

Cardboard-based Unit

TECHNOLOGICAL FIELD AND BACKGROUND

The present invention relates to units substantially or entirely made of cardboard that may be used as structural elements in structures and devices such as wheeled devices (e.g. bicycle or tricycle).

WO11067742 discloses a human-powered land vehicle sufficiently rigid so as to transport a human rider. The vehicle is constructed from pulpably recyclable and shreddably recyclable materials.

GENERAL DESCRIPTION

The present invention provides a structure made from or comprising cardboard as its major component. This means that cardboard constitutes typically at least 80%, 85%, 90%, and at times even at least 95% of the total weight of the structure. The structure comprises, as will be illustrated below, reinforcing, elongated members that may be made of cardboard, e.g. may be cardboard cylinders or rods; or may be made of other light materials, such as wood or plastic. The elongated members are wholly or partially enveloped (or wrapped) by portions of a cardboard panel that are formed to be in tight association with said elongated members throughout all or at least a major part of the length of said members. Some other portions of the cardboard panel are associated with one another to define a multi-layer cardboard element. Said elongated members with the associated portions of the cardboard panel jointly form a core-envelope element. The core-envelope element may be situated at and define edges of a multi-layer planar element, which may serve as functional element in its own right, it may have a structural reinforcing significance, etc. One of the unique features of the unit of the invention is the overall rigidity imparted, at least partially, and at times primarily, by said elongated core-envelope elements, as will also be explained further

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below. The structure of the invention may constitute a part of a device, such as a wheeled device, e.g. parts of a bicycle or tricycle.

The invention provides a cardboard-based unit comprising one or more substantially planar elements, each comprising two or more layers of cardboard that are closely associated with one another and being constituted by a formed cardboard panel having a first and second faces. The unit also comprises at least two core-envelope elements, each comprising enveloping portions of the panel that are wrapped about two or more elongated members such that the panel comes into tight association with said members. These elements in the unit are integral with one another.

Generally, the term "*elongated*" means that the element has a length dimension that is significantly more prominent than other measurements of the element. Such an element may generally have the structure of an elongated element as disclosed in concurrently filed and co-owned PCT application that is entitled "structural element comprising cardboard" and that claims priority from two US provisional applications Serial Numbers 61/715,359 and 61/787,229 (hereinafter: "the structural element PCT application"). One or both of the panel portions embracing the elongated member (referred to therein as the "rectangular sub-structure") is integral with panel portion that forms other parts of the structure.

The term "*cardboard panel*" means a planar or substantially planar cardboard piece with a broad surface that is substantially thin as compared to its length and width. The cardboard panel may be a uniform cardboard piece but may also, for example, be made of two or more planar cardboard pieces glued or otherwise adhered together to form a larger cardboard panel that is formed into the unit's different elements.

The term "*formed*" (or any of its linguistic variations) means to denote the act of giving form or shape to the cardboard panel, namely forming the panel into a final intended shape in the unit. Such forming comprises, for example, wrapping a portion of the panel over the elongated member to thereby obtain the core-envelope structure of the so-formed elongated element. Such forming may also comprise, in some embodiments, defining voids in said planar element.

The term "*integral*" means that the panel portions that are used in the formation of the different elements are all portions of a single, formed panel. Thus, for example, in the case of a panel portion that is enveloping the elongated member, defining two skirts of the panel extending from an apex defined along the elongated member, at least one or

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both of the skirt portions of the panel extends into other portions of the panel that define one or more other elements of the unit.

One or more of the cardboard unit's elements comprise portions of two or more layers of cardboard that are closely associated with one another (e.g. attached to one another by gluing or other adhering means) and constituted by a formed cardboard panel having a first and second faces. As noted, portions of the panel are wrapped about two or more elongated members such that the panel comes into tight association with said members to thereby define said elongated, core-envelope elements. The elongated core-envelope element, formed through the association between the elongated member and the enveloping cardboard panel, may impart an increased rigidity and bend resistance to the cardboard structure, as compared to rigidity and bend resistance of a similar cardboard structure that does not include such elongated core-envelope elements. Said elongated core-envelope element may define an edge of a planar multi-layer (e.g. bi-layer) cardboard unit. Typically, two such elongated core-envelope elements define edges of a substantially planar element that extends therebetween.

