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(54) **ANACONDA-REACTION, LIQUID-CONTAINER/FUEL-TANK STRUCTURE, AND PROECTIVE JACKETING**

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(57) **ABSTRACT**

Anti-burst, anaconda-reaction liquid-container structure featuring both (I) a coating structure, per se, and (II), the overall organization of (A) a liquid container having a barrier wall with an outside surface, and, applied to the wall's outside surface, (B) coating structure possessing (1) a main body formed as a flexible expanse of anti-puncture-wound, self-sealing, high-elastomeric, material, and (2), embedded within, and distributed throughout, this expanse, (a) a population of distributed, container-contained liquid-reactive, liquid-imbiber elements, and (b) a web of restraining-fibre, expansion-following stretch-fabric

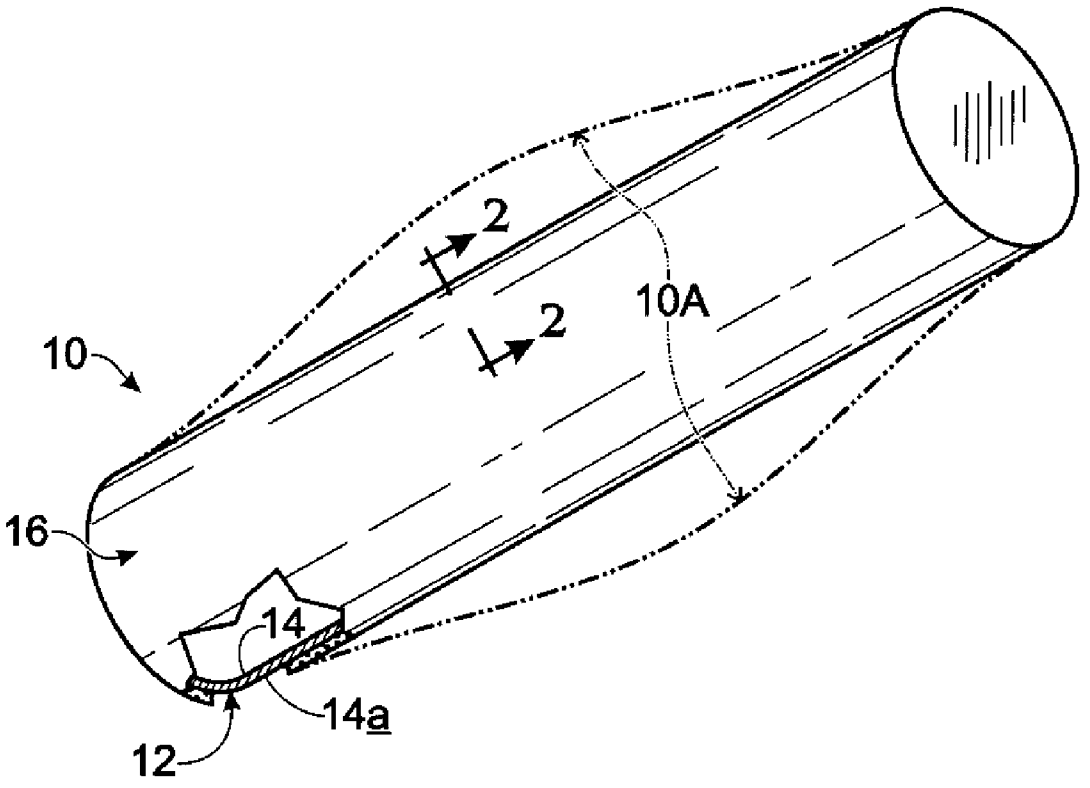


Fig. 1

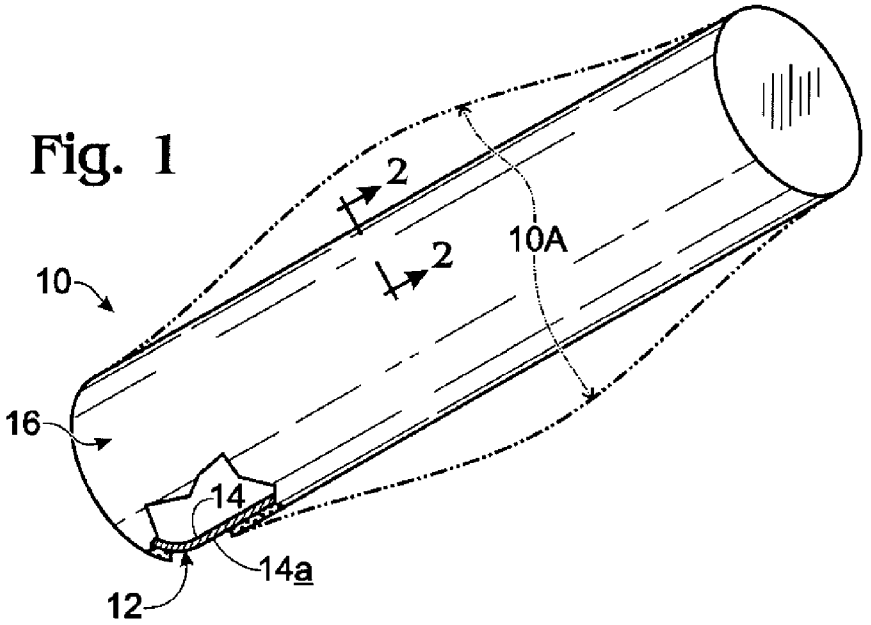


Fig. 2

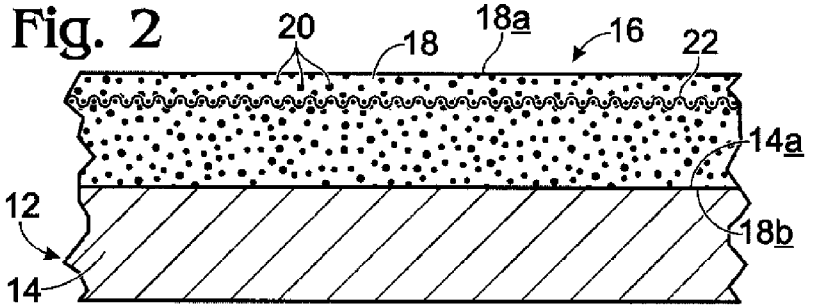
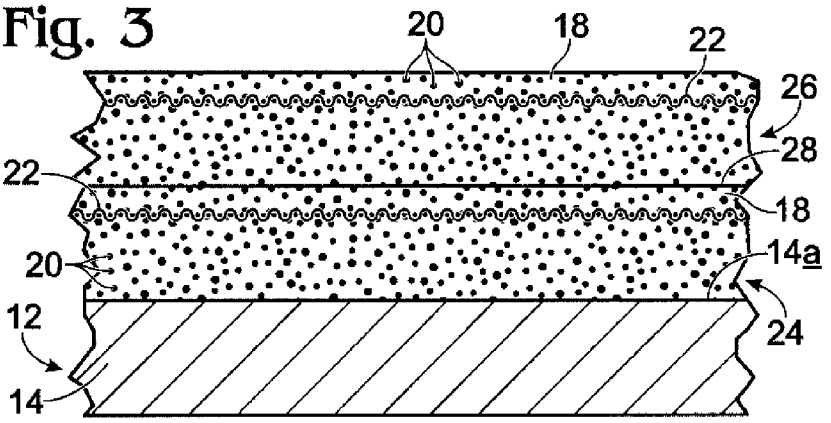


Fig. 3



ANACONDA-REACTION, LIQUID-CONTAINER/FUEL-TANK STRUCTURE, AND PROECTIVE JACKETING

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims filing-date priority to U.S. Provisional Patent Application Ser. No. 61/343,867, filed May 5, 2010, for "Anaconda-Reaction Liquid-Container/Fuel Tank Structure". The entire disclosure content of this provisional application is hereby incorporated herein by reference.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] This invention pertains both to anti-explosion, anti-burst, protective, catastrophic-expansion-containing jacketing, or coating, for liquid containers, such as liquid-fuel containers, and to overall, so-protected liquid containers, per se. in particular, it focuses attention upon both (a) an overall liquid-container structure respecting which the environment (people, other structures, etc.) outside of that structure is protected against dangerous container bursting, and (b) upon coating structure, per se, which is employable, by way of container-outside-surface-application, to protect against an explosion/burst, etc. event, however triggered

[0003] The invention further relates to such containers, and specifically to jacketing for these containers, regarding which the protective jacketing possesses anti-puncture-wound (such as anti-bullet-penetration-wound), anti-liquid-leakage, self-sealing characteristics.

