United States Patent

Stump

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[45] **Mar. 14, 1972**

[54] TUBULAR MEMBER

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[52] **U.S. Cl.** .....**229/49**, 138/177, 229/14 C

[51] **Int. Cl.**.....**B65d 5/50**, F16l 9/16

[58] **Field of Search**.....229/49, 14 C, DIG. 6, DIG. 1; 138/177

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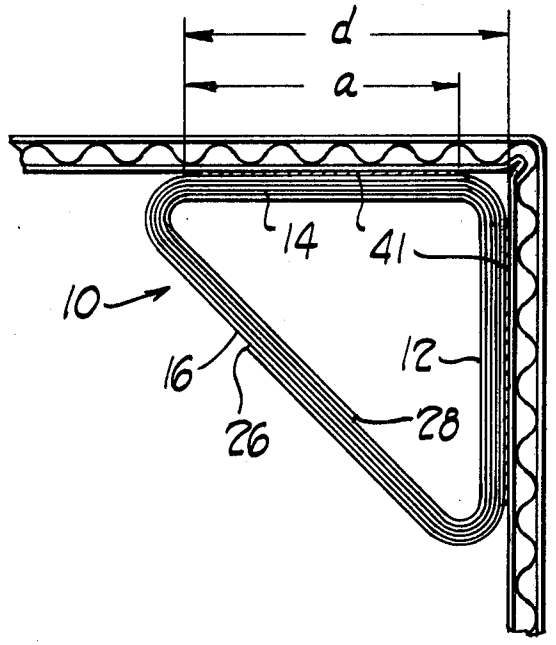
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[57] **ABSTRACT**

A tubular member with a cross section forming a three-sided figure, especially useful as a container reinforcement. The member is convolutely wound of fiber-containing sheet material and the fibers extend predominantly longitudinally of the member. When located in a corner of a box-like container or carton, the member provides substantial area contact with the container walls while occupying little volume and imparts a high degree of cubical rigidity to the container.

