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(54) **Composite paperboard container of optimized axial strength construction**

Verbundpappe-Behälter mit optimierter axialer Festigkeit

Récipient en carton laminé avec une construction optimisée de résistance axiale

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Description

Field of the Invention

[0001] The invention is directed to composite paperboard containers and container bodies for products such as foodstuffs and other commodities. More specifically, the invention relates to composite paperboard containers and container bodies having a body wall construction that optimizes axial strength, stiffness and related properties as compared to conventional container body constructions from comparable materials.

Background of the Invention

[0002] Composite paperboard containers for packaging foodstuffs and various other commodities constitute commercially significant products. These containers are well known to consumers as packaging for various foodstuffs including frozen drinks, ready to eat snack products, powdered beverages, nuts, dough products, and various non-food products including adhesives, sealants, etc. Typically, the containers are formed of a single ply or multiple ply paperboard body wall; an interior liner formed of one or more layers to protect the contents of the container from moisture and/or oxygen; and an exterior label layer identifying the contents of the container. End cap or closure members are attached to one or both ends of the container body and are typically formed of metal, plastics, films or film laminates, or composite paperboard materials. In some cases, one end of the container can be formed of a peelable film layer covered by a protective cap.

[0003] In many cases the container bodies have a circular or round cross-section, see for example, U.S. Patent No. 3,892,351 to Johnson et al. However the container bodies can alternatively have a non-round cross-section, see for example U.S. Patent No. Des. 382,446 to Bacon.

[0004] The composite container bodies are produced by various processes including the spiral winding, convolute winding, and linear draw processes which are conducted by wrapping or winding a structural paperboard body wall ply or plies, and a label ply around a stationary mandrel to form a continuous tubular body. The tubular body is cut into segments, each having the desired length for a single container. Subsequently, a closure member is applied to one end of each container body to thereby provide an open container that can be filled with the desired product. After the container is filled with product, the second closure member is applied to seal the open end of the container.

[0005] The process of applying the closure members to the container ends typically involves the application of considerable axial force to the container body. In some cases, a rolled lip is formed on one end of the container body in order to provide a sealable surface for a peelable film layer and/or to support a snap-on overcap. The operation to form such a rolled lip similarly involves the application of considerable axial load to the container body. In addition, the filled containers are often subjected to considerable axial load during shipping and storage because multiple layers of packaged product may be stacked on top of each other during shipping and storage and/or multiple cartons of the filled containers may be stacked on top of each other or provide support for cartons of other products.

[0006] Because of such axially applied forces that the composite paperboard container bodies must withstand during manufacture, transportation and storage, the strength and thickness of the single ply or multiple ply paperboard material forming the body wall is selected to provide the necessary axial crush strength. This is typically achieved by using relatively high compression strength paperboard to form the single or multiple body wall plies and/or by selecting the thickness of the ply or plies to provide a specific body wall thickness calculated to meet structural requirements. Typically, the paperboard materials have a normalized compression strength, i.e, strength per unit area measured in the machine direction according to the standard "STFI" TAPPI procedure, of greater than about 12.4 $MN/^2$ (1800 psi) (pounds per square inch, 1 psi = 6895Pa, 1Pa=N/m^2) and typically the paperboard portion of the body wall has a thickness greater than about 0.4 mm (0.014 inch).

[0007] Recently, different improved constructions of multiple layer paperboard winding cores for wound products such as films, yarns, and the like, have been disclosed. The different constructions each provide specific enhanced strength properties, tailored for the end use of the winding core. For example, U.S. Patent No. 5,505,395 to Qiu et al. discloses spirally wound paperboard winding cores having enhanced resistance to inside diameter reduction resulting from the radially applied pressure of a tightly wrapped film or yarn material. In these constructions, the cylindrical body wall of the winding core is formed from three or more structural paperboard plies. The middle paperboard ply or plies used to form the body wall is formed of a low strength, low density paperboard material while the paperboard plies forming the outside and inside portions of the winding core are formed of higher strength, high density paperboard materials. On the other hand, U.S. Patent No. 5,393,582 to Wang et al. discloses that paperboard tubes of enhanced flat crush strength may be formed from three or more plies of paperboard materials arranged to provide high compression strength paperboard materials as the middle or central portion of the body wall and low density, low strength paperboard materials at the outside and interior portions of the walls of the paperboard tube.

[0008] In winding core constructions, such as those discussed above, the axial strength of the tubes is not generally

a design parameter because winding core constructions normally provide an axial strength exceeding the requirements imposed by that end use. In general, this results from a relatively high wall thickness, the use of many paperboard plies, and/or from the relatively high strength of the paperboard materials used to form winding cores.

[0009] Although the strength properties of composite paperboard container bodies can likewise be enhanced by forming the paperboard bodies of many paperboard plies, by using high strength paperboard materials, and/or by increasing body wall thickness, these modifications significantly increase the cost of the container bodies particularly in view of the liner and label layers that must be applied to the single ply or multiple ply paperboard body during the container body forming process. Accordingly, as a practical matter, the paperboard body construction techniques to enhance axial crush strength, currently available to those skilled in the art, involve use of paperboards of increased strength, and/or increasing body wall thickness, and/or the choice of one, two, or three paperboard plies as the body wall materials.

Summary of the Invention

[0010] The invention provides composite paperboard container constructions providing optimized axial crush strength, side wall stiffness, implosion resistance and related properties. The optimized axial crush strength, composite paperboard container constructions of the invention provide axial crush strength properties comparable to, or exceeding the axial crush strength properties of conventional container body constructions with decreased reliance on high strength paperboard materials, and/or on total quantity of paperboard materials. In particular, the container body constructions of the invention have comparable or increased axial strength properties as compared to conventional paperboard container constructions; nevertheless, they can be prepared from paperboard materials having a lower overall furnish (paperboard pulp) content per container, and/or from environmentally desirable furnishes having a higher content of low strength materials such as recycled newsprint.

[0011] In accordance with the invention, composite paperboard container bodies are formed of one, two, or three structural paperboard plies that are arranged to form a layered body wall having a cross-section of the ordered construction; high strength paperboard\low strength paperboard\high strength paperboard. Preferably, the container body is formed of one or two structural plies and at least one structural ply is a multiple layer paperboard having both high strength and low strength paperboard layers. The terms, "strength", "compression strength", and "STFI strength" as applied to paperboard sheets and plies, are used herein to mean normalized compression strength, measured in the machine direction (MD), only, of-the paperboard, using the TAPPI standard testing procedure "Short span compressive strength of containerboard; T 826 pm-92 (1992)", known in the industry as the "STFI" test. On the other hand, "axial strength" of container bodies constructed according to the present invention is determined according to Composite Can and Tube Institute (CCTI) Standard Testing Procedure CT-107 (September 1984).

