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WHEEL

TECHNOLOGICAL FIELD

The present invention concerns a wheel for use in bicycles and other land vehicles.

BACKGROUND

PCT Application WO 2011/067742 discloses a human-powered land vehicle, such as a bicycle, which is structured from palpable recyclable material, having wheels that may be made of cardboard. Cardboard-based wheels have also been disclosed in Publication US 3,492,016.

GENERAL DESCRIPTION

The present invention provides a wheel that is made substantially out of cardboard, has sufficient rigidity to support a load and can, thus, be used in a land vehicle, such as a bicycle.

The term "*made substantially out of cardboard*" means to denote that cardboard is the main structural component of the wheel that functions to support the load exerted on the portion of the wheel that bears on the ground or on another driving/riding surface. For example, a wheel that is made substantially out of cardboard may have a hub that incorporates the wheel's axle that will be made of a material other than cardboard, it may comprise coating layers that line portions of the wheel's external surfaces (at times the entire surface) for environmental protection, e.g. a polymeric film layer, lacquer, etc.

Typically, but not exclusively, the wheel of the invention is fitted with a tire or an elastomeric, ground-bearing material on its rim. In the following, the term "*tire*" will be used to refer, collectively, to an elastomeric, ground-bearing element that is fitted around the wheel's rim. The tire may, for example, be a solid mass of an elastomeric

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material, may be inflatable, may be an elastomeric strip fitted on the rim, etc. As is well known in the tire industry, tires may at times comprise also reinforcing metal or non-metallic fibers or mash, may have a treading pattern, etc.

In accordance with the invention, it has been realized that a multi-layered cardboard structure having at least one high density cardboard (hereinafter, at times, "*HDC*") layer and at least two layers of low density cardboard (hereinafter, at times, "*LDC*") sandwiching the HDC layer, forms a robust and relatively light structure that has significant compression resistance as well as torsional and flexural resistance. Such a structure having a rounded circumference, arranged around the central hub, allows it to be used as a wheel in a bicycle or other land vehicle with sufficient rigidity which, in the case of a bicycle, is sufficient to bear the weight load of a rider.

There is, of course, a correlation between the load-bearing capacity and the service lifetime of such a wheel, on the one hand, and the type of HDC and LDC used for forming such layers. It would be a relatively routine undertaking that would not require undue experimentation, to find out the optimal combination (in terms of weight and rigidity) of HDC and LDC for a specific use. For example, a wheel intended for a children's bicycle may be constructed of thinner HDC layers, or a less dense LDC layer than for a bicycle intended for adults.

The term "*resistance*" should be understood in the context of use of the wheel and is intended to denote that, during regular use and stress, encountered during riding/driving, the wheel maintains its integrity as well as its generally planar and rounded structure.

The term "*high density cardboard*" or "*HDC*" is intended to denote a cardboard sheet in which the cardboard is packed without visible voids or gas-containing pockets. A high density cardboard sheet typically has an areal density in the range of 400 to 600 g/m². A particular example is heavy duty cardboard having a density in the range of 500 to 600 g/m². The HDC used in accordance with the invention may have a thickness in the range of 0.5 to 3 mm, typically 1 to 1.5 mm.

The term "*low density cardboard*" or "*LDC*" refers to cardboard sheets having internal structure defining 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 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

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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*". The corrugated or honeycomb cardboard sheets may be single-walled or multi-walled cardboard sheets. These terms are also meant to encompass 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.

The LDC is typically a honeycomb or corrugated cardboard having a thickness in the range of 8 to 20 mm, typically 8 to 15 mm and even 8 to 12 mm.

The invention, thus, provides a wheel that comprises a generally planar, multi-layered cardboard body defined between two side faces, and having circular circumference and a hub that defines its central axis. The layers are arranged parallel to the two side faces. The layers comprise at least one layer of HDC and at least two layers of LDC sandwiching the HDC layer. The at least two LDC layers and the at least one HDC layer are fixedly attached to one another. The fixed attachment is typically by gluing.

