

Description

Technical Field

The present invention relates in accordance with the preamble of Claim 1 to a reactive or « dynamic » protective armour wall structure for protection against hollow explosive charge jets and comprising one or more separate, replaceable panel structures of which each forms a closed container filled with an explosive charge capable of being detonated by the hollow charge jet.

Background Prior Art

One such reactive wall structure is known, for example, from the DE-A-2 031 658, and is effective to degrade or disturb the hollow charge jet to such an extent as to impair penetration of the jet. One known reason for this is because the jet detonates the explosive charge so as to generate forces which accelerate the plates of the panel structure forwards and backwards towards the jet, therewith degrading a large part thereof.

In this known protective wall structure the explosive charge has the form of an explosive layer positioned on the inner surface of the outer wall of the panel and at a given distance of the inner wall thereof, so as to leave an air gap between the inner wall and the explosive layer. Since this air gap is important to the function of the protective wall structure, the interior of the panel cannot be filled completely with explosive, which limits the efficiency of the protective wall structure. Furthermore, in the case of this protective wall structure it is solely the outer wall of the panel and the explosive layer affixed thereto that constitute the functional part of the protective wall structure when impinged upon by a hollow charge jet.

Furthermore, this known wall structure will not degrade a hollow charge jet which impinges on the wall structure at right angles to the plane thereof with the same degree of efficiency as when the jet impinges obliquely to said plane.

Summary of the Invention

Accordingly, the object of this invention is to provide a reactive wall structure of the aforesaid kind which will enable a greater amount of explosive to be used in the panels than was possible hitherto, and which is so formed that the whole of the panel structure is operative in degrading or disturbing the hollow charge jet, even when the jet impinges on the wall structure at right angles to the plane thereof.

This object is achieved with a reactive armour wall structure of the aforesaid kind that has the novel characteristic features set forth in the characterizing clause of Claim 1.

Further developments of the invention are set forth in the depending claims.

The invention is based on the realization that it is not primarily the dimensions of the explosive charge that influence the ability of the panel structure to degrade the hollow charge jet system but rather the dimensioning of the panel structure, or container, and then primarily the characteristics of the side walls of said structure, in combination with the explosive charge.

The side walls of the inventive panel structure, which extend substantially at right angles to the wall structure, have been given shockwave reflecting properties, so that detonation waves generated within the panel structure by an impinging hollow charge jet or thorn will be reflected back towards the jet and therewith degrade the jet. Consequently, in order for the detonation waves to be reflected continually within the panel structure over a prolonged period during the hollow charge jet sequence, it is necessary to ensure that the panel side-walls will remain in situ for as long as possible, so as to effect a gradual offload in pressure in the panel structure. This is achieved in accordance with the present invention with the aid of side walls which are so ductile and of such thickness and mass that the product of the density and thickness of respective walls is at least equally as great, and preferably greater than the corresponding density and thickness of remaining walls in the panel structure. The slow offload in pressure obtained in such a panel structure will ensure that the hollow charge jet is effectively degraded, even when the jet impinges on the protective wall or panel structure at right angles to the plane thereof.

The aforesaid remaining walls of the panel structure preferably comprise two armour plates which are arranged in mutual spaced and parallel relationship and are joined to the side wall with the aid of suitable joining elements, optionally supported by confinement strengthening means in order to establish a strengthened holding force.

The best jet degrading effect is achieved when the inventive panel structure, or container, has cylindrical walls, since the load will then be symmetrical when the panel structure is impinged upon in the vicinity of its centre.

A satisfactory jet degrading effect can also be obtained with elliptical or polygonal panel structures, e.g. square or hexagonal panels, with suitable dimensioning of the corners and edges of such panel with regard to their mechanical strength.

Because of the enhanced jet degrading effect afforded by the detonation forces generated in the inventive panel structure, the panel structure can be safely given smaller dimensions, with a resultant decrease in damage to the protected object. The actual projectile with its explosive charge and shrapnel will therewith dominate from the aspect of damage.

Brief Description of the Drawings

The invention will now be described in more detail with reference to a number of preferred embodiments thereof illustrated in the accompanying schematic drawings, in which

Figures 1-4 illustrate the detonation sequence of a protective armour wall structure constructed in accordance with the invention, when struck by a hollow charge jet at right angles thereto; and

Figure 5 illustrates various applications of the invention used in conjunction with antitank mines.