[0012] The term "ply" is used herein to refer to a paperboard sheet, including wide and narrow sheets, which is wound or wrapped onto a mandrel, or onto another container body ply on the mandrel, to form the body wall of a container. The body wall can be formed from a single ply or multiple plies. The terms "layer" and "paperboard layer" when applied to a ply or to a paperboard sheet, are used herein to refer to a portion of the thickness of the ply or paperboard sheet. In common terminology, a layer of a paperboard sheet is also called a paper layer, and for purposes of the present application, the term paperboard layer also applies to such a "paper" layer of a paperboard sheet. On the other hand, the term "layer" when used with reference to a composite container body or bodywall, in the present application, can refer either to a ply or to a paperboard layer.

[0013] The composite paperboard container bodies of the invention have a total wall thickness and an axial strength comparable to conventional composite container bodies. Thus the total wall thickness is about 1.5mm (0.060 in.) (60 mils or 60 point) or less, normally about 1.3mm (0.050 in.) or less, and the axial crush strength of the container body is 445 N (100 lbs) or greater. In accordance with the invention, it has been found that high strength paperboard layers positioned on the outside and on the inside of the container body wall contribute substantially to the overall axial strength of the container even when the high strength paperboard layers form only a minor portion, for example 10%, of the total body wall thickness.

[0014] In preferred embodiments of the invention, at least one structural paperboard ply is a multiple layer paperboard having both high strength and low strength paperboard layers. Container constructions including one or more multilayer paperboard plies having both high strength and low strength layers, allow for the use of extremely thin, high strength paperboard layers without substantially increasing the complexity of container manufacturing operations. In one such preferred embodiment, the container body wall is formed from a single structural paperboard ply having the three layer construction: high strength paperboard layer/low strength paperboard layer/high strength paperboard layer. In another preferred embodiment of the invention, the container body wall is formed from two structural paperboard plies, each having a two layer paperboard construction of the structure; high strength paperboard layer/low strength paperboard layer. In the latter construction, the two paperboard plies are positioned with the low strength layers in face-to-face contact so that the low strength paperboard layers combine to form a single centrally positioned low

strength paperboard layer of the body wall while the high strength layers form the outer and inner layers of the body wall.

[0015] The multiple layer paperboard ply or plies used to prepare container bodies in accordance with preferred embodiments of the invention can be readily formed without significant modification or disruption of the conventional paperboard manufacturing process. In particular, paperboard materials, because of their substantial thickness, are often formed by superimposing and consolidating a plurality of thinner layers. Typically, the multiple layers are prepared in series using a plurality of papermaking operations. In the conventional process, the furnish used to form each layer has the same composition, although sometimes different furnishes are used for cosmetic purposes such as for the formation of a smooth, printable surface. In the present invention, paperboard layers of different strengths are consolidated to significantly modify the structural properties of the final composite paperboard and can readily be prepared by employing different papermaking furnishes in selected layers of the multiple papermaking operations used to form the multi-layer paperboard sheet.

[0016] As well known to those skilled in the art, the composition of the papermaking furnish used to form a particular paperboard strongly influences the final compression strength of the paperboard. As a result, certain pulps or furnishes are normally considered unsuitable for the formation of paperboards having strengths conventionally believed necessary to form the relatively thin walls of container bodies of high axial strength. For example, a 100% recycled newsprint furnish forms a low compression strength paperboard and is accordingly not normally used in the manufacture of container bodies unless the wall is sufficiently thick to provide a strength corresponding to a body made with high strength paperboard. The present invention allows the use of greater amounts of low strength paperboard, based e. g., on recycled newsprint, in the manufacture of composite container bodies.

[0017] The body walls of the composite paperboard container bodies of the invention typically include a low strength paperboard layer constituting 25% or more of the total body wall thickness. In preferred embodiments of the invention, the low strength paperboard materials used to form the low strength layer constitute about 50% by weight or more of the composition of the body wall of the container, up to as much as 50% of the composition of the body wall of the container, preferably 75 to 90%. Thus, the greatest majority of the body wall can be formed of various furnishes such as those based on low grade recycled materials that would be conventionally considered undesirable for container body manufacture.

[0018] In the case of container bodies formed from two or more plies which are each single grade, i.e., single furnish, paperboard plies, it is preferred that the difference in strength between the high compression strength and the lower compression strength paperboard plies is at least about 10%, more preferably, at least about 15%, based on the strength of the lower strength paperboard ply. However, in the preferred embodiments of the invention which employ at least one multi-layer paperboard ply having layers of different strengths, it is not possible as a practical matter, to measure the separate compression strengths of individual paperboard layers. This is particularly true when one or both of the high strength paperboard layers is an extremely thin layer, e.g. from about 0.03 mm (1 mil) (0.001 inch) to about 0.13 mm (5 mils) (0.005 inch) in thickness, as in highly preferred embodiments of the invention. In such cases, the strength of the high strength paperboard layer or layers in the composite sheet is not measured directly. Instead, the compression strength of the composite paperboard sheet is compared to the compression strength of the low strength paperboard layer (which is measured after removing the high strength paperboard layer or layers by gentle grinding). In the case of a two layer (high strength, low strength) composite paperboard sheet, the composite sheet preferably has a compression strength at least about 20% greater, more preferably at least 30% greater, than the strength of the low strength layer. In the case of a three layer composite paperboard sheet (high strength, low strength, high strength) the composite sheet preferably has a strength at least about 20% greater, preferably 30% greater, than the low strength paperboard layer.

[0019] In various preferred embodiments of the invention, the composite paperboard container bodies also include an outside label ply for identifying a product associated with the container body. The container bodies also typically include an interior liner ply having moisture and/or oxygen barrier or other protective properties. The label and liner plies can be integrally formed on a surface of the ply or plies forming the body wall, if desired.

[0020] The composite paperboard container bodies of the invention can be prepared from a wide range of grades of papermaking materials and in particular, allow the manufacture of optimized axial crush strength container bodies based in substantial part on low grade paper-making furnishes that were previously considered by those of ordinary skill in the art, as unsuitable for use in making high axial crush strength container bodies. Accordingly, the container bodies of the invention allow decreased reliance on natural resource-intensive papermaking furnishes while allowing greater use of low grade recycled materials. The composite paperboard container bodies of the invention also increase the flexibility of the manufacturing process by providing a choice among different grades of papermaking materials for achieving an axial crush strength in the final composite paperboard container body that meets a customer's specifications.