The elongated members (which, as noted above, may be made of cardboard, wood or plastic) typically have a rounded shape, e.g. circular cross-section (although at times it may be oval, elliptical, etc.); and accordingly said elongated core-envelope elements are typically rounded, although they may be shaped by the use of appropriate dies into other shapes, e.g. to have a rectangular external cross-sectional shape.

The invention embodies some features, common with those of the structural element PCT application as well as of another concurrently filed and co-owned PCT application that is entitled "cardboard-based structure" and that claims priority from US provisional application 61/787,292, the relevant contents of which being incorporated herein by reference.

The cardboard-based unit of the invention has a 3- or 4-point bending strength normal to said elongated core-envelope elements that is significantly larger than that of a bi-layer cardboard structure devoid of such elongated core-envelope elements. The term "*significantly larger*" means that it is at least two, five and, at times, at least 10-fold larger than that of either the reinforcing members or the regular bi-layer cardboard structure, one without the elongated members. Some explanations and parameters concerning this bend resistance can be found in the structural element PCT application,

the contents of which, as noted above, are incorporated herein by reference for the relevant portions thereof.

The cardboard panel may be of a kind comprising (i) at least one low-density layer made of paper, heavy duty paper or cardboard (for ease of reference the term "*paper*", will be used hereinafter to refer collectively to paper, heavy duty paper or cardboard) arranged to define a plurality of cells or voids, e.g., formed by corrugated, fluted or otherwise loosely packed paper sheets or strips that define a plurality of voids therebetween, and comprising (ii) one or more liner cardboard sheets lined at one side or both sides of the low-density layers (namely sandwiching the low-density layer between them). Examples of such cardboard panels are such known as "*corrugated cardboard*", which consists of a fluted or corrugated paper panel(s) or strip and one or two flat linerboards at one or both (i.e. sandwiching) sides of the fluted or corrugated paper; and may also be such referred to as "*honeycomb cardboard*". Such materials are widely used in the manufacture of boxes and shipping containers. The corrugated or honeycomb cardboard panels may be single-walled or multi-walled cardboard panel. These terms are also meant to encompass heavy-duty cardboard of various strengths, ranging from a simple arrangement of a single thick panel of paper to complex configurations featuring multiple corrugated, honeycomb and other layers.

By one embodiment, the cardboard-based unit comprises two first elongated core-envelope elements that are parallel one to the other, being formed with corresponding parallel elongated members. Such first elongated core-envelope elements define edges of a first, planar element that extends therebetween. The first elongated core-envelope elements are associated to corresponding first parallel elongated members. Said first elongated members may separate each between a central segment of the original cardboard panel and one of first or second segments that flank the central segment; the two segments once a portion of the panel is wrapped over the elongated members to jointly form a two-layer element.

According to one embodiment, one or more portions of the first face of a first flanking segment are attached to one or more portions (opposite in the formed structure) of the first face of the central segment. By another embodiment, one or more portions of the first face of a first flanking segment and one or more portions of the first face of the second of the two flanking segments are both attached to corresponding portions of the first face of the central segment.

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At least two parallel elongated members according to the embodiments defined in the previous paragraph are associated with the first face of the panel. The structure is typically formed such that opposite edges of the original panel, which are the edges at the end of the flanking segments, are proximal to one another. In this manner a closed loop structure is formed by the panel, with the first elongated core-envelope elements defining the extreme ends of such a loop.

By another embodiment, rather than forming a closed loop structure, a cardboard panel is folded into a form generally resembling an “S” shape with oppositely oriented folds. In such a configuration, one or more portions of a first face of the first flanking segment is attached to corresponding one or more portions of the first face of the central segment; while one or more portions of the second face of the central segment is attached to corresponding one or more portions of the second face of the second flanking segment. In this configuration, the elongated members within the first parallel elongated core-envelope elements are associated one with the first face and the other with the second face of the panel.

By one embodiment such a planar cardboard piece is substantially rectangular in form with a complete cardboard multi-layer structure over the entire surface. In another embodiment, one or more voids in this planar cardboard element are defined, e.g. through cut-outs from the multi-layer cardboard element or through appropriately forming of the original cardboard panel, which may have decorative or functional significance.

In accordance with one embodiment, the cardboard-based unit comprises one or more integral second elongated, core-envelope elements (formed by a portion of the cardboard panel that is wrapped about an elongated member oriented normal to said first elongated core-envelope elements).