[0004] As will be seen, we refer to the technology associated with this invention as one employing, or as being characterized by, "anaconda-reaction" behavior—a structural-integrity controlled-bulge behavior which is somewhat analogous to the extraordinary, controlled body stretching which takes place when an anaconda consumes large prey. The structure of the invention, additionally, responds with this kind of "anaconda" behavior in an aggressively dynamic manner to deal successfully with an explosion-type event.

[0005] Liquid fuel containers protected, in a self-sealing manner, against puncture-wound-induced leakage are known. Typically, such a container, in its protected configuration, takes the form of a generally rigid barrier wall (metal or plastic), the outside of which is coated with an added, self-sealing elastomeric coating—a coating which, in some applications, includes both (1) a main, elastomeric body mass, and (2) a body-mass-embedded distribution of particulate matter, formed specifically from liquid-reaction material designed to react to puncture-produced contact with leakage liquid fuel to produce a self-sealing (a) liquid-imbibing, (b) material-swelling, and/or (c) material-congealing action(s), thus to close the relevant puncture wound in cooperation with basic "elastomeric-material-return" sealing behavior. Wound closure results, in the case of a coating offering these features, usually, quite rapidly, and extremely effectively.

[0006] This kind of structural organization works usually very well respect to puncture wounds that do not trigger an explosion, or an explosion-like, catastrophic outburst event which causes basic rigid, barrier, tank-wall structure to bulge, bubble, burst outwardly, etc. However, with the occurrence of an explosion-like event involving bursting of a liquid fuel container, available anti-leak coatings of the type just generally described have often failed to hold together because of over-stressing, and companion "bursting", or tearing, of the elastomeric material used in the coating, with the result that major problems result (loss of life, fire, massive property damage, etc.).

[0007] The present invention addresses this serious, potential fuel-tank-and-coating burst (or tearing), etc. problem by proposing an arrangement wherein a liquid container (tank) has its barrier wall coated with an otherwise currently known and available, high-elastomeric-body, protective coating, or coating structure, preferably including, embedded within its main elastomeric body, particulate liquid-reaction material (as mentioned above)—this coating being significantly enhanced by the further incorporation, within its main elastomeric body, of distributed, elastomeric, elongate-fibre restraining and "expansion-following" fabric, such as may be provided by a high-elongation-capable, elastomeric-nylon-fibre fabric which is spread as an embedded web extending throughout the coating's main body material. The "expansion-following" concept just mentioned will be explained below.

[0008] Such a coating arrangement, in the event of an explosion-like occurrence as mentioned above, allows the coating, and in particular its main, elastomeric body, to bulge safely, dramatically, dynamically and for the most part somewhat returnably, under the main-body-expansion-following, restraining control of the elastic-fibre fabric, without the main elastomeric body material, per se, tearing or bursting—much in the way—and now here using a free-form, visual analogy—that nature has equipped the anaconda to engorge huge objects, and then surface-bulge dramatically, without bursting. The main-body-included elastomeric fabric follows, rather than stubbornly resists, elastomeric expansion occurring in an explosion-initialed expansion of the main body elastomeric material, and furnishes important, internally-local material stabilization against dangerous tearing and fragmenting of the main-body material.

[0009] Accordingly, proposed by, and in accordance with one view of, the invention is an anti-burst, anaconda-reaction liquid-container structure including (A) a liquid container having a barrier wall with an outside surface, and, applied to the wail's outside surface, (B) coating structure possessing (1) a main body formed as a flexible expanse of anti-puncture-wound, self-sealing, high-elastomeric, material, and (2), embedded within, and distributed throughout, this expanse, both (a) a population of distributed, container-contained liquid-reactive, liquid-imbiber elements, and (b) a web of coating-elastomer-restraining-fibre, expansion-following stretch-fabric.

[0010] From another point of view, the invention features anti-burst, anaconda-reaction liquid-container structure including (A) a liquid container having a barrier wall with an outside surface, and, applied to that surface, (B) plural-layer coating structure including, in each layer, (1) a main body formed as a flexible expanse of anti-puncture-wound, self-sealing, high-elastomeric, material, and (2), embedded within, and distributed throughout, this expanse, both (a) (a) a population of distributed, container-contained liquid-reactive, liquid-imbiber elements, and (b) a web of coating-elastomer-restraining-fibre, expansion-following stretch-fabric.