Brief Description of the Drawings

[0021] In the drawings which form a portion of the original disclosure of the invention:

Figure 1 is a perspective view of a cylindrical, composite paperboard container according to one preferred embodiment of the invention;

Figure 2 is a perspective view of a different container body according to another preferred embodiment of the invention;

Figure 3 is a greatly enlarged, exploded, fragmentary sectional view taken along line 3-3 of Figure 1 and illustrates one preferred container body construction according to the invention in which a single, three-layer structural paperboard ply forms the body wall of the container;

Figure 4 is a greatly enlarged, exploded, fragmentary sectional view of an alternative container body wall construction according to the invention in which two identical structural paperboard plies, each having two layers, are used to form the a container body wall;

Figure 5 is a greatly enlarged, exploded, fragmentary sectional view of a third alternative container body wall construction according to the invention wherein the container body wall is formed from two structural paperboard plies, with one of the paperboard plies formed of a single papermaking furnish composition, and the other paperboard ply having a two-layer, high strength/low strength construction; and

Figure 6 is a greatly enlarged, exploded, fragmentary sectional view of a third alternative body wall construction according to the invention wherein the container body wall is formed from three structural paperboard plies, with each of the paperboard plies being formed of a single papermaking furnish; the outside and inside plies being formed of a high strength furnish, and the central ply being formed from a low strength furnish.

Detailed Description of the Preferred Embodiment

[0022] In the following detailed description, various preferred embodiments of the invention are described. It will be understood, however, that the invention is not to be limited to its preferred embodiments. But to the contrary, the invention includes various alternatives and modifications as will be apparent to the skilled artisan from a consideration of the foregoing and following detailed description of preferred embodiments of the invention.

[0023] Figures 1 and 2 illustrate perspective views of preferred composite paperboard containers **10** and **11** according to the invention. The container **10** is a substantially cylindrical container having a spirally orientated seam **12** visible on the outer label **14**. The container **11** of Figure 2 has a generally elliptical or oval cross-section and includes an outer label **14** having a visible seam **12** that is oriented parallel to the axis of the container **11**. The container **10** of Figure 1 is formed by the well known spiral winding process whereas the container **11** of Figure 2 is prepared by the linear draw process, also well known to those of ordinary skill in the art. The container bodies of Figure 1 and Figure 2 can alternatively be formed in accord with the invention using a convolute winding process which is also well known to those of ordinary skill in the art. Moreover, the container body of Figure 1 can be formed using a linear draw process, and the container body of Figure 2 can be formed using a spiral winding process.

[0024] Each of the container bodies **10** and **11**, as shown in Figures 1 and 2 respectively, include a top end closure member **15** and a bottom end closure member **16** attached to the respective top and bottoms of the respective containers. Although metal, end-seamed, closure members are illustrated in Figures 1 and 2, various different end-closure members can be employed in containers of the invention including film, foil, paperboard, and laminated composite closure members. Exemplary paperboard bottom closure members disclosed and illustrated in U.S. Patent No. 5,431,619 to Bacon issued July 11, 1995. Similarly, peelable heat-sealed film, foil, paperboard and laminated closures, and/or snap-on overcap closures can be employed as a closure member, as disclosed, for example, in the aforementioned Bacon patent, and/or in U.S. Patent No. 3,892,351 to Johnson and in U.S. Des. Patent No. 382,446 to Bacon.

[0025] Preferred alternative constructions for the body wall of containers **10** and **11** are illustrated in Figures 3, 4, 5 and 6. In the embodiment of Figure 3, the container body wall **18** is formed of a single, three-layer, structural paperboard ply **20** which is positioned between an exterior label ply **14** and an interior liner ply **24**. The liner ply **24** is traditionally employed to provide barrier properties and/or heat seal properties to the container body inside surface and can be formed from a single layer sheet material such as a polymeric film or a metallic foil, or from a multiple layer sheet material such as a film/foil, film/paper, or foil/paper structure. The exterior label ply **14** typically includes an outer printed surface in order to provide information as to the contents of the container **10**. For the purposes of the present invention, such exterior and interior label and liner plies, respectively, which are provided for specific non-strength (axial) imparting purposes, and which do not individually increase the axial strength of the container body by an amount of about 10% or more, are considered to be non-structural portions of the body wall.

[0026] In some instances, the liner ply function and/or the label ply function can be achieved by the structural body wall layer or layers, as for example when functional barrier materials are deposited directly on the interior surface of

the structural ply **20**, or when a printing layer is provided on the outer surface of the structural ply **20**. In such instances, the label and/or liner ply functions are achieved directly by the structural paperboard ply, and such structural paperboard plies having modified interior and/or exterior surfaces to provide such additional functions are intended to be included within the scope of the term, structural paperboard ply, as used herein.

[0027] Returning now to Figure 3, it will be seen that the structural paperboard ply **20** is formed of three separate layers, including an outer layer **30**, and an interior layer **32**. A central layer **34** is sandwiched between the outer layer **30** and the interior layer **32**. In accordance with the invention, the central layer **34** is formed of a low strength paperboard material. Each of the exterior and interior layers **30** and **32** are formed of a higher strength paperboard material. Preferably the outer and interior layers **30** and **32**, respectively, have a strength sufficient to increase the STFI normalized compression strength of the structural paperboard ply **20** so that it is at least about 20%, more preferably at least about 30% higher than that of the central layer **34**. The strength of the two higher strength layers **30** and **32** is preferably the same, however, the strength of the two high-strength layers can vary from layer to layer so long as each high strength layer is formed of a high strength paperboard furnish and the composite paperboard sheet has a strength at least 20% greater than the strength of the central layer (based on the strength of the central layer).

[0028] Paperboard strengths are determined for the purposes of the subject invention in accordance with the TAPPI "STFI" standard test, modified however in that in the case of a multi-layer, multi-composition, composite paperboard, the test is applied to the low strength layer of a composite paperboard sheet, e.g., to the central portion of a three layer ply, or to the low strength layer of a two layer composite paperboard sheet; and the test is also applied to the composite paperboard sheet. For example, in the case of the high strength/low strength/high strength composite paperboard sheet shown in Figure 3, the test is applied to the composite sheet **20** and to the middle layer **34**.

[0029] As indicated previously, in the case of multi-layer composite paperboard sheets, the low strength portion of the paperboard sheet is typically of greater thickness than the high strength portion of the paperboard sheet and is accordingly more readily tested for compression strength. The compression strength of the low strength portion of the paperboard sheet can be determined by separating (by a very gentle rotary sanding or grinding operation using a very fine grit abrasive wheel or by an equivalent cutting/peeling operation) the high strength layer or layers of the paperboard sheet so as to completely remove the high strength layer or layers from a suitable test strip. Thereafter, the compression strength of the low strength layer can readily be determined. Because the STFI compression strength measurement is a "normalized" measurement which measures strength per unit area of cross-section (transverse to the sheet), small variations in the thickness of the low strength paperboard layer as compared to the original thickness of this layer in the composite sheet (up to 5 to 10% of the original thickness) are relatively unimportant so long as the thickness is uniform along the sample being tested. In addition, it is relatively easy to determine the boundary between the high strength paperboard layer and the low strength paperboard layer or layers because, as generally known to those skilled in the art, the coloring of high strength paperboard materials is generally different than the coloring of low strength paperboard materials due to the differences in the composition of the furnishes used to form high strength and low strength paperboard materials. At any rate, even when the variations in coloring are not readily apparent, the differences in the pulp materials are readily apparent upon microscopic examination of the cross-section of the composite sheet so that it is a relatively straightforward matter to determine when all of the high strength paperboard layer has been removed from the low strength paperboard layer.