In accordance with some embodiments, the cardboard-based unit is part of a wheeled device, such as a bicycle or tricycle. A unit of such embodiments may comprise a planar element formed between parallel, first, elongated elements configured for attachment to (i) a front wheel and (ii) one or more other parts of the bicycle or tricycle and comprises a second elongated element normal to the first ones and integral with the planar elements, and being configured as a handlebar of the bicycle or tricycle. The planar piece is typically configured with voids that have the function of association with (i) a front wheel and (ii) one or more other parts of the bicycle or tricycle.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1A is a schematic representation of the manner of production of a cardboard-based unit according to an embodiment of the invention.

Figs. 1B and 1C show, respectively, a schematic perspective view and a view from above, of the so formed unit.

Figs. 2A is a schematic representation of the manner of production of a cardboard-based unit according to another embodiment of the invention.

Figs. 2B and 2C show, respectively, a schematic perspective view and a view from above, of the so formed unit.

Fig. 3A is a schematic illustration of the manner of production of a cardboard-based unit according to a further embodiment of the invention.

Fig. 3B shows a cardboard-based unit according to that embodiment.

Fig. 3C shows a side view of the unit of Fig. 3B.

Fig. 4 shows a front view of a cardboard-based unit according to another embodiment of the invention, which is similar in overall shape to that of Fig. 3B, with some functional cut-outs.

Fig. 5A is a front view of a cardboard panel with marked segments to be cut-out prior to forming of the cardboard-based unit according to another embodiment of the invention.

Fig. 5B shows the panel of Fig 5A with segments cut-out and after positioning of the elongated members.

Fig. 5C shows a front view of the cardboard-based unit formed from the panel of Fig. 5B.

DETAILED DESCRIPTION OF EMBODIMENTS

The invention will now be illustrated below with reference to a number of embodiments, schematically represented in the attached drawings. In the description

below, Fig. 1 (namely 1A, 1B and 1C) relate to one embodiment, and each of Figs. 2, 3, 4 and 5 relate to different embodiments. The different components of these embodiments are each indicated by a three digit numeral, the first digit given according to the figure in which they appear (for example, in Figs. 1 the numerals all begin with “1”; whereas in Figs. 2 with the numeral “2”); while the last two digits are specific for the component. In different figures like components are indicated by a three digit numeral having the same last two digits. By way of example, component 102 in Figs. 1A and 1B is like (having similar function to) component 202 in Figs. 2A and 2B. Such like components may not be described each time and the reader is directed to look into the description of the corresponding component in other embodiments.

It should be noted that for the purpose of illustration, some dimensions were drawn out of proportion. By way of example, in some figures a cardboard panel is shown, from which a cardboard-based unit is produced. The panel is shown to have a thickness that is out of proportion of the thickness of at least some of the actual panel to be used in accordance with the invention. The out of proportion thickness is for illustration purposes only as had it been drawn to proportion, it may have been more difficult to view it in the drawings.

Reference is first being made to Fig. 1A showing a cardboard panel 100 associated with two elongated members 102, 104 positioned on corresponding parallel lines 106, 108, on a first face 140 of panel 100, equidistant from respective opposite edges 110, 112 (lines 106,108 are imaginary lines that do not exist in the actual panel). Elongated members 102, 104, that are parallel to one another, separate between respective flanking portions 114, 116 and a central portion 118 of the panel.

In order to form a cardboard-based unit according to an embodiment of the invention, panel 100 is folded along lines 106, 108, as represented by arrows 106A, 108A such that portions thereof 120, 122 along and flanking lines 106, 108 wrap around and envelope tightly the elongated members 102, 104, such that in the eventually formed unit, as seen in Figs. 1B and 1C, portions 114, 116 are tightly associated at their first face, e.g. through use of adhesive, with the first face of portion 118.

In the formed unit shown in Figs. 1B and 1C, two elements can be identified: two parallel, elongated, core-envelope elements 130, 132 that define edges of the unit with a planar bi-layer element 134 extending therebetween. Also, in this embodiment, panel edges 110, 112 are brought into close proximity with one another. In this way, the

formed cardboard panel defines a closed loop configuration about the two elongated members.

The elongated members 102, 104 in this embodiment and those described below have a circular cross-section. In some embodiments they may have other round cross-sections, e.g. elliptical, oval.

The elongated, core-envelope elements 130,132, as also the other elongated, core-envelope elements in the embodiments described below, have rounded edges which are a result of the forming process. However, through the use of appropriate dies or molds, the edges may be press-formed to have other forms, e.g. rectangular. The cardboard panel may, by one embodiment, be a corrugated or honeycomb cardboard panel. However, the invention is not limited to cardboard panels of this type.