4 Claims, 7 Drawing Figures



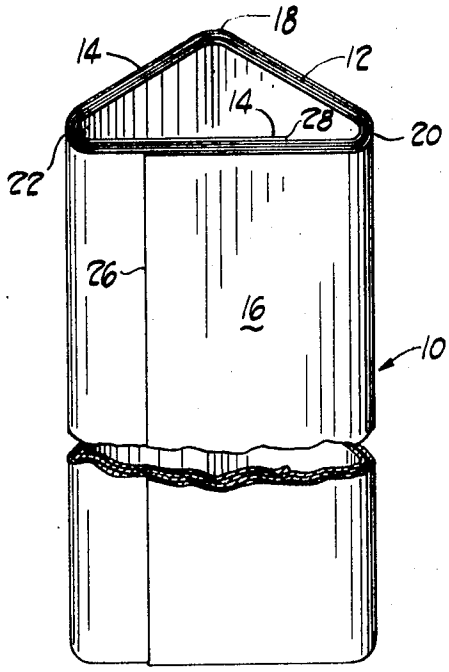


Fig. 1

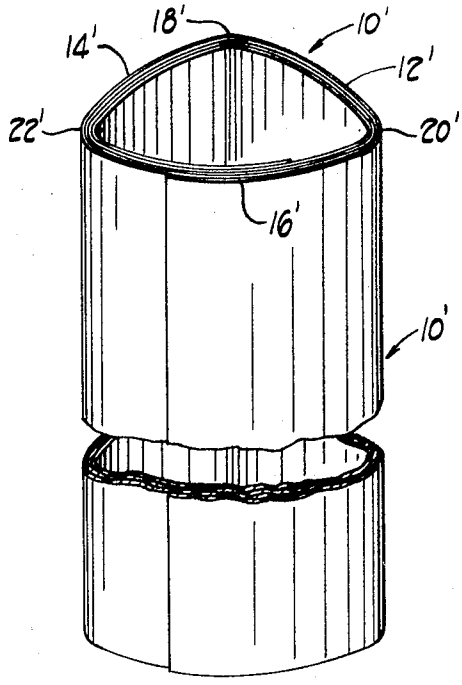


Fig. 2

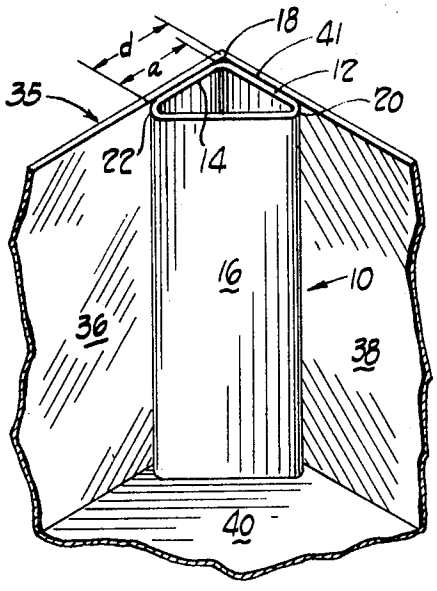


Fig. 3

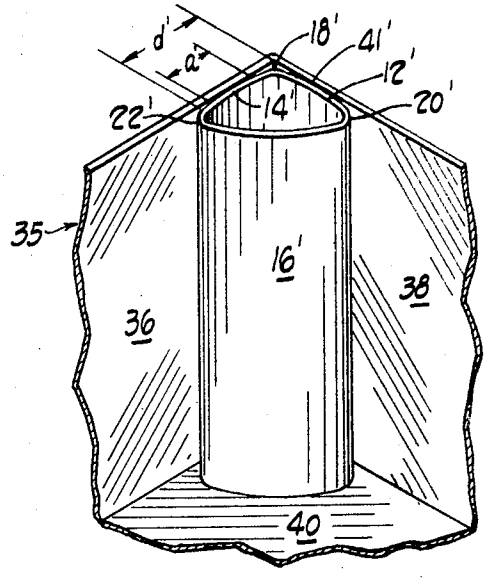


Fig. 5

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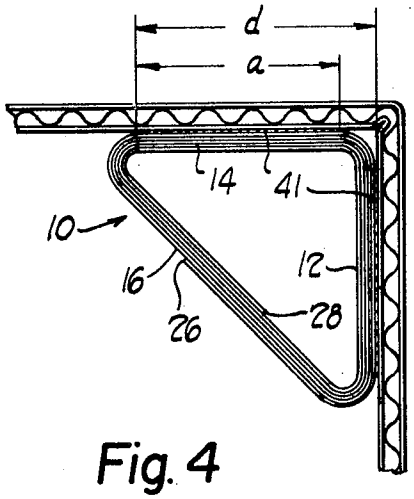