[0030] Paperboard strips or plies of a widely varying range of strengths and thicknesses are used to form paperboard composite containers as is well known in the art. The present invention can employ paperboard materials in the high compression strength layers **30** and **32** of ply **20** having strengths throughout the range of strengths normally used in the art. Typically the high compression strength paperboard layers used to form composite container bodywall in accord with the invention, have strengths or a strength contribution from about 10,235 to 26,700 N (2,300 to 6,000 psi) more typically from about 11,570 to 22,250 N (2,600 to 5,000 psi). The low strength paperboard layer **34** of ply **20** can be formed from paperboard materials having a strength range including strengths below the strength of paperboard materials typically used in the art to form container bodies. Typically the low compression strength paperboard layer will have a strength ranging from about 5,340 to 15,130 N (1,200 to 3,400 psi), more typically from about 8,900 to 12,460 N (2,000 to 2,800 psi). As is apparent from the above, the low strength paperboard layer can in some cases have a strength within the range of high compression strength paperboard materials, as set forth above. In such instances, the higher strength paperboard layers **30** and **32** of ply **20**, have even a higher strength (typically still within the strength ranges set forth above) as will be apparent.

[0031] As indicated previously, the high compression strength layers **30** and **32** preferably have a strength difference as compared to the low strength layer such that the strength of the composite sheet **20** is at least 20% greater, more preferably at least 30% greater than the strength of the low strength layer alone. This difference is determined by subtracting the STFI strength the lower strength paperboard layer from the STFI strength of the composite paperboard sheet and then expressing the difference as a percentage of the strength of the lower strength paperboard layer.

[0032] Figures 4 and 5 illustrate container body wall constructions according to the present invention in which two structural paperboard plies are used to form the container body wall. In Figure 4, two structural paperboard plies **20A**

and **20B** of like construction are used to form the body wall **18** of the container. Each of the paperboard plies **20A** and **20B** are formed of two layers **30** and **34,** representing high compression strength and low compression strength paperboard layers, respectively. As discussed previously, the high compression strength layers **30** have a difference in strength from that of and low compression strength paperboard layers **34**, such that the STFI strength of each composite paperboard sheet or ply, **20A** and **20B**, exceeds that of the corresponding low strength layer of the ply **34** by at least about 20%, preferably 30%, based on the strength of the low strength layer **34**. The body wall construction illustrated in Figure 4 also includes an exterior label ply **14** and an interior liner ply **24** like the body wall construction illustrated in Figure 3.

[0033] As also seen in Figure 4, the two low strength paperboard layers **34** are arranged in contacting face-to-face relationship in the bodywall. In such arrangement, the two low strength paperboard layers **34** combine in the final body wall **18** to form a single central paperboard layer as will be apparent.

[0034] The container body wall construction illustrated in Figure 5 is formed of two structural paperboard plies **20C** and **20D**. In this construction, one of the structural paperboard plies, **20C**, is a paperboard ply of uniform strength and of uniform furnish composition throughout its cross-section. The other paperboard ply, **20D**, is a two-layer paperboard ply formed of a high compression strength layer **30** and a lower strength layer **34**. The single layer paperboard ply, **20C** is formed entirely of higher strength paperboard material. As illustrated in Figure 5, the lower strength paperboard layer **34** of paperboard ply **20D** is sandwiched between the higher strength paperboard layer **30** of paperboard ply **20D** and the single layer, high compression strength paperboard ply **20C**. Although Figure 5 illustrates the two layer paperboard ply **20D** as the interior bodywall structural ply, the ply **20D** could alternatively form the exterior structural ply and ply **20C** could form the interior structural ply as will be apparent. The compression strength of composite sheet **20D** is preferably at least 20% greater than the compression strength of the low strength layer thereof, layer **34**. In addition, the compression strength of the high strength ply **20C**, is preferably at least about 20% greater than the compression strength of the low strength layer **34** of composite sheet **20D**.

[0035] The container body wall construction illustrated in Figure 6 is formed of three structural paperboard plies **20E, 20F**, and **20E**. In this construction, the interior and exterior paperboard plies are each of uniform strength and uniform furnish composition throughout their cross-sections. Similarly, the central paperboard ply **20F**, is of uniform strength and uniform furnish composition across its cross-section. The STFI strength of each of the outer and interior layers **20E,** exceeds the STFI compression strength of the central paperboard ply **20F** by at least about 10%, based on the strength of the central paperboard ply **20F**.

[0036] The container body constructions of the present invention provide container bodies having an axial crush strength which is the same or comparable to container bodies having a body wall of slightly smaller thickness formed entirely of the same higher strength, paperboard materials used in the higher strength layers of the multi-layer paperboard plies employed in the present invention. In accord with the present invention, it has been found that axial strength properties of container body walls formed of a single paperboard ply or from two paperboard plies, can be determined primarily by the strength of the outside and inside portions of the body wall when the body wall is properly constructed. Accordingly, the substitution of a low strength, paperboard material for the middle or central portion of the body wall, particularly when accompanied by a small increase in bodywall thickness, does not detract materially from the overall axial crush strength of the container body.

[0037] In the various preferred embodiments of the invention illustrated in Figures 3-6, the high compression strength paperboard layers will typically form from about 5% to about 50%, preferably about 5% to about 25%, more preferably about 10% to about 20% of the total thickness of the container body wall. The exact ratio between the thickness of high compression strength and the thickness of the low strength paperboard layer can be varied depending on the total body wall thickness and strength requirements. In general, the structural paperboard ply or plies forming the container body wall will have a total combined thickness of between about 0.4mm (0.014 in.) (14 mil) and about 1.5mm (0.060 in.) (60 mil), more preferably between about 0.4 mm (0.016 in.) (16 mil) and about 1.1mm (0.045 in) (45 mil). In highly preferred embodiments, the total body wall thickness is constructed such that it exceeds the normal total body wall thickness of a conventional single ply container body wall made of high grade paperboard in which the container has a comparable axial strength. In order to achieve the most efficient use of the high compression strength paperboard materials, it is preferred that the total thickness of the low strength paperboard materials exceeds 50% of the total body wall thickness. Although the exterior and interior high compression strength paperboard layers are preferably of about the same thickness with respect to each other, these layers can have thicknesses different from one another within the scope of the invention, as will be apparent.