Reference is now being made to Figs. 2A-2C which illustrates a unit according to another embodiment (Figs. 2B and 2C) and the manner of forming such a unit (Fig. 2A). As distinct from the embodiments of Figs. 1A-1C, according to those of Figs. 2A-2C the cardboard panel is formed into a shape resembling an "S", rather than a closed loop.

In describing the embodiments of Figs. 2A-2C, in order to facilitate description, reference will be made to two opposite faces of the panel designated as a first face 240 and a second opposite face 242.

As can be seen in Fig. 2A, elongated member 202 is associated with first face 240 (positioned along line 206 parallel to edge 210) and elongated member 204 (parallel to elongated member 202) is associated with the second face 242 (positioned along line 208 parallel to edge 212).

As illustrated in Fig. 2A, lines 206, 208 define three portions of substantially the same widths, including two flanking portions 214, 216, and a central portion 218. The panel 200 is formed by folding it along line 206 in the direction represented by arrow 206A and in the opposite direction along line 208 in the direction represented by arrow 208A. Eventually the so-formed cardboard-based unit, seen in Figs. 2B-2C has two parallel, elongated, core-envelope elements 230, 232 at opposite ends of an overall substantially planar 3-layer element 234.

In the two embodiments of Figs. 1A-2C, as previously described, parallel elongated members 102, 104 and 202, 204 (corresponding to elongated core-envelope elements 130, 132 and 230, 232) extend the entire length of the original cardboard panel

and hence along the entire length of the formed cardboard-based unit. However, in some embodiments, such members may extend only the partial length, typically the majority of the length of the panel. According to another embodiment, rather than a single elongated member in said elongated, core-envelope element, two or more elongated members, arranged along the same axis, may be comprised within the elongated elements. In other words, the elongated member, in this case, is defined by a number of individual segments that may all be of the same or a different length. Such segments may be positioned such that an end of one is position adjacent an end of another; or such segments may, at times, be spaced apart from one another. The different segments may be made of the same or a different material. While such segments will typically have the same cross-sectional shapes, they may, at times, have different cross-sectional shapes.

Another cardboard-based unit and the manner in which it is formed are shown in Figs. 3A-3C, which has a somewhat more complex design than that of the preceding illustrated embodiments.

Turning now to Fig. 3A, a cardboard panel 300 and three elongated members 302, 304, 350 can be seen. Elongated members 302, 304 are situated parallel to one another and to edges 310, 312, along lines 306, 308; and elongated member 350 is positioned parallel to edge 358, namely, oriented normal to elongated members 302, 304. Cardboard panel 300 is cut along lines 306B, 308B which extend parallel to edge 358 from respective edges 310, 312 to respective lines 306, 308.

The flanking portions 314, 316 defined between lines 306, 308 and respective cuts 306B, 308B are folded in the direction of arrows 306A, 308A, in a similar manner to that described with respect to Fig. 1A, to eventually form, in the unit shown in Fig. 3B, a vertical structure 370 with a bi-layer element defined between two parallel, elongated core-envelope elements 330, 332 at the edges thereof. The top portion 354 of the cardboard panel, defined between lines 352 and edge 358, is then folded along line 352 and over elongated member 350 in the direction of arrow 352A to form a transverse elongated, core-envelope element 372. As can best be seen in Fig. 3C, the cardboard panel portion extending down from element 372 is integral with the central portion of the panel in structure 370.

Turning now to Fig. 4, showing a cardboard-based unit according to another embodiment of the invention, having the overall shape as that shown in Figs. 3B and

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3C. As can be seen, the unit in Fig. 4 differs from that of Fig. 3B by having two cut-outs voids 476, 478 that may be cut-out after forming the unit of Fig. 3B. The unit may serve as a front element of a tricycle in which cut-out 478 accommodates a front wheel of a tricycle, the wheel received through axle holders embedded in the bottom part of element 470 (not shown in this Fig. but will be illustrated further below); while cut-out 476 is articulated to the rear part of a tricycle via a vertical axle receptacle embedded in element 470 (not shown but will be illustrated in Figs. 5B and 5C).

In some distinction from unit of Fig. 4, the cutouts may also be pre-formed in the panel. This is illustrated in Fig. 5. The cardboard panel 500 seen in Fig. 5A has an overall rectangular shape, but several pieces thereof, drawn as shadows, are cut out to yield the pre-formed panel shown in Fig. 5B.

