FUEL TANK AND FILLER PACKET FOR DISPERSING BALLISTIC SHOCK

Inventor: Ronald L. Fenton, Mt. Prospect, IL (US)

Correspondence Address:
Douglas B. White
21 Carrol Lane
Cary, IL 60013 (US)

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(57) ABSTRACT

An improved tank design incorporates a new shock dispersing filler packet insert. This filler packet is formed from a sheet of foil and exhibits in its unformed shape an expanded foil center and an unexpanded denser border. All of the edges of the foil sheet are then folded inwardly and the filler insert is finally rolled and secured to produce a cylindrical packet having a dense core. Once the fuel tank is filled with these packets, the ballistic shock is dissipated by the distributed dense portions within the tank.
FUEL TANK AND FILLER PACKET FOR DISPERSING BALLISTIC SHOCK

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a Continuation-in-Part of prior U.S. patent application Ser. No. 10/367,467, now abandoned.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The present invention relates generally to receptacles, such as fuel tanks, used to hold combustible liquid, and further relates to explosion suppression devices for such tanks in the nature of filler elements or filler packets positioned within the tank. More particularly, this invention relates to a new design for such a filler packet which improves its effectiveness in maintaining tank integrity during the impact and subsequent penetration by a ballistic body.

[0005] 2. Description of the Prior Art

[0006] It is well known in the prior art that a filler mass insert or packet may be formed from expanded foil mesh and used as an insert within a tank to suppress explosion. This “expanded” foil mesh is formed from an “unexpanded” sheet of metal foil which is slit and pulled to “expand” the sheet into a foil mesh (see U.S. Pat. No. 5,000,336). These thermal inserts serve to absorb and transmit the heat encountered during a fire or explosion, thereby eliminating hot spots in the tank that could result in the ignition of the tank contents. The typical prior art filler insert is formed of multiple layers of an expanded metal foil, as described in U.S. Pat. No. 3,356,256, U.S. Pat. No. 5,000,336, U.S. Pat. No. 6,604,644, and U.S. Pat. No. 4,921,118. The resulting filler mass can also be rolled into a coil, cut into pieces and stacked, or fan-folded, as described in U.S. patents U.S. Pat. No. 4,149,649 and No. 4,556,589, to produce a filler mass insert of the size and shape of the tank.

[0007] In order to provide protection from the impact of a bomb blast, there has been proposed in U.S. Pat. No. 5,563,364 that a tank wall could be padded to absorb the shockwave of the blast. This shockwave absorbing pad is described as two sheets of expanded metal foil applied to the exterior of a tank wall and separated by a layer of balls also formed from the expanded foil.

[0008] Although such a padded wall provides limited exterior absorption of the shockwave from a bomb blast, when a tank is struck with a ballistic body, such as a bullet, this shock absorbing padding is easily penetrated. And in such a case, the ballistic body carries with it into the tank a powerful concentrated shockwave that can ultimately cause the tank to disintegrate.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is the principal objective of this invention to present a new tank design which resists disintegration caused by a projectile.

[0010] It is a further objective to present a new thermal insert which serves to dissipate the thermal hot spots and suppress explosion, yet also serves to dissipate the ballistic shockwave accompanying a projectile.

[0011] It is yet another objective of the present invention to provide an insert packet and its method of manufacture which is both effective and economical.

[0012] The present invention provides a solution for the above noted vulnerability to the ballistic effect on the tank by providing a new filler packet insert and an improved tank design incorporating the new filler packet insert. This filler packet begins, in its unformed shape, with a foil sheet having an expanded foil center and an unexpanded border region of denser material. All of the edges of the foil sheet are then folded inwardly and this folded packet is finally rolled to produce a cylindrical packet having a defined dense portion within the packet. (Alternatively, a separate dense portion or object may be inserted into a packet.)

[0013] A tank interior is provided with these filler packets to provide a fluid permeable tank volume having the dense portions of the filler packets dispersed throughout the tank. These spaced dense masses then serve to dissipate the ballistic shockwave accompanying the projectile.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a perspective view of a tank having within its interior a plurality of filler packets in accordance with the present invention.

[0015] FIG. 2 is a perspective view of a completed filler packet in accordance with one embodiment of the present invention.

[0016] FIG. 3 is a perspective view of a sheet of partially expanded foil sheet for the manufacture of the filler packet in accordance with one embodiment of the present invention, showing an unexpanded dense border region.

[0017] FIG. 4 is a perspective view of a sheet of partially expanded foil sheet for the manufacture of a filler packet, this foil sheet being similar to the sheet of FIG. 3 but with a dense border region on just two sides.

[0018] FIG. 5 is a cross sectional view of the sheet of FIG. 4 showing a folding technique for the manufacture of a filler packet in accordance with the present invention.

[0019] FIG. 6 is a cross sectional view of the folded sheet of FIG. 5 showing further folding steps in the construction of a filler packet.