Fig. 4

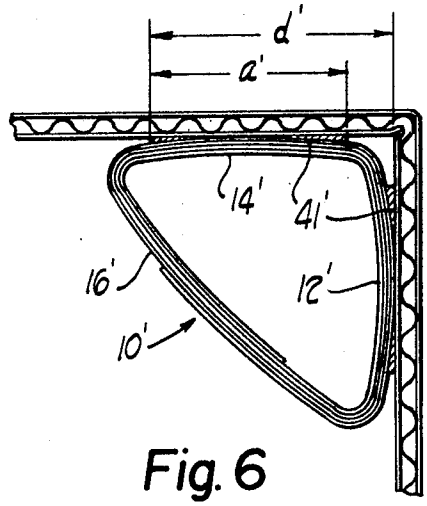


Fig. 6

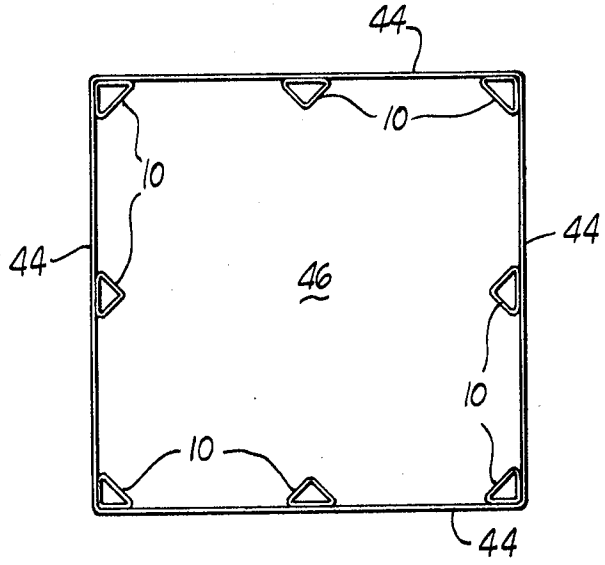


Fig. 7

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TUBULAR MEMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to tubular members and more particularly to three-sided tubular members especially useful in reinforcing containers, and to container constructions.

2. Description of the Prior Art

With many containers, especially corrugated or solid fiber boxes, the sidewalls often require reinforcement so that the container can withstand certain stresses and strains. For example, when containers are stacked one upon another and the containers rather than the contents must provide the support, the walls of the lowermost containers in a stack must bear substantial forces which tend to deform the sidewalls. If the walls are permitted to significantly deform, any fragile contents may suffer damage.

To increase cubical rigidity, wooden corner posts, corrugated or fiber posts or cylindrical tubes have been inserted in containers to provide reinforcement along particular coordinates. Wooden posts are becoming more costly and interfere in conventional scrap carton recycling, wherein containers are shredded for return to paper makers. Corrugated and fiber posts are often inadequate in strength, when large stresses are to be placed upon containers in which they are the primary reinforcement. This is because the typical shaping cuts reduce their load-bearing capacity. Cylindrical tubes, besides occupying peripheral storage space, contact containers only tangentially along the tube length and this minimal surface-to-surface contact provides little abutment strength even when adhered to the container walls for reinforcing a container in the coordinates transverse to such tubes.

SUMMARY OF THE INVENTION

The present invention embodies tubular construction of triangular cross section fabricated to gain improved strength and other desirable characteristics. Such construction are especially useful as reinforcing supports or columns for corrugated or other containers and, when adhered into the corners of cubical containers, integrate with the container walls to provide both axial and transverse strength against carton deformation. Advantageously, fiber laminae are bound into an integral wall, and the construction is essentially seamless, strong and light weight, and has sides more or less planar with a cross section approximately triangular—i.e., planar or psuedo planar sides forming a triangular or psuedo-triangular shape, so that the sides provide a large contact area for bearing against or adherance to a container wall. Such tubular constructions may be inserted singly at corners or applied along a wall, used intermediately between corners, or can be used singly or in multiples for central or other vertical reinforcement as well as transverse resistance to carton deformation. For most universal use, the tubular member is provided with a cross section in the shape of a right isosceles triangle so that it not only fits within corners of rectangular boxes, but also provides a surface of relatively large area forming the hypotenuse for use against a flat surface to be reinforced, as between the corners of a container.

Two factors that affect the cubical rigidity, both axial and transverse, provided by reinforcement columns in a container are the surface area contact between the reinforcing members and the walls of the container, and the distance that such contact extends from the corners. The greater the distance from the corner, the greater the moment of deformation resistance. In particular, a binding force is created by an adhesive or other bond established between the container and the amount of wall surface of the reinforcing member in frictional or adherent contact therewith that provides an integrated area factor affecting rigidity, and there is a moment arm factor due to the distance of the surface bonded from the corner as determined by the shape and dimensions of the reinforcing member. A tubular corner support of right triangular configuration has the advantage of occupying a minimum of usable

central carton space in a container having planar sides in relation to the wall surface contact area and moment arm length established by mutual contact between the tubular member and the container walls. For example, a square cross section with comparable corner contact surface occupies twice the usable carton area as a triangular support, while cylindrical supports afford only line or tangential contact with sides of a container. For a given central space sacrifice, the distance of such a tangential contact of a cylindrical support from the apex of the container corner is shorter than that of a triangular member and its integrated frictional force opposing transverse carton deformation is much smaller.