[0038] As indicated previously, the multiple layer paperboard ply or plies used to prepare container bodies of the invention can be formed without significant modification or disruption of conventional paperboard manufacturing processes. This is because paperboard materials, due to their increased thicknesses as compared to paper, are often formed by superimposing and consolidating a plurality of layers. In the conventional process, the multiple layers are prepared using the same papermaking furnish in a plurality of papermaking operations. The multiple strength paperboard plies employed in the present invention can readily be prepared by employing different grades of papermaking

furnish with different ones of the papermaking operations being used to form the different layers of the paperboard sheet material illustrated in Figures 3-6.

[0039] The manufacture of container bodies of optimized axial strength construction according to the invention similarly can be accomplished without substantial modification to conventional container manufacturing processes. As indicated previously, the container body constructions according to the present invention may be formed using various well known spiral winding, linear draw and convolute winding processes as are well known to those skilled in the art. For example, spiral winding processes are illustrated in U.S. Patent No. 5,393,582 issued to Yiming Wang et al. and U.S. Patent No. 5,505,395 to Qiu et al. Similarly, linear draw processes are disclosed and illustrated in, for example, U.S. Patent 3,122,305 to Young and in U.S. Patent 3,656,513 to Evans. Convolute winding processes are disclosed in numerous patents including, for example, U.S. Patent 3,506,183 to Turpin et al.

EXAMPLES

[0040] The following examples illustrate container body constructions according to the present invention and illustrate axial strength properties thereof as compared to conventional container constructions which are prepared relying entirely on high compression strength paperboard materials.

[0041] Multiple layer and single layer container bodies were prepared by a conventional spiral winding process from the paper materials set forth in Table 1 below. The low strength layer STFI strength test data shown for paperboard B in Table 1 was obtained by removing the outermost high strength layers by gentle grinding using a rotary abrasive wheel of very fine grit while the composite sheet was held by vacuum on a vacuum table. STFI strength was then measured from a test strip of the single layer sample thus obtained.

TABLE 1

Paperboard	Thickness of Ply	No. of Layers	Thickness of Layers	Basis Wt kg/100m^2 (Lhs/ 1000ft^2)	Composition of Layers	Total Strength (STF_{md})	Strength of Low Strength Layer (STF_{md})
A	0.572 mm (22.5 mil)	1	5.72 mm (22.5 mil)	34.25 (70.05)	Furnish A	15.15 MN/ m^2 (2197 psi)	Not Applicable
B	0.544 mm (21.4 mil)	3	0.046 mm (1.8 mi)l/ 0.452 mm (17.8 mil)/ 0.046 mm (1.8 mil)	33.75 (69.02)	Furnish B/ Furnish A/ Furnish B	16.37 MN/ m^2 (2374 psi)	12.11 MN/ m^2 (1757 psi)
C	0.483 mm (19 mil)	1	0.18 mm (7.25 mil)/ 0.18 mm (7.25 mil)	30.05 (61.46)	Fumish B	18.16 MN/ m^2 (2634 psi)	Not Applicable

* 1 mil = 10^{-3}in = 2.54 x 10^{-3}cm

* 1 psi = 6895 pa = 6895 N/m$^{\bullet 2}$

Furnish A: 50% medium grade recycled paper + 50% low grade recycled paper

Furnish B: 50% medium grade recycled paper + 50% high grade recycled paper

[0042] Container bodies prepared from the paperboard materials listed in Table 1 above each had an ID of 10.319 cm (4.0625 inches). The OD of each container body was varied depending upon the thickness of the container body. The body wall construction of each container body is set forth in Table 2 below. In addition, the axial strength of the container bodies is also set forth in Table 2.

TABLE 2

Papergrade	Number of Plies	Can Height cm (in)	Can ID cm (in)	Axial Strength N (lbs)
A	1	15.24 (6)	10.319 (4.0625)	1633.15 (367)
B	1	15.24 (6)	10.319 (4.0625)	1744.4 (392)
C	1	15.24 (6)	10.319 (4.0625)	1437.35 (323)
* 1 in = 2.54 cm * lbs = 4.45 Newton				

[0043] In Table 2, experimental data of axial compression strength is presented. The container bodies made from paperboard B are clearly stronger than the container bodies made from the other two single grade paperboards. Although paperboard B is thinner than paperboard A, the axial compression strength of the corresponding container body is higher due to the two thin layers of strong grade paperboard on the top
and bottom of the paperboard sheet which is otherwise made from the same furnish as paperboard A. Although paperboard B is composed mostly of low grade of paper grade, by slightly increasing wall thickness, and introducing thin layers of high grade paper, the cans made with paperboard B have better axial compression strength than cans made with 100% strong grade paperboard (paperboard C).

Claims

1. A composite paperboard container body having a body wall (18) with a total wall thickness of less than 1.5 mm (0.060 inch) and an axial crush strength of at least 445 N (100 pounds) and which comprises at least one structural paperboard ply (20, 20A through 20F) and wherein each ply is formed by at least one paperboard layer (30, 32, 34), the arrangement being such that the number of plies is one, two or three and the wall has at least three layers (30, 32, 34) including two layers (30, 32) which are of high compression strength and are in opposing interior and exterior relationship with another layer (34) which is of low compression strength.

2. The composite paperboard container body according to Claim 1 wherein said body wall is formed from a single structural paperboard ply (20) having a three-layer construction of the ordered structure:

   high strength paperboard layer (30)/low strength paperboard layer (34)/high strength paperboard layer (32).

3. The composite paperboard container body according to Claim 1 in which said structural paperboard plies include at least one two-layer paperboard ply (20A) having the ordered structure:

   high strength paperboard layer (30)/low strength paperboard layer (34).

4. The composite paperboard container body according to Claim 3 in which said structural paperboard plies include two paperboard plies (20A, 20B) each comprising a two-layer paperboard ply having the ordered structure:

   high strength paperboard layer (30)/low strength paperboard layer (34).

5. The composite paperboard container body according to Claim 3 in which said structural paperboard plies include a second paperboard ply (20D) wherein said second paperboard ply is a single-layer high strength paperboard ply formed of a single papermaking furnish.

6. The composite paperboard container body according to Claim 1 in which said structural paperboard plies include three structural paperboard plies (20E, 20F) and wherein each paperboard ply is a single layer made from a single papermaking furnish and wherein two of said plies are high strength paperboard plies (20E) and one of said plies is a low strength paperboard ply (20F).

