**, **14** are formed of metal, and are in the shape of an L-beam. I-beams and other similar structures would also be useful due to their inherent strength. The mounting flanges **34** and **36** provide a plurality of mounting apertures **38** through which bolts or other mounting structures can extend to fasten the blast shield **10** to a surface, covering the structure to be protected with the plurality of deflection members **16**, **18**.

[0032] From a review of the figures, it will be appreciated that the plurality of first deflection members **16** and the plurality of second deflection members **18** each present a V-shaped surface **40**. This V-shaped surface **40** points away from the structure to be protected and points toward an incoming explosive force such that an incoming explosive force will be deflected by the V-shaped surfaces **40**. Thus, in the embodiment of FIG. 1, the structure to be protected is behind the deflection members **16**, **18**, and the blast shield **10** is intended to protect that structure from an explosion occurring externally of the blast shield **10**. With reference to FIGS. 2-4, it can be seen that the row **22** of the plurality of second deflection members **18** is positioned behind the row **20** of the plurality of first deflection members **16**, relative to the direction of an incoming explosive force. That is, the row **22** is "behind" the row **20** inasmuch as the explosive force will first encounter row **20** and then encounter row **22**. To improve the protection against the blast, the plurality of first deflection members **16** are spaced apart such that there is a gap **g** provided between each neighboring deflection member **16**. The plurality of second deflection members **18** are positioned such that one of the plurality of second deflection members **18** is aligned with each gap **g** between neighboring first deflection members **16**. Notably, there is an overlap between the first deflection members and the deflection members **18**, the second deflection members **18** being aligned with the gap **g** but not necessarily positioned wholly within that gap.

[0033] The plurality of first deflection members **16** define a first discontinuous blast face, and the plurality of second deflection members **18** define a second discontinuous blast face. The term "blast face" as used herein generally connotes a planar or non-planar surface defined by the conceptual joining of the lowermost points of the blast members. In some embodiments, this blast face will be planar, as, for example, in the structures specifically shown in the Figures. However, the blast members may extend so as to provide a non-planar blast

face, as, for example, by following a general contour. This may be advisable for contouring around the shape of the object(s) that are to be protected.

[0034] Though the blast face is discontinuous, it receives the explosive force of a blast. In the embodiments shown, the first discontinuous blast face for the first deflection members **16** is conceptualized as being at the plane that runs through all of the points **42** of the first deflection members **16**, and is shown at **43** (FIG. 2). Similarly, the second discontinuous blast face for the second deflection members **18** is conceptualized as being at the plane that runs through all of the points **44** of the second deflection members **18**, and is shown at **45** (FIG. 2). The second discontinuous blast face is behind the first discontinuous blast face relative to the direction of an incoming explosive force. This can also be expressed by stating that the second discontinuous blast face is positioned closer to the surface to be protected than is the first discontinuous blast face.

[0035] Notably, in some embodiments, the supports present an I-beam or L-beam type structure having a web and one (L-beam) or two (I-beam) flanges. This is appreciated as being a very strong structure particularly when the web portion extends in the direction of the incoming blast.

[0036] Although this invention is not limited to or by any particular embodiment shown herein, from a review of FIGS. 2-4, it can be appreciated that the deflection members **16**, **18** may take various forms. In FIG. 2, the deflection members **16**, **18** are shown as solid square rods. In FIG. 3, the deflection members **16**, **18** are hollow square tubes, and in FIG. 4, they are angle bars, which might be considered to be L-shaped or V-shaped beams. In some embodiments, the rods are hollow but are filled with strengthening materials. By way of non-limiting example, these materials can be selected from concrete, epoxy and foams, and polymers, such as aromatic polyamides (including fibers thereof, e.g. Kevlar), acrylonitrile butadiene styrene (ABS) and polycarbonates. It should be appreciated that, although each embodiment of FIGS. 2-4 employs the same type of deflection member, the deflection members may be the same or different in a particular blast shield construct. That is the plurality of first deflection members **16** may be the same as or different from each other. Similarly, the second deflection members may be the same as or different from each other. Notably, when considering forming the various exemplary types of deflection members from the same material, the solid square rod will be heavier than the hollow square tube, which will likewise be heavier than the angle bar. Filled versions will be relatively heavier as well. However, the solid rods will typically be found to be stronger than the hollow tubes, which will likewise be stronger than the angle bar. These square rods, square tubes and angle bars present a V-shaped surface **40** that points in the direction away from the structure to be protected and toward an incoming explosive force.

[0037] Although square members and angle bars are shown presenting 90 degree V-shaped surfaces **40**, it should be appreciated that other V-shaped surfaces could be provided. In the specific embodiments shown, the V-shaped surfaces **40** provide surfaces at 45 degrees to the blast face, but, in other embodiments, the deflection members may be chosen and positioned so as to present a V-shape having surfaces extending at 65 degrees or less to the blast face, in other embodiments, at 60 degrees or less, in other embodiments, at 55 degrees or less, in other embodiments, at 50 degrees or less, in other embodiments, at 45 or less, in other embodiments, at 40

degrees or less, in other embodiments, at 35 degrees or less, in other embodiments, at 30 degrees or less, in other embodiments, at 25 degrees or less, in other embodiments, at 20 degrees or less. In other embodiments, the deflection members may be chosen and positioned so as to present a V-shape having surfaces extending at 10 degrees or more to the blast face, in other embodiments, at 15 degrees or more, in other embodiments, at 20 degrees or more, in other embodiments, at 25 degrees or more, in other embodiments, at 30 degrees or more, in other embodiments, at 35 degrees or more, in other embodiments, at 40 degrees or more, in other embodiments, at 45 degrees or more.