A further characteristic of the present tubular construction of right isosceles cross section is the somewhat greater degree of axial resilience afforded by the larger area of the hypotenuse side, as compared with tubular constructions of square or circular cross section. It is believed that this resiliency may relieve momentary impact stresses that otherwise would cause failure in a more brittle construction.

Triangular or psuedo-triangular tubular constructions embodying the present invention are most advantageously fabricated of axially oriented materials, e.g., materials with fibers predominantly oriented in one direction. This is best accomplished by convolutely winding a sheet or fabric of axially oriented material into a tubular shape, triangular in cross section, with the fibers of the material extending longitudinally. High axial compressive or tensile resistance is obtained in the finished member from the inherent strength of the fibers in their lengthwise direction. Paper made by a cylinder machine, such as reprocessed kraft paper, has fibers predominantly oriented in what is known as the "machine direction" of the paper, i.e., the direction in which the web of paper is produced from the cylinder of the paper making machine. The compressive strength of such webs is substantially different, i.e., greater, in the machine direction and the cross machine direction. This difference is advantageously employed to fabricate triangular tubular constructions by convolutely winding the paper shapes in a direction across the machine direction of the paper. Such fiber orientation, coupled with the inherently good plybond characteristic of cylinder machine paper, results in a paper strength in the machine direction that may be two to four times greater than in the cross direction. Other fiber-like materials having appropriate length-to-cross-sectional strength characteristics may offer strength advantages when used to construct triangular or psuedo-triangular tubular structures, but paper is advantageous because it has high strength, is relatively light, and is inexpensive.

A preferred corner support or reinforcing tube of triangular or pseudo-triangular shape embodying this invention is made of convolutely wound kraft paper with the paper fibers aligned transversely to the direction of winding. This support has especially good weight and strength characteristics and is relatively low in cost. The sheet material is coated or impregnated with an adhesive that adheres the layers or windings together and enhances the load bearing capacity of the finished article. A psuedo-triangular shape has the advantage over straight-sided structures of facilitating good adhesion and lamination while facilitating higher winding speeds by virtue of the slight wall curvature which tends to keep the sheet under tension during winding. At the same time, this shape maintains a relatively long moment arm and substantial area contact as compared with a tube of circular cross section.

Accordingly, an object of the present invention is to provide a novel and improved triangular or psuedo-triangular tubular structure having a high strength-to-weight ratio and which imparts a high degree of cubical rigidity to a container when used as a reinforcing element.

A related object of the present invention is to provide a novel and improved support for container constructions which provides substantial frictional or adhered area contact with a surface of a container and a long moment arm from the corners of the container, yet occupies little of the container space.

A further object is to provide a triangular or psuedo-triangular tubular structure formed with axially oriented materials such as fibers and the like extending longitudinally of the tubular structure and bonded together.

Another object of this invention is to provide a stiff, unitary triangular or psuedo-triangular tubular structure of convoluted sheet material, especially sheet material formed of fibers oriented predominantly longitudinally of the structure, with convolutions of the material bonded together.

One more specific object is to provide a right triangular or psuedo-triangular tubular structure of kraft paper convolutely wound across the machine direction of the paper and adhesively bonded to form an improved container reinforcing member.

These and other objects, features and advantages will become more apparent and a more complete understanding of this invention will be obtained from the following detailed description, when considered in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial detailed perspective view of a tubular member embodying the present invention;

FIG. **2** is a partial detailed perspective view of another tubular member embodying the present invention;

FIG. **3** is a partial perspective view of the member of FIG. **1** positioned in a corner of a container;

FIG. **4** is a partial plan view on an enlarged scale of the member and container of FIG. **3**;

FIG. **5** is a partial perspective view of the member of FIG. **2** positioned in the corner of a container;

FIG. **6** is a partial plan view on an enlarged scale of the member and container of FIG. **5**; and