7. The composite paperboard container according to Claim 2 wherein the compression strength of said single paperboard ply (20) is at least about 20% greater than the compression strength of the central low strength paperboard layer (34), based on the compression strength of the central low strength paperboard layer.

8. The composite paperboard container according to Claim 7 wherein the compression strength of the single paperboard ply (20) is at least about 30% greater than the compression strength of the central low strength paperboard layer (34).

9. The composite paperboard container according to Claim 3 wherein the compression strength of said two-layer paperboard ply (20A) exceeds the strength of the low strength paperboard layer (34) thereof by at least about 20%, based on the strength of the low strength paperboard layer.

10. The composite paperboard container body according to Claim 1 wherein one or more low strength paperboard layers (34) centrally positioned with respect to said high strength paperboard layers (30, 32) constitute about 50% or greater of the total body wall thickness.

11. The composite paperboard container according to Claim 10 wherein the high strength paperboard layers (30, 32) constitute from about 5% to about 25% of the total thickness of the container body wall.

12. The composite paperboard container according to Claim 11 wherein the body wall (18) has a thickness of between about 0.4 mm (0.016 inch) and about 1.1 mm (0.045 inch).

13. The composite paperboard container according to Claim 11 wherein the high strength paperboard layers (30, 32) constitute from 10% to 20% of the total thickness of the container body wall.

Patentansprüche

1. Verbundbehälterkörper aus Pappe, der eine Körperwand (18) mit einer gesamten Wanddicke von weniger als 1,5 mm (0,060 inch) und eine axiale Bruchfestigkeit von mindestens 445 N (100 pounds) sowie wenigstens eine strukturelle Lage aus Pappe aufweist (20, 20A bis 20F), wobei jede Lage durch mindestens eine Schicht (30, 32, 34) aus Pappe gebildet ist und die Anordnung derart ist, dass die Anzahl der Lagen eins, zwei oder drei ist und die Wand mindestens drei Schichten (30, 32, 34) hat, einschließlich zweier Schichten (30, 32), die von hoher Druckfestigkeit sind und in einer gegenüberliegenden inneren und äußeren Beziehung mit einer weiteren Schicht (34) stehen, die von geringer Druckfestigkeit ist.

2. Verbundbehälterkörper aus Pappe nach Anspruch 1, bei dem die Körperwand aus einer einzelnen strukturellen Lage (20) aus Pappe gebildet ist, die eine Drei-Schicht-Konstruktion mit dem folgenden geordneten Aufbau aufweist:

   Schicht (30) aus Pappe mit hoher Festigkeit/Schicht (34) aus Pappe mit geringer Festigkeit/Schicht (32) aus Pappe mit hoher Festigkeit.

3. Verbundbehälterkörper aus Pappe nach Anspruch 1, in welchem die strukturellen Lagen aus Pappe mindestens eine Zwei-Schicht-Lage (20A) aus Pappe mit dem folgenden geordneten Aufbau aufweisen:

   Schicht (30) aus Pappe mit hoher Festigkeit/Schicht (34) aus Pappe mit geringer Festigkeit.

4. Verbundbehälterkörper aus Pappe nach Anspruch 3, in welchem die strukturellen Lagen aus Pappe zwei Lagen (20A, 20B) aus Pappe aufweisen, die jede eine Zwei-Schicht-Lage aus Pappe mit dem folgenden geordneten Aufbau aufweist:

   Schicht (30) aus Pappe mit hoher Festigkeit/Schicht (34) aus Pappe mit geringer Festigkeit.

5. Verbundbehälterkörper aus Pappe nach Anspruch 3, in welchem die strukturellen Lagen aus Pappe eine zweite Lage (20D) aus Pappe aufweisen, wobei die zweite Lage aus Pappe eine Ein-Schicht-Lage aus Pappe mit hoher Festigkeit ist, die aus einem einzigen Papierfertigungs-Mahlgut gebildet ist.

6. Verbundbehälterkörper aus Pappe nach Anspruch 1, in welchem die strukturellen Lagen aus Pappe drei strukturelle Lagen (20E, 20F) aus Pappe aufweisen, wobei jede Lage aus Pappe eine einzige Schicht ist, die aus einem einzigen Papierfertigungs-Mahlgut hergestellt ist, und wobei zwei der Lagen Lagen (20E) aus Pappe mit hoher Festigkeit und eine der Lagen eine Lage (20F) aus Pappe mit geringer Festigkeit ist.

7. Verbundbehälter aus Pappe nach Anspruch 2, bei dem die Druckfestigkeit der einzelnen Lage (20) aus Pappe mindestens ungefähr 20 % größer als die Druckfestigkeit der zentralen Schicht (34) aus Pappe mit geringer Festigkeit ist, basierend auf der Druckfestigkeit der zentralen Schicht aus Pappe mit geringer Festigkeit.

8. Verbundbehälter aus Pappe nach Anspruch 7, bei dem die Druckfestigkeit der einzelnen Lage (20) aus Pappe mindestens ungefähr 30 % größer als die Druckfestigkeit der zentralen Schicht (34) aus Pappe mit geringer Festigkeit ist.

9. Verbundbehälter aus Pappe nach Anspruch 3, bei dem die Druckfestigkeit der Zwei-Schicht-Lage (20A) aus Pappe die Festigkeit der Schicht (34) aus Pappe mit geringer Festigkeit um mindestens ungefähr 20 % übersteigt, basierend auf der Festigkeit der Schicht aus Pappe mit geringer Festigkeit.

10. Verbundbehälterkörper aus Pappe nach Anspruch 1, bei dem eine oder mehrere Schichten aus Pappe mit geringer Festigkeit (34), die in Bezug auf die Schichten (30, 32) aus Pappe mit hoher Festigkeit zentral angeordnet sind, ungefähr 50 % oder mehr der gesamten Körperwanddicke ausmachen.

11. Verbundbehälter aus Pappe nach Anspruch 10, bei dem die Schichten (30, 32) aus Pappe mit hoher Festigkeit ungefähr 5 % bis ungefähr 25 % der gesamten Dicke der Behälterkörperwand ausmachen.

12. Verbundbehälter aus Pappe nach Anspruch 11, bei dem die Körperwand (18) eine Dicke von zwischen ungefähr 0,4 mm (0,016 inch) und ungefähr 1,1 mm (0,045 inch) hat.

13. Verbundbehälter aus Pappe nach Anspruch 11, bei dem die Schichten (30, 32) aus Pappe mit hoher Festigkeit 10 % bis 20 % der gesamten Dicke der Behälterkörperwand ausmachen.