By one embodiment, the wheel includes a single HDC at the wheel's mid-line with two LDC layers sandwiching this single high density cardboard layer. Typically, a wheel with such embodiment would have axial symmetry about the HDC layer. However, other embodiments may also be envisaged, in accordance with the general teachings of the invention. By way of example, there may be alternating layers of high and low density cardboard, e.g. the following layer arrangement: one with a plurality of alternating LDC-HDC layers, for example: LDC-HDC-LDC-HDC-LDC; or HDC-LDC-HDC-LDC-HDC; or the same layer structure with additional, respective, HDC or LDC layers at each side of these structures; etc. By other examples, the HDC layer at the mid-line may consist of two or more HDC sheets fixedly attached to one another, forming a thicker HDC mid-line layer; or one or more LDC layers may be formed by two or more LDC sheets.

By one embodiment, the wheel comprises one or more pliable strips that are fitted around the circumference of said body, in fact defining the perimeters of the cardboard body. Such a strip may typically be made of cardboard or paper but other materials, such as plastic, rubber or other polymeric material, may also be used.

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Such a strip, particularly where it is made of cardboard, typically comprises lateral flaps that are folded and attached to the wheel's side faces thereby securing the strip in position and providing further reinforcement to the structure.

By one embodiment the body of the wheel is a continuous mass extending from the hub to the circumference. By another embodiment said body is patterned by cutouts defining arms with side and inner faces extending radially between the hub and a circumferential wheel portion. Such inner faces may be overlaid with a pliable sheet, e.g. cardboard or paper. Such a patterned wheel configuration, define also inner faces of the circumferential wheel portion, which by one embodiment are also overlaid with a pliable sheet, e.g. cardboard or paper.

The wheel, as noted above, is typically fitted with a tire.

For environmental, in particular water-resistance, the wheel's external faces may be impregnated, e.g. by a water repelling material or coated by such a material. Examples are resins such as lacquer or epoxy, a polymeric sheet, a combination of these, etc.

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. 1 shows a perspective view of a wheel in accordance with an embodiment of the invention.

Fig. 2 shows the wheel of Fig. 1 fitted with a tire.

Fig. 3 is an exploded perspective view of the wheel of Fig. 2 showing its constituting elements.

Fig. 4A is a cross-section along lines IV-IV in Fig. 2.

Fig. 4B shows a layered structure according to another embodiment of the invention.

Fig. 5 shows a side view of a wheel according to another embodiment, patterned through cut-outs.

Fig. 6 is a cross-section along lines VI-VI in Fig. 5.

DETAILED DESCRIPTION OF EMBODIMENTS

Referring first to **Fig. 1**, shown is a wheel which has a generally planar configuration and has a cardboard body **102** with two side faces **104** and **106**. As inherent in a wheel structure, it has a circular circumference and a hub **108** that defines the wheel's central axis. The cardboard body, as can be seen in **Fig. 4** and as will be elaborated upon further below, has layered structures, the layers being arranged in parallel to the two side faces.

The wheel of **Fig. 1** is made substantially out of cardboard, although the hub may be made of other materials, such as plastic, wood, metal, may comprise ball bearings, etc. The hub may be incorporated into the wheel by forming a circular cut-out in body **102** and fitting the hub element **108** into it, tightly attaching it to the body, e.g. through gluing.

As can be seen in **Fig. 2**, the wheel is typically fitted with a tire **110** made of rubber or another elastomer. In the embodiment seen in **Fig. 2**, the tire is a solid elastomeric mass, but according to other embodiments the tire may be a foamed mass, may be inflatable, may be of reinforced rubber, or may have a variety of other structures.

As can further be seen in **Fig. 1**, the circumference of body **102** is fitted with a pliable strip **112**, typically made of cardboard, paper or a polymeric film, having flaps **114** that are folded onto side faces **104** and **106** to secure the strip in position. This strip, among others, seals the otherwise exposed perimeter of the layered structure.

Typically, the wheel will be covered by an environmentally protected layer, e.g. polymeric resin, polymeric layer, epoxy, lacquer, paint, etc.