Similar as in the case of Fig. 3A, elongated members 502, 504 are positioned along parallel, vertical lines 506, 508 and another elongated member 550 is positioned along line 552 normal to lines 506, 508. Short axle receptacles 580, 582 are placed close to the bottom end of portions 518A, 518B, defined at the two sides of the cut-out 578, which are typically hollow plastic tube segments for receiving respective ends of the axles of the front wheel of a tricycle. Also placed at the cardboard's first face are two vertical segments 584, 586, which may be also hollow plastic tubes, and serve for articulation to the main body of a tricycle. The pre-formed panel is then folded about the elongated member in the direction represented by arrows 506A, 508A and 552A and then, after adhering opposite cardboard faces to one another, the cardboard-based unit shown in Fig. 5C is formed.

CLAIMS:

1. A cardboard-based unit, comprising
one or more substantially planar elements comprising two or more layers of cardboard that are closely associated with one another and being constituted by a formed cardboard panel having a first and second faces; and
at least two core-envelope elements comprising enveloping portions of the panel that are wrapped about two or more elongated members such that the panel comes into tight association with said members;
the planar elements and the core-envelope elements in the unit are integral with one another.
2. The unit of claim 1, wherein the cardboard layers in said planar elements are attached to one another at portions thereof.
3. The unit of claim 1 or 2, wherein said elongated members have a rounded cross-section.
4. The unit of claim 3, wherein said elongated members have a circular cross-section.
5. The unit of any one of the preceding claims, wherein said elongated members are made of wood, cardboard or plastic.
6. The unit of any one of the preceding claims, wherein said cardboard panel comprises (i) at least one low-density layer and (ii) one or more liner cardboard sheets lining at least one side of the at least one low-density layer.
7. The unit of claim 6, wherein the at least one low-density layer comprises paper, heavy duty paper, corrugated cardboard, honeycomb cardboard, or cardboard arranged to define a plurality of cells or voids.
8. The unit of any one of the preceding claims, wherein said elongated core-envelope elements impart an increased rigidity and bend resistance to the cardboard unit.
9. The unit of any one of the preceding claims, wherein said elongated core-envelope elements define edges thereof.
10. The unit of claim 9, wherein said edges have a rounded external cross-sectional shape.

- 11.** The unit of any one of the preceding claims, comprising two of said elongated core-envelope elements parallel one to the other.
- 12.** The unit of claim 11, wherein the two parallel elongated core-envelope elements define edges of a substantially planar structural element that extends therebetween.
- 13.** The unit of any one of the preceding claims, wherein the elongated members separate each between a central segment and first and second flanking segments of the panel flanking opposite sides of the central segment.
- 14.** The unit of claim 13, wherein one or more portions of the first face of said first flanking segment are attached to one or more portions of the first face of said central segment.
- 15.** The unit of claim 13 or 14, wherein
one or more portions of the first face of said first flanking segment and one or more portions of the first face of said second flanking segment are attached to corresponding portions of the first face of said central segment.
- 16.** The unit of claim 14 or 15, wherein the elongated members are associated with the first face of the panel.
- 17.** The unit of any one of claims 13-16, wherein opposite edges of the panel, at the end of said flanking segments, are proximal to one another.
- 18.** The unit of claim 13 or 14, wherein
one or more portions of the first face of said first flanking segment are attached to corresponding one or more portions of the first face of said central segment, and
one or more portions of the second face of said second flanking segment are attached to corresponding one or more portions of the second face of said central segment
- 19.** The unit of claim 18, wherein
one of the parallel elongated members is associated with the first face of the panel, and
the other of the parallel elongated members is associated with the second face of the panel.
- 20.** The unit of any one of the preceding claims, wherein said planar element comprises one or more voids.

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- 21.** The unit of any one of claims 11-20, comprising one or more integral second core-envelope elements oriented normal to said parallel elongated core-envelope elements.
- 22.** The unit of any one of the preceding claims, being part of a wheeled device.
- 23.** The unit of claim 22, wherein the wheeled device is a bicycle or tricycle.
- 24.** The unit of claim 20 or 21, having the following characteristics:
being part of a bicycle or tricycle;
having one said planar element configured for attachment to (i) a front wheel and (ii) one or more other parts of the bicycle or tricycle; and
having a core-envelope element integral with said planar element and configured as a handlebar of the bicycle or tricycle. .