Description of a Preferred Embodiment

Figure 1 illustrates in cross-section two mutually identical panels 1 and 1' forming part of a protective wall structure which is intended to be placed in front of an object 10 that is to be protected against hollow explosive charge jets, e.g. a conventional armoured wall structure 10. Each of the panels comprises two metal plates 2 and 3 which are arranged in mutually parallel spaced relationship and which form respectively the outer and inner walls of the panel structure, and further comprises side walls 4 which extend perpendicularly to the plates 2 and 3 and which are attached sealingly to respective edges of said plates with the aid of joining elements not shown, so that the panel structure has the form of a closed container.

The panel structure 1 is filled completely with an explosive charge 5, e.g. a plastic explosive.

The plates 2 and 3 and the sidewalls 4 may be made, for example, of steel or some equivalent material having a density greater than 2 000 kg/m³, preferably greater than 7 000 kg/m³.

According to one practical embodiment of the invention the plates 2 and 3 of the panel structure 1 have a hexagonal configuration with a plate thickness of about 3 mm to 10 mm, and the side walls 4 have a corresponding hexagonal configuration with a wall thickness of 5 mm to 12 mm.

In the illustrated embodiment there is placed between mutually adjacent panel structures a shock-absorbing layer 6 of soft resilient material, such as a plastics or rubber material for example, that has a much lower density than the density of the side walls 4. The layer 6 prevents flashover and serious deformation of mutually adjacent panel structures due to shock, and will also permit the side walls of the panel structure to shift transversely to some extent, when the explosive in the panel structure is detonated. The layer 6 is preferably slightly thicker than the side walls 4, and suitably has a thickness of at least about 6 mm.

Figure 1 illustrates schematically a hollow charge jet or thorn 7 which strikes the panel 1 at right angles to the plane thereof and penetrates the plates 2 and 3, and which subsequently continues along a path 7a, cf. Figure 2, and exits through the rear side of the panel. The hollow charge jet 7 initiates detonation of the explosive

charge 5, therewith giving rise to detonation waves 8 which propagate between the plates 2 and 3, in a direction towards the side walls 4, and which impinge obliquely on said plates 2 and 3.

As shown in Figure 2, the detonation waves 8 are reflected by the side walls 4 and propagate back towards the hollow charge jet, these detonation waves (load relieving waves) colliding with the jet and degrading the jet.

The hollow charge jets will have already been disturbed to some extent at an earlier stage, by detonation waves reflected from regions of the plates 2 and 3 located in the close vicinity of the jet.

Because of this disturbance or degradation of the jet caused by the interaction of the reflected detonation waves with the jet, the hollow charge jet will be imparted a substantially sinusoidal propagation path 7a through the panel.

The reflected detonation waves 8 are again thrown back towards the side walls 4, subsequent to interaction of the waves with the hollow charge jet, vide Figure 3. This sequence of events continues until the side walls 4 and the plates 2 and 3 are parted from one another, whereupon the panel structure is relieved of pressure and the reflected detonation waves are lost to the surrounding atmosphere.

The plates 2 and 3 will also be blown away, whereas the side walls 4 will be displaced transversely so as to enter the resilient shock-absorbing layer 6 while compressing the same, possibly with a subsequent rebound of the side walls. When only one panel assembly is used, the side walls will also be blown away subsequent to parting company with the plates 2 and 3.

In addition to absorbing shockwaves, the layer 6 will also prevent flashover between mutually adjacent panel structures and will protect these panel structures against serious deformation and damage.

When constructing armoured wall structures, it is not possible to place the panel structures contiguous with one another, for structural reasons.

In order to protect the object 10 against the flying plate 3 located immediately adjacent thereto, a shockwave absorbing layer 9 may be placed on the object 10, so as to prevent shrapnel entering the object at 11.

The layer 9 will also cause the outwardly flying plate 3 to bounce back powerfully towards the hollow charge jet, therewith further degrading the jet.

The distance between the panel structures, and e.g., a conventional armoured wall structure 10 may vary from 0 mm to several hundreds of millimeters, with essentially the same effect.

The side walls 4 are preferably dimensioned so that when the explosive charge is detonated the walls will have a velocity which is equal to or less than the velocity of the plates 2 and 3. Such dimensioning can be achieved through appropriate selection of material, thickness etc. Since the manner in which the side walls can be dimen-

sioned in order to meet the aforesaid requirements will be obvious to those skilled in this art, no further description with regard hereto will be given here. The side walls 4 will also preferably have a high dynamic mechanical strength, and may therefore be made of, e.g., steel as beforementioned.

The panel structures are fitted to the protected object 10 with the aid of thin plates 12 placed on respective opposite sides of the panel structure.