[0020] FIG. 7 is a perspective view of the folded sheet of FIG. 6 showing further folding steps in the construction of a filler packet.

[0021] FIG. 8 is a perspective view of the folded sheet of FIG. 7 showing the completion of the folding construction.

[0022] FIG. 8a is a perspective view of the folded filler packet of FIG. 8, but showing an alternative construction of the filler packet with the addition of a dense member.

[0023] FIG. 9 is a cross sectional view of the filler packet of FIG. 8 rolled into a cylinder.

[0024] FIG. 9a is a cross sectional view of the filler packet of FIG. 8a rolled into a cylinder, showing an alternate construction of the filler packet.
While the invention will be described in connection with a preferred embodiment, it will be understood that it is not the intent to limit the invention to that embodiment. On the contrary, it is the intent to cover all alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning first to FIG. 1 there is shown a tank 12 in accordance with the present invention having filler packets 14 positioned within the interior thereof. These packets are preferably thermally conductive and positioned in thermal contact with the exterior walls 16 of the tank to thereby dissipate heat from the tank wall, as is now well known in the art. In the preferred embodiment, the individual filler packets 14 of the present invention (one embodiment of which is shown in FIG. 2) each exhibit a thermally conductive porous fuel permeable body portion 18 for accommodating fuel within the tank and suppressing explosion by thermal conduction. However, for suppressing ballistic shock, a denser portion or member 20 is provided within each packet 14, which denser portion or member 20 has a greater mass density than that of the sheet of foil material in its unexpanded state used for the outer body portion 18, as more fully described below.

Formation of one embodiment of a filler packet in accordance with the present invention begins with a sheet of unexpanded metal foil. There is shown in FIG. 4 one embodiment of a sheet of metal foil 26, having a defined center region 28 which has been expanded into a mesh according to techniques well known to the art, and further having a defined denser outer border region 30 (on at least one side) of unexpanded foil. This denser border region is comprised of foil material having a higher density than the density of the sheet of foil material in its unexpanded state used to form the center region 28. Similarly, in FIG. 3 there is shown a second embodiment of a foil sheet 26a for construction of the filler packet. In this second embodiment, the unexpanded higher density border region 30a extends along all sides surrounding the expanded lower density center region 28a. As equivalent alternatives, the higher density border region (in whole or in part) may comprise:

(a) a higher density material than that used for the center region;

(b) multiple layers of the foil sheet or an added layer of dense material, where the composite of layers in the border region has a higher density the sheet of metal foil material in its unexpanded state from which the center region is formed; or

(c) any other equivalent means which serves to increase the mass density within that border region relative to the density of the metal foil sheet (in its unexpanded state) used for the center region 28, or ultimately increases the mass density in a defined portion of the completed filler packet.

The construction of the filler element is shown in detail in the sequence of steps depicted in FIGS. 5-8 and 8a, and will be described with respect to the sheet of foil shown in FIG. 4; the construction with the sheet of foil shown in FIG. 3, and variations thereof being identical thereto. The sheet is first bent or folded along lines 32 and 34 (FIGS. 5 and 6) to thereby cause the peripheral edges 36 and 38 to be positioned inwardly toward the center of the packet. This inward positioning of the peripheral edges 36 and 38 is a safety measure, as it serves to place those cut edges within the center of the filler packet to trap any pieces of the sheet which might break off and enter the fuel in the tank. In the embodiments where these edges carry dense border regions, those dense regions will also be placed near the center of the packet.

Next in the construction of the filler packet, the sides 30 bearing higher density border regions are bent or folded along lines 40 and 42 (FIG. 7) to position those dense regions inwardly of the packet, as shown in FIG. 8. Alternatively, the filler packet at this stage of construction may have a dense member 52 placed within the packet, as shown in FIG. 8a, to produce or enhance the higher density portion of the packet. As a further alternative, the addition of the dense member 52 may be employed in place of the aforementioned dense border region of the foil sheet, allowing the filler packet to be formed from a sheet of foil having a uniform density. Such additional dense member 52 preferably presents a higher density than said sheet of foil material from which said body portion of said filler packet is formed, but it may be of a lower density when used in conjunction with the aforementioned dense border region. Finally, although the dense member 52 is shown positioned near the center of the packet, such center positioning is not required.

Finally, the flat intermediate folded member of FIG. 8 or FIG. 8a is rolled or otherwise formed into the completed packet of FIG. 9 and FIG. 9a respectively. Once the filler packet is completely formed (FIG. 2), means for securing the packet, such as a band 62, or other equivalent means for securing the packet, is applied to secure the formed packet and to keep it in its final shape during its insertion into the tank. The secured, completed packet is shown in perspective in FIG. 2 and shown partially filling the tank in FIG. 1.