FIG. **7** is a plan view of a container with members embodying the present invention in corners and at positions intermediate the corners.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the drawings, the invention is embodied in a preferred form by the elongated tubular member **10** of generally triangular cross section and most advantageously includes two flat side portions **12, 14** of equal dimensions in perpendicular planes, a third side portion or hypotenuse **16** connecting the sidewall portion, and curved integral corner portions **18, 20, 22** at the junctures of the three side portions. In cross section, then, the member **10** is in the shape of a right isosceles triangle with rounded corners. The rounded corner portions **18, 20, 22** avoid weakening the tubular member at the junctures of the flat sides, facilitate the forming of the member **10**, which may be accomplished by rapidly winding a sheet of material about a triangular-shaped mandrel, and facilitate close contact and a good bond between the windings at the corners. To assure these advantages, the corner portions **18, 20, 22** should preferably have a radius of curvature at least one-tenth the distance between the corner portions **20, 22**, adjacent the largest side wall **16** when the member is fabricated by winding paper or the like about a mandrel. By way of illustration, the radius of curvature of the corner portions **18, 20, 22** of a triangular-shaped tube convolutely wound of paper is at least one quarter inch when the distance between the corner portions **20, 22** measured along the inner surface of the sidewall **16** is two and one-half inches. By way of example only, a typical member convolutely wound of kraft paper and suitable for use as a container support column may have two flat sides of 2¼ inches in length joined at a corner by a curved portion of three-eighths inch radius, a hypotenuse side with a flat surface about 3¼ inches in length joined at corners to the other sides by curved portions of three-eighths inch radius, a length of 60 inches, and a wall thickness of three-eighths inch.

The member **10** is composed of axially oriented sheet material having fibers of high compressive strength contribution predominantly aligned longitudinally of the finished tubular member. When the sheet is wound into tubular form about a mandrel, rounded mandrel corners facilitate the attainment of better between-ply lamination and prevent creasing and weakening of the material, which could occur if the corners of the mandrel had sharp angles. As a result, it is possible to use material of lower tensile strength and wind at higher speeds without weakening the material. For added strength, the fiber material layers are bonded together with adhesive and/or impregnated with a hardening material, such as an adhesive or resin. In the embodiment shown, the support member **10** is formed of paper, such as reprocessed kraft paper formed on cylinder machines. This is low in cost and has fibers that extend predominantly in one direction, which corresponds to the longitudinal extent of the web of paper as formed and which is referred to as the "machine direction" of the paper. The paper is in a single sheet, or a lamination of multiple plies, or more than a single sheet, coated with an air drying adhesive or chemically linking thermoplastic or thermosetting resin and is convolutely wound to provide a plurality of layers, typically **8** to **11** layers in one preferred embodiment. The outer end of the sheet is shown at **26** and the inner end at **28**. The paper is wound across the machine direction so that the fibers of the paper extend predominantly along the length of the member. In the preferred embodiment at least the outer end of the sheet forming the member **10** is skived, i.e., tapered in thickness, and is quite flexible, allowing it to lie flat against the underlying layers until the adhesive sets. This facilitates manufacture and permits the use of thicker paper which otherwise could not conveniently be used because the end of the sheet would spring up from the wound member. The thicker paper facilitated by the skived end permits a strong tubular member to be wound with fewer windings, increasing the speed of production and reducing costs.

The member **10** as shown in FIG. **1** may be manufactured by winding sheet material on an elongated mandrel. Most advantageously the member is wound initially to a triangular shape, which is more difficult than winding a cylinder, but which provides a much stronger support than one which is shaped after winding. The sheet material to be wound is as wide as the desired length of the member **10** and is convolutely wound under tension upon the mandrel. The inner end **28** is placed on the mandrel and the mandrel is rotated about its longitudinal axis. A number of layers are wound (depending upon the thickness and strength of the material and the ultimate strength desired in the finished product) and the outer end **26** is adhered in place. Alternatively, a continuous web can be used and cut after the support is wound. However, in forming the preferred embodiment from commercially available kraft paper manufactured on cylinder paper machines, a sheet of paper must be cut from the web or roll of paper, as supplied, to the length of the support desired. While this is inconvenient, it permits winding the paper transversely to the machine direction, which is along the web, resulting in a tubular member having superior strength over a member wound directly from a web. The cut sheet material is coated with an adhesive and then wound in the direction across the web. If the sheet material is pre-coated or already impregnated with an adhesive, the coating step is oriented.