Figure 5 illustrates panel structures 1 intended for various applications at an armoured vehicle or tank front 13.

The reference numerals 14 and 15 designate panel structures 1 which define an air gap and with which a damping material is used.

The reference 16 designates a panel structure 1 with which solely a damping material is used.

The reference 17 designates panel structures 1 with which a shockwave absorbing layer 6 is provided between the panel structures and a damping material is provided between the panel structures and the protective object.

The reference 18 designates a panel structure which defines an air gap that slopes down to zero width.

These various arrangements afford good protection and prevent flashover between the panel structures.

The additional degrading function of the reactive panel structure provided by the side walls can be optimized with regard to certain significant aspects:

The explosive charge shall have a high detonation pressure (> 10 GPa), which will generate a high pressure in the panel structure or container, and therewith radically disturb or degrade the hollow charge jet.

This disturbance of the hollow charge jet is enhanced by the high density and thickness of the side walls of the dynamic panel structure.

The reactive wall structure should have a flow stress or yield point σ_s in excess of 200 MPa.

Claims

1. A reactive armour wall structure for protection against hollow explosive charge jets, comprising one or more separate and replaceable panel structures (1) each forming a closed container which is filled with an explosive substance (5) capable of being detonated by the hollow charge jet, characterized in that for the purpose of disturbing or degrading a hollow charge jet that impinges upon the protective wall structure each of the panel structures is provided with mutually spaced side-walls (4) which extend substantially at right angles to the plane of the protective wall structure and which possess shockwave reflecting properties such as to reflect the detonation waves initiated by the hollow charge jet in a direction towards the jet and therewith disturb or degrade the same; and in that the side walls are made of ductile material

such, and have a thickness and mass such that the product of the density and thickness of respective side walls is at least equal to, or preferably greater than the corresponding product of the density and thickness of the remaining walls (2, 3) of the panel structure.

2. A protective wall structure according to Claim 1, characterized in that the remaining walls of each said panel structure comprise two mutually spaced and mutually parallel armour plates (2, 3) which are able to move in relation to one another as a protective function of the wall structure.

3. A protective wall structure according to any of the preceding Claims, characterized in that the explosive substance has a detonation pressure in excess of 10 GPa.

4. A protective wall structure according to any of the preceding Claims, characterized in that each side wall (12) has a flow stress or yield point (σ_s) in excess of 200 MPa.

5. A protective wall structure according to any of the preceding Claims, characterized in that each side wall has a density greater than 2 000 kg/m³, preferably greater than 7 000 kg/m³.

6. A protective wall structure according to any of the preceding Claims, characterized in that the panel structure has a circular, elliptical or polygonal cross-section.

7. A protective wall structure according to any of the preceding Claims, characterized in that when the wall structure incorporates more than one panel structure said mutually adjacent panel structures have arranged therebetween a shock absorbing material effective in preventing flashover between said panel structures.

8. A protective wall structure according to any of the preceding Claims, characterized in that a material (9) having good shockwave absorbing properties, e.g. a plastic or rubber material, is placed between the wall structure and the object (10) to be protected.

Patentansprüche

1. Eine Wandstruktur mit reaktiver Panzerung für den Schutz gegen explosive Hohlladungsgeschosse, welche eine oder mehrere getrennte und ersetzbare Plattenstrukturen (1) aufweist, wobei jede einen geschlossenen Behälter bildet, der mit einer explosiven Substanz (5), welche durch das Hohlladungsgeschoß zur Detonation gebracht werden kann, gefüllt ist, dadurch gekennzeichnet, daß zum Stören oder Abbau eines auf die schützende Wandstruktur aufstoßenden Hohlladungsgeschosses jede Plattenstruktur mit gegenseitig beabstandeten Seitenwänden (4) vorgesehen ist, welche sich im wesentlichen in rechten Winkeln von der Ebene der schützenden Wandstruktur erstrecken und welche Schockwellen reflektierende Eigenschaften aufweisen, um die Detonationswellen, welche durch das Hohlladungsgeschoß in einer Richtung auf das Geschoß erzeugt werden, zu reflektieren und demzufolge

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The reactive wall structure should have a flow stress or yield point σ_s in excess of 200 MPa.

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such, and have a thickness and mass such that the product of the density and thickness of respective side walls is at least equal to, or preferably greater than the corresponding product of the density and thickness of the ramming walls (2, 3) of the panel structure.

2. A protective wall structure according to Claim 1, characterized in that the remaining walls of each said panel structure comprise two mutually spaced and mutually parallel armour plates (2, 3) which are able to move in relation to one another as a protective function of the wall structure.