[0011] From still a further view regarding the present invention, it provides self-sealing, anti-burst, anaconda-reaction liquid-container coating structure applicable to the outside of the barrier wall in a liquid container featuring (A) a

main body formed as an expanse of anti-puncture-wound, self-sealing, high-elastomeric, material having container-facing and non-container-facing sides, and (B) embedded within, and distributed throughout, the body expanse, both (1) a population of container-liquid-reactive, liquid-imbiber beads, and (2) a web of coating-elastomer-restraining-fibre, expansion-following stretch-fabric.

[0012] Other features and advantages offered by the present invention which has just been generally outlined above will become more fully apparent as the detailed description presented below is read in conjunction with the accompanying drawings.

DESCRIPTIONS OF THE DRAWINGS

[0013] FIG. **1** is a simplified, isometric view of an anaconda-reaction, liquid-container/fuel tank structure including a fuel container (cylindrical in this illustration) whose outside barrier wall, has been coated with an anaconda-reaction, single-layer coating structure made in accordance with a preferred and best mode embodiment of the present invention to protect against a catastrophic, event-induced, explosion-like container burst. Portions of the structure shown in FIG. **1** have been broken away to illustrate, cross-sectionally, details of construction.

[0014] Additionally pictured in this figure, in curving, dash-double-dot lines, and in a greatly exaggerated and stylized manner, is an explosion-produced, generally central container bulge, or burst, which has been effectively restrained by the coating structure of the present invention.

[0015] FIG. **2** is an enlarged, fragmentary cross section taken generally along the line **2-2** in FIG. **1**.

[0016] FIG. **3** is similar to FIG. **2**, with the exception that it illustrates a plural-layer, specifically a two-layer, coating structure produced in accordance with a modified form of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Turning attention now to the drawings, and referring first of all to FIGS. **1** and **2**, indicated generally at **10** in FIG. **1** is a preferred and best-mode embodiment of an overall, anti-burst, anaconda-reaction liquid-container structure proposed by the present invention. More specifically, structure **10** includes, in the illustration of the invention now being given, an elongate, cylindrical, metallic, liquid-fuel container **12** having a barrier wall **14** with an outside surface (cylindrical and end) **14***a* which has been jacketed/coated/covered, as will shortly be explained, with an explosion/burst-containing, anaconda-reaction, single-layer jacket **16**, also referred to as a jacketing structure, and as a coating, or coating structure. The term "single layer" regarding jacket **16** is employed as a convenient way to reflect the unitary nature of the three cooperative elements, shortly to be described, which collectively make up the jacket.

[0018] In solid lines in FIG. **1**, structure **10** is shown in a condition prior to the occurrence of any form of a container-wall explosion or burst event, such as might be created by a bullet-penetration wound which happens to ignite fuel contained in the container. In a highly exaggerated fashion, and illustrated just for the central, cylindrical portion of barrier wall **14** in container **12**, a jacket-contained burst event is illustrated in dash-double-dot lines **10**A to picture the intended, anaconda-reaction-type restrained-bulge behavior of coating, or jacket, **16**. What is intended, of course, by the anaconda-behavioral characteristic of the structure of the present invention is that a container explosions/burst event will be confined within the container-wall-applied coating structure—a structure which will not fail, and which will, rather, stay elastomerically intact, though perhaps somewhat permanently deformed, to prevent an outwardly experienced, dangerous, and probably fragmentary, outwardly-directed outburst resulting from such an event. Elastomeric, expansion-following restraining fabric embedded within coating **16** furnishes the necessary "stay-together" characteristic of the overall coating.

[0019] The two elastomeric materials, now to be described, which are included in jacket **16** are capable of non-fragmenting, elastomeric stretching or extension up to an elongation residing within the range of about 200-400% elongation.

[0020] Included in single-layer jacket/coating **16** are (1) a liquid-fuel-reactive, high-elastomeric, polyurethane main body, or body expanse, **18**, and (2) suitably entrained and distributed within this body expanse (a) a plurality of liquid-fuel-reactive liquid-imbiber beads, such as those shown at **20**, and (b) an all-throughout web in the form of expansion-following, restraining-fibre, stretch-fabric material **22** made of elastomeric nylon fibres.