Revendications

1. Récipient en carton composite ayant une paroi de récipient (18) présentant une épaisseur de paroi totale inférieure à 1,5 mm (0,060 pouce) et une résistance à l'écrasement axial d'au moins 445 N (100 livres) et qui comprend un pli de carton structurel (20, 20A à 20F) et dans lequel chaque pli est formé par au moins une couche de carton (30, 32, 34), l'agencement étant tel que le nombre de plis est de un, de deux ou de trois et que la paroi comporte au moins trois couches (30, 32, 34) incluant deux couches (30, 32) qui sont d'une résistance à la compression élevée et sont en relation intérieure et extérieure opposée avec une autre couche (34) qui présente une faible résistance à la compression.

2. Récipient en carton composite selon la revendication 1, dans lequel ladite paroi du récipient est formée à partir d'un seul pli de carton structurel (20) ayant une structure à trois couches selon la structure ordonnée :

   couche de carton à résistance élevée (30)/couche de carton à faible résistance (34)/couche de carton à résistance élevée (32).

3. Récipient en carton composite selon la revendication 1, dans lequel lesdits plis de carton structurel incluent au moins un pli de carton à deux couches (20A) présentant la structure ordonnée :

   couche de carton à résistance élevée (30)/couche de carton à faible résistance (34).

4. Récipient en carton composite selon la revendication 3, dans lequel lesdits plis de carton structurel incluent deux plis de carton (20A, 20B), chacun comprenant un pli de carton à deux couches présentant la structure ordonnée :

   couche de carton à résistance élevée (30)/couche de carton à faible résistance (34).

5. Récipient en carton composite selon la revendication 3, dans lequel lesdits plis de carton structurel incluent un

second pli de carton (20D) dans lequel le second pli de carton est un pli de carton à une seule couche à résistance élevée formé d'une seule composition de papier.

6. Récipient en carton composite selon la revendication 1, dans lequel lesdits plis de carton structurel incluent trois plis de carton structurel (20E, 20F) et dans lequel chaque pli de carton est une seule couche constituée à partir d'une seule composition de papier et dans lequel deux desdits plis sont des plis de carton à résistance élevée (20E) et un desdits plis est un pli de carton à faible résistance (20F).

7. Récipient en carton composite selon la revendication 2, dans lequel la résistance à la compression dudit seul pli de carton (20) est au moins environ 20 % plus grande que la résistance à la compression de la couche centrale de carton à faible résistance (34), sur la base de la résistance à la compression de la couche centrale de carton à faible résistance.

8. Récipient en carton composite selon la revendication 7, dans lequel la résistance à la compression du seul pli de carton (20) est au moins 30 % plus grande que la résistance à la compression de la couche centrale de carton à faible résistance (34).

9. Récipient en carton composite selon la revendication 3, dans lequel la résistance à la compression dudit pli de carton à deux couches (20A) dépasse la résistance de la couche de carton à faible résistance (34) de celle-ci d'au moins environ 20 % sur la base de la résistance de la couche de carton à faible résistance.

10. Récipient en carton composite selon la revendication 1, dans lequel une ou plusieurs couches de carton (34) à faible résistance positionnées au centre par rapport auxdites couches de carton à résistance élevée (30, 32) constituent environ 50 % ou plus de l'épaisseur de paroi totale du récipient.

11. Récipient en carton composite selon la revendication 10, dans lequel les couches de carton à résistance élevée (30, 32) constituent d'environ 5 % à environ 25 % de l'épaisseur totale de la paroi du récipient.

12. Récipient en carton composite selon la revendication 11, dans lequel la paroi du récipient (18) présente une épaisseur située entre environ 0,4 mm (0,016 pouce) et environ 1,1 mm (0,045 pouce).

13. Récipient en carton composite selon la revendication 11, dans lequel les couches de carton (30, 32) à résistance élevée constituent de 10 % à 20 % de l'épaisseur totale de la paroi du récipient.

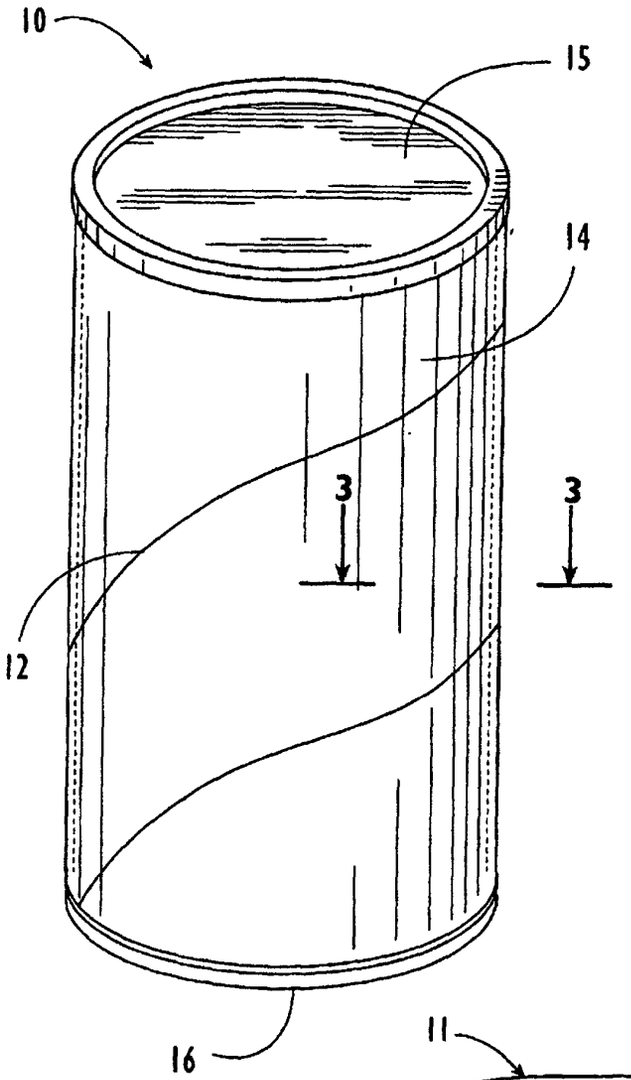

FIG. 1.