The exploded view of the wheel of **Fig. 2** can be seen in **Fig. 3**, showing the four basic constituting elements which are the hub **108**, body **102**, strip **112** and tire **110**.

Fig. 4A shows a cross-section through the wheel of **Fig. 2**. As can be seen, the layers include an inner HDC layer **116** defining a mid-line **118**. The HDC layer **116** is sandwiched by two LDC layers **120** and **122**, arranged symmetrically about it. The HDC typically is made of high density or heavy duty cardboard having a thickness in the range of 0.5-3 mm, typically of about 1-1.5 mm; while the LDC layers are typically corrugated or honeycombed cardboard having a thickness in the range of 8-20 mm, typically of about 12 mm.

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As can further be seen in **Fig. 4A**, the pliable strip **112** that surrounds the wheel's circumference is overlaid with a tire **110**.

Another embodiment of a cardboard body for use in a wheel can be seen in **Fig. 4B**. In this embodiment, two additional HDC layers **124** and **126** sandwich the two LDC layers. It should, however, be noted that the two embodiments illustrated in **Figs. 4A** and **4B** are mere examples and other different embodiments, e.g. those noted above in the summary, may be used in accordance with the invention.

The wheel according to another embodiment is illustrated in **Fig. 5**. The wheel of **Fig. 5** is based on that of **Fig. 1** and is patterned through cut-outs **130** that together define an enlarged hub portion **132** linked to a peripheral portion **134** through radial arms **136**. Inner faces **138** of arms **136**, inner faces **140** of peripheral portion **134**, as well as inner face **142** of hub portion **132**, are typically lined with a liner layer which may be identical in constitution to that of strip **112**.

As can be seen in **Fig. 6**, arm **136** is enveloped by a layer **144**. However, in other embodiments, rather than enveloping the entire arm, a strip of such pliable material may be fitted only on the inner faces, e.g. in a similar manner as in the case of strip **112**, by deploying, for example, flaps to fix the strips in position.

CLAIMS:

1. A wheel, comprising:

a generally planar, multi-layer cardboard body having two side faces, a circular circumference and a hub that defines a central axis, the layers being arranged in parallel to the two side faces;

the layers comprising at least one layer of a high-density cardboard sheet sandwiched between at least two layers of low-density cardboard sheet, each of said low-density cardboard sheet, comprising two liner cardboard layers fitted on opposite sides of a low-density cardboard layer;

the at least two layers of cardboard sheet and the at least one layer of high density cardboard being fixedly attached (e.g. by gluing) to one another.
2. The wheel of claim 1, wherein a high density layer is disposed at the wheel's midline.
3. The wheel of claim 2, wherein the wheel has an axial symmetry about said high density layer.
4. The wheel of claim 2 or 3, comprising two layers of low density cardboard sheet symmetrically fitted about said high density layer.
5. The wheel of any one of claims 1-4, comprising one or more pliable strips fitted around the circumference of said body.
6. The wheel of claim 5, wherein said strip is made of cardboard or paper.
7. The wheel of claim 5, wherein said strip comprises lateral flaps that are folded and attached to the wheel's side faces.
8. The wheel of any one of claims 1-7, wherein said body is a continuous mass extending from the hub to the circumference.
9. The wheel of any one of claims 1-7, wherein said body is patterned by cutouts defining arms with side and inner faces extending radially between the hub and a circumferential wheel portion.
10. The wheel of claim 9, wherein the inner faces of said arms are overlaid with a pliable sheet.
11. The wheel of claim 10, wherein the inner faces of said arms are overlaid with cardboard or paper.

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12. The wheel of claim 10 or 11, wherein inner faces of the circumferential wheel portion are overlaid with a pliable sheet.
13. The wheel of claim 12, wherein the inner faces of said arms are overlaid with cardboard or paper.
14. The wheel of any one of claims 1-11, wherein the wheel's circular circumference is fitted with a tire or a surface-engaging body.
15. The wheel of claim 14, wherein the surface-engaging body is made of an elastomer.
16. The wheel of any one of claims 1-15, being coated by liquid impermeable material.