[0021] Preferably, and more specifically, body expanse **18** is made of a two-component, polyurethane elastomer product sold under the trademark TUFF STUFF®FR, and manufactured by Rhino Linings USA, Inc. in San Diego, Calif. The preferred, embedded liquid-imbiber beads **20** are made by Imbibitive Technologies America, Inc. in Midland, Mich., and are designated with the product designator IMB230300—these beads being distributed extensively within, and dispersed throughout, body expanse **18**. Embedded, expansion-following, stretch-fabric web **22** is formed preferably of conventionally available, 4-way stretchable, 100-denier, elastomeric nylon fibres, referred to herein as restraining fibres, and is disposed as a thin, embeddedly contained sublayer extending completely throughout body expanse **18**. Relative to the overall thickness of the body expanse, web **22** is positioned preferably closer to the non-container-facing side **18***a* of that expanse, than to the container-facing side **18***b* of the expanse. In the particular illustration now being described for jacket/coating **16**, the overall thickness of expanse **18** is approximately ¼-inches, with fabric web **22** being disposed approximately 1/16-inches within the expanse as measured from surface **18***a*.

[0022] Making now a reference to U.S. Pat. No. 7,169,452, this patent describes a protective-barrier, container-coating structure, and a spray-application manner for creating such a coating structure, which are useful in relation to understanding certain aspects of the structure, and of the creation, of coating **16** herein. Accordingly, the full disclosure content of this '452 U.S. Patent is hereby incorporated herein by reference. While the coating structure illustrated and described in the '452 patent has nothing whatsoever to do with the presence of an embedded, expansion-following fabric, such as fabric **22**, it does very usefully describe both a practical ratio of certain coating-content materials that are relevant to the present invention, and a spray-application and liquid-imbiber-bead-embedment technique for creating a coating structure including a main body of the same high-elastomeric body-expanse material employed here in body expanse **18**, and in that body-expanse embedded liquid-imbiber beads having the same features as beads **20** employed in the present invention. The '452-patent content ratio discussion just

referred to involves the content ration of (a) body-expanse high-elastomer material and (b) liquid-imbiber beads.

[0023] In terms of creating single-layer coating **16**, and considering an overall coating thickness such as that mentioned above, namely ¼-inches, the first 3/16-inches of this coating, including high-elastomeric, body-expanse material with properly included liquid-imbiber beads is, first, suitably spray-applied to the outside surface **14***a* of the barrier wall in container **12**. Next, expansion-following fabric web **22** is placed over this initial spray-application partial-coating structure, and then, the remaining 1/16-inches of the combined body expanse and embedded liquid-imbiber beads is spray applied to finish the spray-preparation of coating **16**.

[0024] The sprayed high-elastomeric material, with the included/embedded beads and elastomeric, expansion-following fabric, is allowed to cure to completion. Following such curing, liquid-container structure **10** is complete, and ready for anaconda-reaction, "explosion-burst-guarding" use.

[0025] Accordingly, the two principal facets of the present invention, namely, the liquid-container structure as a whole, and the self-sealing, anti-burst, liquid-container coating structure per se, are ready to perform, under most explosions/burst situations of the kind generally discussed above, extremely well generally as illustrated in FIG. **1** herein. When an explosion event occurs in a manner calling upon the anaconda-reaction behavior of the invention, the important elastomeric, expansion-following restraining fabric which is within the coating structure stabilizes and restrains the behavior of the elastomeric body-expanse structure in what may be thought of as an expansion-following manner wherein its own expansion follows that forced into the body expanse by an explosion, furnishing allover localized stabilization against tearing and/or breaking up of the body-expanse material. This behavior is to be distinguished from the kind of rigid stabilizing structure which is introduced in certain other kinds of embedded fabric materials wherein the embedded fabric is effectively formed of non-stretch fibers. The elastomericity present in the included stretch restraining fabric is, therefore, a very important contributor to supporting the anaconda-reaction behavior which is a central performance focus of the present invention.

[0026] When an explosion event does occur, of course, in all probability the jacketed container per se is effectively destroyed beyond reuse, but importantly, will not have caused an outwardly directed outburst with the possibility of the several serious kinds life-threatening and injury prone possibilities discussed above.