[0038] Although solid bars, hollow tubes and angle bar deflection members are specifically shown herein, other structures may be employed. In accordance with this invention, each of the plurality of first deflection members and plurality of second deflection members should present opposed surfaces angling away from the direction of an incoming explosive force, such that an incoming explosive force is split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force. Though flat opposed surfaces are shown in the V-shaped deflection members of the figures, curved surfaces are also acceptable, though angling away from the incoming explosive force.

[0039] The present blast shields reduce the momentum of an incoming explosive force by causing the force of the blast to do work. That is, the traveling air and debris must expand and mix and contract and squeeze through gaps, and this dissipates the momentum and thus the force of the blast. When considering the two row structures of FIGS. 2-4, an explosive force traveling upwardly (and outwardly, as the explosion is typically more spherical than linear) will contact the first row of deflection members and the traveling air will be split at the v-shaped surfaces of the deflection members. This will reduce momentum. Additionally, the air split at one V-shaped surface will mix with air split at neighboring V-shaped surface, the mixing causing the air to do work and thus reducing momentum. The mixed air then must travel through the gap g, doing further work (perhaps warping the deflection members), and thereafter is split and mixed again at the second row of deflection members. Past the second deflection members, the air will expand, again reducing momentum.

[0040] From computer simulations it was found that the angle bar, having an open mouth that extends toward the structure to be protected, provides room for expansion that is not present in the enclosed structure of the solid bar. Eddies form in the mouths of the angle bar, and this further reduces momentum.

[0041] In light of the foregoing, it should be appreciated that the present invention significantly advances the art by providing a blast shield that is structurally and functionally improved in a number of ways. While particular embodiments of the invention have been disclosed in detail herein, it should be appreciated that the invention is not limited thereto or thereby inasmuch as variations on the invention herein will be readily appreciated by those of ordinary skill in the art. The scope of the invention shall be appreciated from the claims that follow.

What is claimed is:

1. A blast shield placed over a structure to be protected from the force of a blast, the blast shield comprising:

a support assembly;

a plurality of first deflection members secured to said support assembly, each of said plurality of first deflection members presenting opposed surfaces angling away from the direction of an incoming explosive force, such that an incoming explosive force is split and deflected by the opposed surfaces, thus dissipating the momentum of the explosive force.

2. The blast shield of claim 1, further comprising:

a plurality of second deflection members presenting opposed surfaces angling away from the direction of an incoming explosive force, whereby an incoming explosive force is split and deflected by the opposed surfaces thus dissipating the momentum of the explosive force.

3. The blast shield of claim 2, wherein said plurality of second deflection members are positioned behind said plurality of first deflection members relative to the direction of an incoming explosive force.

4. The blast shield of claim 3, wherein a gap is provided between neighboring ones of said plurality of first deflection members, and said plurality of second deflection members are positioned such that one of said plurality of second deflection members is aligned with each said gap, whereby an incoming explosive force is split and deflected by the opposed surfaces of said plurality of first deflection members, thereafter proceeding through said gap and encountering said plurality of second deflection members thus dissipating the momentum of the explosive force.

5. The blast shield of claim 3, wherein said plurality of first deflection members define a first discontinuous blast face.

6. The blast shield of claim 5, wherein said plurality of second deflection members define a second discontinuous blast face.

7. The blast shield of claim 6, wherein said second discontinuous blast face is positioned closer to the surface to be protected than is said first discontinuous blast face, such that an incoming explosive force is split and deflected by said first discontinuous blast face and further split and deflected by said second discontinuous blast face.

8. The blast shield of claim 7, wherein said plurality of first deflection members extend in a longitudinal direction and said plurality of second deflection members extend in a direction oblique or perpendicular to said longitudinal direction.

9. The blast shield of claim 2, wherein said plurality of first deflection members may be the same or different and are selected from solid bars, hollow tubes, hollow tubes filled with a strengthening material and v-shaped angle bars.

10. The blast shield of claim 9, wherein said plurality of second deflection members may be the same or different and are selected from solid bars, hollow tubes, hollow tubes filled with a strengthening material and v-shaped angle bars.

11. The blast shield of claim 1, wherein said support assembly comprises:

a first side support and an opposed second side support, said plurality of first deflection members extending transverse to said longitudinal direction, from said first side support to said second side support.

12. The blast shield of claim 1, wherein said opposed surfaces of said first deflection members define a v-shaped surface pointing away from the structure to be protected and toward the direction of an incoming explosive force.

13. The blast shield of claim 12, wherein said opposed surfaces of said first deflection members define a v-shaped surface opening in a direction toward the structure to be protected.

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