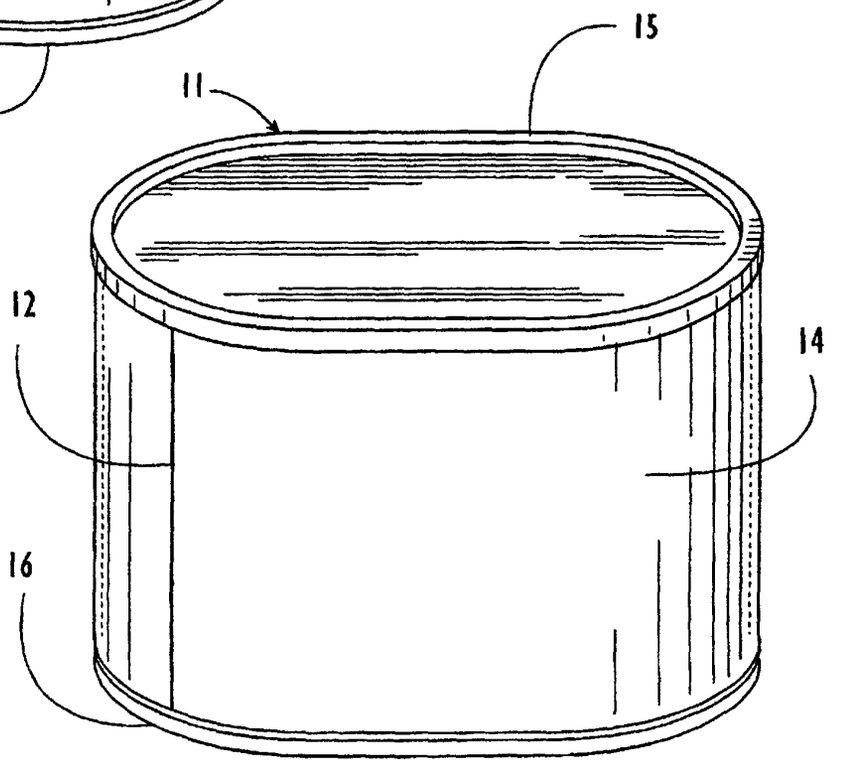

FIG. 2.

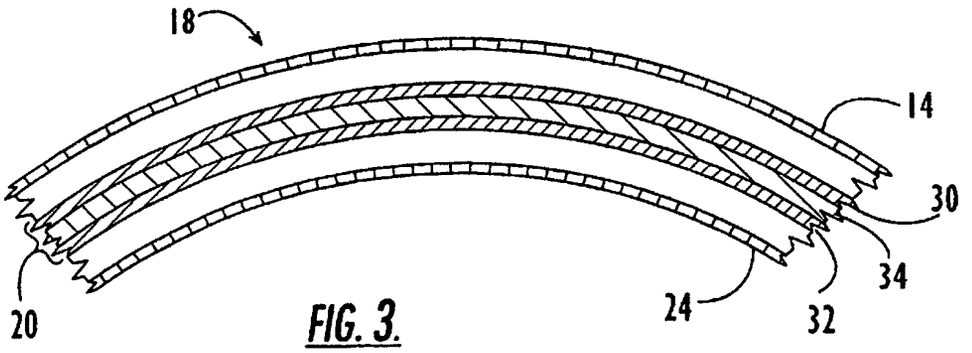

FIG. 3.

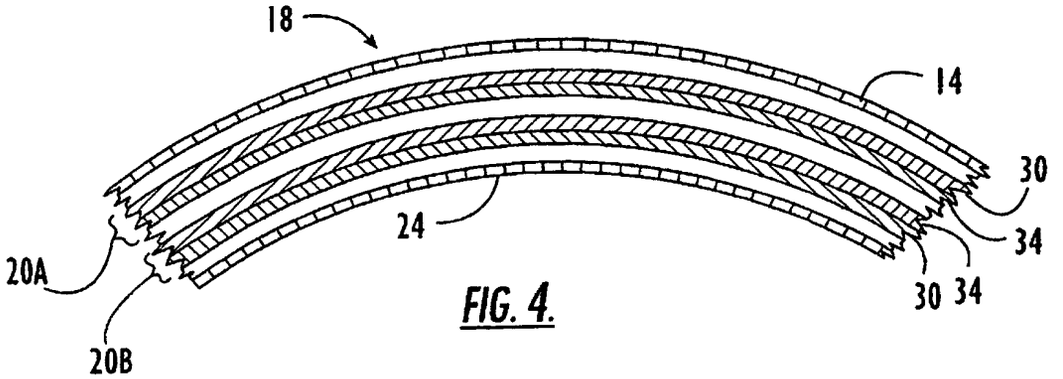

FIG. 4.

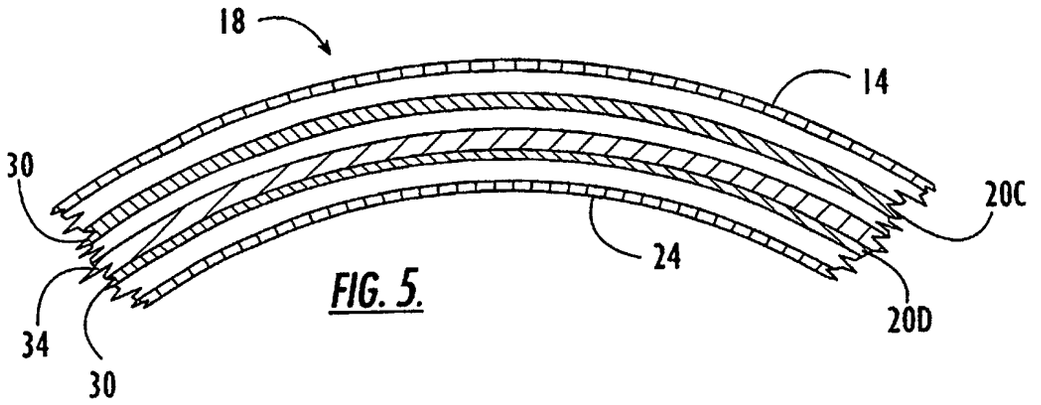

FIG. 5.

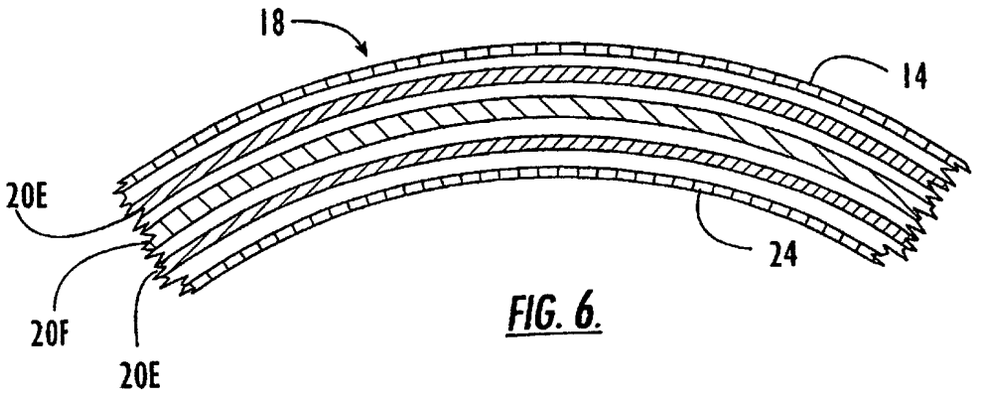

FIG. 6.