A modified form of the triangular-shaped structure of FIG. **1** is shown in FIG. **2** and indicated generally by reference numeral **10'**. The tubular structure **10'** is psuedo-triangular in cross section but otherwise of identical construction to the member **10** and corresponding parts are identified with similar reference numerals with a prime designation. The structure is psuedo-triangular in that the side portions **12', 14', 16'** are slightly curved rather than straight, yet the structure is a three sided member of generally right triangular configuration constructed to fit within a corner of a rectangular box. The slight convex curvature, as shown, facilitates convolutely winding the structure from sheet material at a rapid rate while constantly maintaining a tension on the material. It will be appreciated that a psuedo-triangular shape with concave sides can be formed by winding a triangular tube and post-forming it. Good corner bearing moments can be attained with such a shape, but fabrication is more complex.

With a structure having flat sides, the tension on the sheet material being wound is maintained by the pull exerted through contact at each corner of the winding mandrel or preceding layer since, theoretically at least, there is no contact between the sheet material and the flat side until rotation brings the next adjacent corner into contact with the material, at which time that corner then exerts a tension or pulling force due to its effective lever arm length from the central axis of the winding mandrel. Thus, there is relatively little force urging adjacent layers into intimate contact along the flat sides of the structure and the rate at which the rotating mandrel, conventionally driven at a constant angular speed, demands sheet material is extremely non-uniform, making it difficult to maintain winding tension as material is placed on the flat sides. The slight convex curvature of the sides **12'**, **14'**, **16'** causes the location that exerts tension on the sheet material as the structure is wound to progressively move from each successive corner across a side of the structure to the next corner in a rolling action. This not only makes higher winding speeds and more uniform tension possible by creating a more uniform demand for sheet material during winding, it also assures that each layer will be pressed against the preceding layer at all points about the periphery of the structure. At the same time, as long as the radius of curvature is maintained relatively large, e.g., at least as great as the distance from corner portion to corner portion of the respective side portion, the area contact and distance of such contact from a corner of a container will remain relatively large as will be described subsequently in connection with FIG. **4**.

The tubular structures **10** and **10'** are advantageously used to reinforce rectangular cardboard containers to increase the cubical rigidity and to bear the compressive load when containers are stacked. FIGS. **3** to **6** illustrate the manner in which these structures are secured in each corner of a container to provide large area contact with the container wall and long moment arms while occupying only a small part of the internal volume of the container.

A partial, corner portion, of a box-type container **35** is shown in FIGS. **3** and **4**, for example, a corrugated cardboard box or carton. Two sidewalls **36**, **38** a bottom **40** and top (not shown) are all mutually perpendicular. The tubular member **10** of a length essentially equal to the height of the sidewalls **36**, **38** is located at the juncture of walls **36**, **38** and abuts the bottom **40**. Side **12** of the member **10** is against sidewall **38** and side **14** is against sidewall **36** and are adhered over the contacting area, as by a suitable adhesive indicated at **41**. Alternatively, staples or other fastening means can be used to adhere the member to the sidewalls. The area of surface contact of both side portions **12**, **14** extends along the entire height of the tubular member and along the entire width of each side portion, as indicated at *a* in connection with side portion **14**. The length of the moment arm that resists distortion of the mutually perpendicular relationship of the container walls **36**, **38** and bottom **40** is represented at *d*, which is the distance along the walls **36**, **38** from their juncture to the farthest point of adherence between the respective wall and the reinforcing member **10**. Both distances *a* and *d* are about equal in the member **10** and, except for the rounded corner portions **18**, **20**, **22**, have been maximized by the triangular cross sectional shape of the tubular member with respect to the volume occupied and the periphery of the member. Because the cubical rigidity is a direct function of the integrated moments of the resistance, which is the summation of the products of the distances on the support from the carton wall intercepts and the adhesive strength per unit area, maximum transverse reinforcement is achieved with the triangular-shaped tubular member **10**.