[0027] Turning attention now to FIG. **3** in the drawings, here illustrated, as mentioned earlier in the descriptions of the drawings, is a modified form of the invention in which the outside surface **14***a* in container barrier wall **14** is jacketed with a pair of applied, individually-single-layer coatings **24**, **26**, each of which essentially has exactly the same construction just described above for jacket/coating **16**. Formation of this overall, double-layer jacketing arrangement is performed by an appropriate series of spray-application steps, such as those mentioned above in conjunction with the descriptive information provided in the '452 patent, which produce a surface, or interface, of joinder Illustrated generally at **28** in FIG. **3**. Bonding between the two jacketing structures, **24**, **26**, may be accomplished during spray application of the relevant materials in any suitable manner, as, for example, by beginning spray application of the body-expanse material included in jacketing structure **26** at a point in time when the outer surface of the body-expanse material in jacketing structure **24** is not quite fully cured.

[0028] Accordingly, a preferred and best-mode embodiment of an anaconda-reaction structure as described herein has been illustrated and explained, and one useful modification has also been illustrated and described. One should note that the modified form of the invention which specifically illustrates a dual-layer jacketing arrangement, stands as a representative model for further plural-layer modifications which might include more than two jackets/coatings. One should also observe that specific dimensions that have been discussed herein may be modified in accordance with different applications and users' specific wishes.

[0029] Accordingly, we understand that invention as described herein may be subject to certain variations and modifications that will come to within the minds of those generally skilled in the art, and we intend that all of these variations will be construed to be within the spirit of the present invention, and within the appropriate scopes of the following claims to invention.

We claim:

1. Anti-burst, anaconda-reaction liquid-container structure comprising a liquid container having a barrier wall with an outside surface, and

applied to said wall's said outside surface, coating structure including

a main body formed as a flexible expanse of anti-puncture-wound, self-sealing, high-elastomeric, material, and, embedded within, and distributed throughout, said expanse, both

(a) a population of distributed, container-contained liquid-reactive, liquid-imbiber elements, and

(b) a web of restraining-fibre stretch-fabric.

2. The liquid-container structure of claim **1**, wherein said main body expanse possesses container-facing and non-container-facing sides, and said fabric is positioned within said expanse closer to the expanse's said non-container-facing side than to its said container-facing side.

3. The liquid-container structure of claim **1**, wherein the restraining fibres in said stretch-fabric are formed of 100-denier, stretchable nylon.

4. The liquid-container structure of claim **1**, wherein said stretch-fabric is formed of 100-denier, 4-way stretchable nylon.

5. The liquid-container structure of claim **1**, wherein said main body expanse is formed of a container-contained liquid-reaction material.

6. Anti-burst, anaconda-reaction liquid-container structure comprising a liquid container having a barrier wall with an outside surface, and, applied to said wall's said outside surface,

plural-layer coating structure including, in each layer,

a main body formed as a flexible expanse of anti-puncture-wound, self-sealing, high-elastomeric, material, and, embedded within, and distributed throughout, said expanse, both

(a) (a) a population of distributed, container-contained liquid-reactive, liquid-imbiber elements, and

(b) a web of restraining-fibre stretch-fabric.

7. The liquid-container structure of claim **6**, wherein said main body expanse possesses container-facing and non-container-facing sides, and said fabric is positioned within said

expanse closer to the expanse's said non-container-facing side than to its said container-facing side.

8. The liquid-container structure of claim **6**, wherein the restraining fibres in said stretch-fabric are formed of 100-denier, stretchable nylon.

9. The liquid-container structure of claim **6**, wherein said stretch-fabric is formed of 100-denier, 4-way stretchable nylon.

10. The liquid-container structure of claim **1**, wherein said main body expanse is formed of a container-contained liquid-reaction material.

11. Self-sealing, anti-burst, anaconda-reaction liquid-container coating structure applicable to the outside of the barrier wall in a liquid container comprising

a main body formed as an expanse of anti-puncture-wound, self-sealing, high-elastomeric, material having container-facing and non-container-facing sides, and

embedded within, and distributed throughout, the expanse of said body (a) a population of container-liquid-reactive, liquid-imbiber beads, and (b) a web of restraining-fibre stretch-fabric.

12. The coating structure of claim **11**, wherein said stretch-fabric is positioned within said expanse closer to the expanse's said non-container-facing side than to its said container-facing side.

13. The liquid-container structure of claim **11**, wherein the restraining fibres in said stretch-fabric are formed of 100-denier, stretchable nylon.

14. The liquid-container structure of claim **11**, wherein said stretch-fabric is formed of 100-denier, 4-way stretchable nylon.

15. The coating structure of claim **11**, wherein said main body expanse is formed of a container-contained liquid-reaction material.

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