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diese zu stören oder abzubauen; und daß die Seitenwände aus einem derartig verformbaren Material bestehen und eine derartige Dicke und Masse aufweisen, daß das Produkt aus der Dichte und der Dicke der jeweiligen Seitenwände mindestens gleich oder vorzugsweise größer ist als das entsprechende Produkt aus der Dichte und der Dicke der verbleibenden Wände (2, 3) der Plattenstruktur.

2. Eine schützende Wandstruktur nach Anspruch 1, dadurch gekennzeichnet, daß die verbleibenden Wände jeder Plattenstruktur zwei wechselseitig beabstandete und wechselseitig parallele Panzerungsplatten (2, 3) aufweisen, welche sich im Verhältnis zueinander bewegen können als Schutzfunktion der Wandstruktur.

3. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die explosive Substanz einen Detonationsdruck, welcher 10 GPa überschreitet, aufweist.

4. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jede Seitenwand (12) eine Stoßbeanspruchung oder Elastizitätsgrenze (σ_s), welche 200 Mpa überschreitet, aufweist.

5. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jede Seitenwand eine Dichte größer als 2 000 kg/m³, vorzugsweise größer als 7 000 kg/m³, aufweist.

6. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Plattenstruktur einen kreisförmigen, elliptischen oder polygonalen Querschnitt aufweist.

7. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß wenn die Wandstruktur mehr als eine Plattenstruktur aufweist, zwischen den wechselseitigen angrenzenden Plattenstrukturen ein schockabsorbierendes Material angeordnet ist, welches dafür sorgt, daß ein Überschlag zwischen den Plattenstrukturen vermieden wird.

8. Eine schützende Wandstruktur nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß ein Material (9), welches gute Schockwellen absorbierende Eigenschaften aufweist, z. B. ein Plastik- oder Gummimaterial, zwischen der Wandstruktur und dem Objekt (10) angeordnet wird, um geschützt zu werden.

Revendications

1. Structure de parois à blindage réactif pour la protection contre des fusées explosives à charge creuse, comprenant une ou plusieurs structures de panneaux séparés remplaçables (1) formant chacune une boîte fermée remplie d'une substance explosive (5) qu'on peut faire détoner par la fusée à charge creuse, structure caractérisée en ce que, dans le but de perturber ou de dégrader une fusée à charge creuse venant frapper la structure de paroi protectrice, chacune des struc-

tures de panneau est munie de parois latérales mutuellement espacées (4) disposées essentiellement perpendiculairement au plan de la structure de parois protectrice, et présentant des propriétés de réflexion d'ondes de choc de manière à réfléchir les ondes de détonation déclenchées par la fusée à charge creuse, dans une direction dirigée vers la fusée pour perturber ou dégrader ainsi cette dernière; et en ce que les parois latérales sont réalisées dans un matériau ductile choisi de façon telle, et présentant une épaisseur et une masse telles, que le produit de la densité par l'épaisseur des parois latérales respectives soit au moins égal, ou de préférence supérieur, au produit correspondant de la densité par l'épaisseur des autres parois (2, 3) de la structure de panneau.

2. Structure de parois de protection selon la revendication 1, caractérisée en ce que les autres parois de chaque structure de panneau sont constituées de deux plaques de blindage mutuellement espacées et parallèles (2, 3) capables de se déplacer l'une par rapport à l'autre pour assurer une fonction de protection de la structure de paroi.

3. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce que la substance explosive présente une pression de détonation dépassant 10 GPa.

4. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce que chaque plaque latérale (12) présente une résistance au fluage ou un point de limite élastique (σ_s) dépassant 200 MPa.

5. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce que chaque paroi latérale présente une densité supérieure à 2 000 kg/m³, et de préférence supérieure à 7 000 kg/m³.

6. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce que la structure de panneau présente une section transversale circulaire, elliptique ou polygonale.

7. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce que lorsque la structure de paroi incorpore plus d'une seule structure de panneau, ces structures de panneaux mutuellement adjacentes comportent un matériau d'absorption de chocs disposé entre elles pour empêcher des projections d'étincelles entre ces structures de panneaux.

8. Structure de parois de protection selon l'une quelconque des revendications précédentes, caractérisée en ce qu'un matériau (9) présentant de bonnes propriétés d'absorption d'ondes de choc, comme par exemple une matière plastique ou un caoutchouc, est placé entre la structure de parois et l'objet (10) à protéger.