The same box **35** is shown in FIGS. **5** and **6** with the psuedo-triangular-shaped tubular member **10'** located at the juncture of walls **36**, **38**. Because of the slight curvature of the side portions **12'**, **14'**, the contact area between the member **10'** and the container walls **36**, **38** is somewhat less than that between the walls and the member **10**, as indicated by the shorter length *a'* in FIGS. **5** and **6**. A substantial area of mutual contact is created, notwithstanding the curved side portions **12'**, **14'** by distortion of the container wall portions that abut the member **10'**. As compared with a flat-sided member **10**, some area contact is lost adjacent the corner portions **18'**, **20'**, **22'** due to the curvature of the side portions **12'**, **14'**, yet the contact area is adequate to assure a strong bond as with an adhesive **41'**. The curvature of the side portions **12'**, **14'** has a lesser effect upon the effective moment arm length *d'* of the member **10'** because the length of the moment arm is diminished only by the decreased contact adjacent the corner portions **20'**, **22'** and not by the decreased contact adjacent the juncture of the container walls **36**, **38**. As compared with a tubular member of cylindrical cross-sectional shape of similar perimeter or area, this psuedo-triangular construction **10'** provides substantially increased contact area and effective moment arm length, yet occupies less usable space in the container. At the same time, it facilitates rapid winding when fabricated from sheet material. Moreover, the effective moment arms of the psuedo-triangular-shaped member can be increased either by effective cementing with a self-adhering filling adhesive, or by stapling or mechanically attaching the support to the container wall at points beyond the closest contact of the curved side of the support, i.e., further away from the apex of the triangular member. It will be apparent that a psuedo-triangular-shaped member having concave sides will have somewhat less area contact with the container walls than a triangular member but will maintain a maximum moment arm length.

Another manner in which tubular members **10** can be used to reinforce a container is shown in FIG. **7** in conjunction with a box **42** with a base or bottom wall **44** and perpendicular sidewalls **46**. Four members **10** are located at the inside corners formed by the sidewalls **46** and four additional members are located one adjacent each wall **46** intermediate the corners. For optimum strength, the largest sidewall **16** of each of the four additional members **10** bears against the associated sidewall of the container **42** to maximize the area of mutual contact. In addition, the smallest dimension, i.e., the altitude or distance of the triangular-shaped cross section from the wall **16** to the corner portion **18**, extends inwardly and thus the usable space of the container occupied by the member is kept small. The four additional members can also afford protection to many objects inside the container by acting as a "stand-off" or cushioning spacer between the object and the carton wall.

While in the foregoing disclosure preferred embodiments have been described in detail, certain modifications or alternations within the spirit and scope of the invention will be apparent to those skilled in the art.

What is claimed is:

1. In combination, a generally rectangular box-like container, an elongated three-sided tubular reinforcing member in a corner of said container in intimate contact over a substantial area along two sides with inside surfaces of two angularly related container walls forming said corner, and means securing said two sides of said member to said two angularly related walls at locations laterally outward from said corner, said member being substantially right isosceles triangular in cross section and comprised of convoluted fiber-containing sheet material in which the fibers extend predominantly longitudinally of the member and the convolutions are bonded together with a hardenable bonding material.

2. In combination, a generally rectangular box-like container, an elongated three-sided tubular reinforcing member in a corner of said container in intimate contact along two sides with inside surfaces of two angularly related container walls forming said corner, and means securing said member to said two angularly related walls; the three sides of said member being outwardly curved transversely of their length, corner portions at junctures of said sides being integral therewith and rounded, and said member being comprised of convoluted fiber-containing sheet material in which the fibers extend predominantly longitudinally of the member.

3. The combination as set forth in claim 2, wherein said member is substantially right isosceles triangular in cross section and in which the convolutions are bonded together.

4. The combination as set forth in claim 3, including an additional elongated three-sided tubular reinforcing member located against a container wall, intermediate to the corner portions of the container and parallel to the first said member, with a side of said additional member being secured against the container wall.

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