When a fuel tank is provided with the filler packets (the tank shown in FIG. 1 is partially filled), a multitude of dense portions of the packets are broadly distributed throughout the volume of the tank, thereby presenting a non-homogenous internal volume with numerous distributed dense mass concentrations. Alternatively, although it is preferred that all of these inserts present dense portions, it is within the scope of the invention that some, but not all, of the insert packets will present dense portions. Further, it is also within the scope of this invention that the filler packets could present dense portions of varying degrees of mass concentrations, and thereby accomplish the same purposes and objectives.

From the foregoing description, it will be apparent that modifications can be made to the apparatus and method for using same without departing from the teachings of the present invention. Accordingly, the scope of the invention is only to be limited as necessitated by the accompanying claims.

What is claimed is:

1. A filler packet for a fuel tank for dispersing ballistic shock comprising:
   a fuel permeable body portion formed from a sheet of metal foil material, said sheet being first expanded into a mesh and then formed into said body portion; and
   a dense portion exhibiting a higher density than said sheet of metal foil material in its unexpanded state from which said body portion is formed.
2. The filler packet of claim 1 wherein said body portion comprises said sheet of metal foil formed into a packet, wherein edges of said sheet are positioned inwardly of said packet.

3. The filler packet of claim 1 wherein said filler packet is formed from a sheet of metal foil material, wherein said sheet of metal foil material comprises an expanded center region and an unexpanded border region defined thereon, wherein said border region exhibits a higher density than said sheet of metal foil material in its unexpanded state used to form said center region, and wherein said center region is formed to provide said body portion of said filler packet and said border region is positioned within said packet interior to provide said dense portion of said filler packet.

4. The filler packet of claim 1 wherein said dense portion of said packet comprises a member positioned within said packet.

5. The filler packet of claim 1 wherein said filler packet is thermally conductive.

6. The filler packet of claim 5 wherein said body portion comprises said sheet of metal foil formed into a packet, wherein edges of said sheet are positioned inwardly of said packet.

7. The filler packet of claim 6 wherein said filler packet is formed from a sheet of metal foil material, wherein said sheet of metal foil material comprises an expanded center region and an unexpanded border region defined thereon, wherein said border region exhibits a higher density than said sheet of metal foil material in its unexpanded state used to form said center region, and wherein said center region is formed to provide said body portion of said filler packet and said border region is positioned within said packet interior to provide said dense portion of said filler packet.

8. The filler packet of claim 5 wherein said dense portion of said packet comprises a member positioned within said packet.

9. The filler packet of claim 3 wherein said border region defined on said sheet of metal foil material comprises a plurality of layers of metal foil sheet material.

10. The filler packet of claim 1 further comprising means for securing said filler packet.

11. A fuel tank for dispersing ballistic shock comprising:

an enclosure for containing fuel;

a plurality of filler packets for dispersing ballistic shock positioned within said enclosure;

wherein said filler packets each comprise:

a fuel permeable body portion formed from a sheet of metal foil material, said sheet being first expanded into a mesh and then formed into said body portion; and

a dense portion exhibiting a higher density than said sheet of metal foil material in its unexpanded state from which said body portion is formed.

12. The fuel tank of claim 11 wherein said body portion of each of said respective filler packets comprises said sheet of metal foil formed into a packet, wherein edges of said sheet are positioned inwardly of said packet.

13. The fuel tank of claim 11 wherein each of said respective filler packets is formed from a sheet of metal foil material, wherein said sheet of metal foil material comprises an expanded center region and an unexpanded border region defined thereon, wherein said border region exhibits a higher density than said sheet of metal foil material in its unexpanded state used to form said center region, and wherein said center region is formed to provide said body portion of said respective filler packet and said border region is positioned within said respective packet interior to provide said dense portion of said filler packet.

14. The fuel tank of claim 11 wherein said dense portion of said filler packets comprises a member positioned within said packet.

15. The fuel tank of claim 11 wherein said filler packets are thermally conductive.

16. The tank of claim 15 wherein said body portion of said respective filler packets comprises said sheet of metal foil formed into a packet, wherein edges of said sheet are positioned inwardly of said packet.

17. The fuel tank of claim 16 wherein each of said filler packets is formed from a sheet of metal foil material, wherein said sheet of metal foil material comprises an expanded center region and an unexpanded border region defined thereon, wherein said border region exhibits a higher density than said sheet of metal foil material in its unexpanded state used to form said center region, and wherein said center region is formed to provide said body portion of said respective filler packet and said border region is positioned within said respective packet interior to provide said dense portion of said filler packet.

18. The fuel tank of claim 15 wherein said dense portion of said filler packets comprises a member positioned within said packet.

19. The fuel tank of claim 13 wherein said border region defined on said sheet of metal foil material further comprises a plurality of layers of metal foil sheet material.

20. The fuel tank of claim 11 further comprising means for securing each of said filler packets.

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