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Declarations under Rule 4.17:

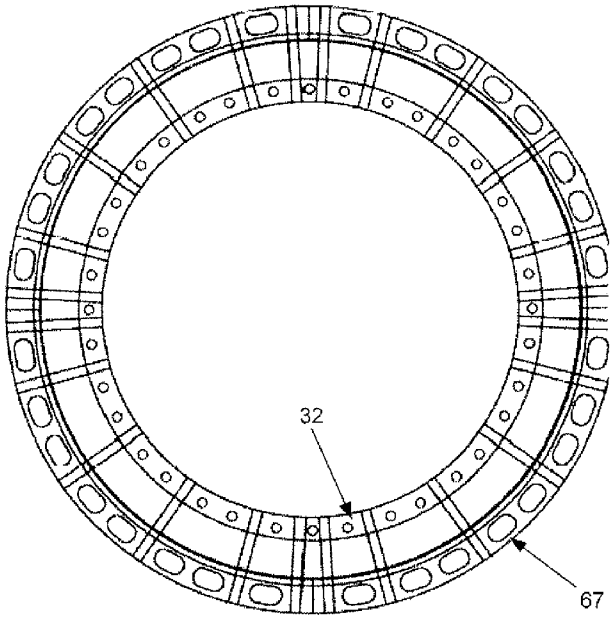
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) **Title**: WHEEL WITH COMPOSITE RIM

FIG. 16



(57) **Abstract**: The present invention relates to a composite rim, comprising an open cavity and a closed cavity, a tire-accommodating surface located within the closed cavity wherein the tire accommodating surface is curved and provided with a first ridge and a second ridge, a spoke support wherein the spoke support accepts a spoke; and the tire-accommodating surface, the outer surface surface, and the spoke support enclose the closed cavity.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: Wheel with Composite Rim

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FIELD OF THE INVENTION

This invention relates to rims, and particularly to composite rims used in wheels for bicycles.

BACKGROUND OF THE INVENTION

Composite rims are known in the art. An example of such a rim is shown in U.S. Patent No. 6,398,313, the disclosure of which is hereby incorporated herein by reference. While the rim disclosed in U.S. Patent No. 6,398,313 is adequate, it is of a two-piece design which requires more time and labor in fabrication.

The present invention is directed to overcoming this and other disadvantages inherent in prior-art systems.

SUMMARY OF THE INVENTION

The scope of the present invention is defined solely by the appended claims, and is not affected to any degree by the statements within this summary. Briefly stated, a composite rim, comprising an open cavity and a closed cavity, a tire-accommodating surface located within the closed cavity wherein the tire accommodating surface is curved and provided with a first ridge and a second ridge, a spoke support wherein the spoke support accepts a spoke; and the tire-accommodating surface, the outer surface surface, and the spoke support enclose the closed cavity.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 depicts a cross-sectional view of a preferred embodiment of a rim.

Figure 2 depicts a cross-sectional view of the rim of figure 1 with a plurality of plys of unidirectional material.

Figure 3 depicts a cross-sectional view of the tire accommodating surface 15 of figures 1 and 7 in greater detail.

Figure 4 depicts a cross-sectional view of the rim with a tire and an uninflated inner tube.

Figure 5 depicts a cross-sectional view of the rim with a tire and an inflated inner tube.

Figure 6 depicts a cross-sectional view of the rim.

Figure 7 depicts an alternative embodiment of a rim with an aerodynamically shaped annulus 53.

Figure 8 depicts plys of unidirectional material being laid upon one another with the fibers in each ply forming a crossing angle with respect to each other.

Figure 9 depicts the rim with spokes and a three-flange hub.

Figure 10 depicts a cross-sectional view of the rim with lips that each function as a wickerbill.

Figure 11 depicts a cross-sectional view of a lip that functions as a wickerbill.

Figure 12 depicts a cross-sectional view of a ply of unidirectional material being placed into a mold at a 0 degree crossing angle with respect to the circumference 12.

Figure 13 depicts a cross-sectional view of a plurality of plys of unidirectional material within the mold and an inflatable bladder within the plys of unidirectional material.

Figure 14 depicts a inner portion of the mold assembled to the outer portion of the mold with an inlet body and a bladder.

Figure 15 depicts a cross-sectional view of a spoke used with the rim of figure 1 or figure 11.

Figure 16 depicts the outer diameter portion of the mold connected to the inner diameter portion of the mold.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTs

FIG. 1 depicts a cross-sectional view of a rim 10 constituting a preferred embodiment of the present invention. As is shown in FIG. 9, the rim 10 is part of a bicycle wheel 40 and hence includes spokes 41, a hub 42, an axis 11, and a circumference 12 that extends about the axis 11 to form a circle. The rim 10 is provided with a closed cavity (though the cavity is provided with openings for the spokes) and an open cavity for a tire. The axis 11 and the circumference 12 of the rim 10 extend in directions that are orthogonal to one another. As shown in FIG. 8, the rim 10 is manufactured to include a composite material 43 formed from a plurality of plys of resin-impregnated fibers 44.

In the presently preferred embodiment, the fibers are carbon fibers; however, in an alternative embodiment, the fibers are boron. In another alternative embodiment, the fibers are glass fibers. In yet another alternative embodiment, the fibers are an aramid. In still yet

another alternative embodiment, the fibers are combinations of the foregoing fibers (boron and carbon, carbon and glass, carbon and aramid fibers).

The fibers 45 within each ply 13 are oriented to extend generally parallel to each other in the same direction (hereinafter referred to as "unidirectional material"). Each ply 13 of unidirectional material 46 is laid within a mold, one on top of another, so that the unidirectional material 46 of each ply 13 is oriented with respect to each other to form predetermined crossing angles 48.

Referring now to FIG. 2, the rim 10 is illustrated in a cross-sectional view with the circumference 12 extending out of the page. As noted above, the circumference 12 extends about the axis 11 and therefore is oriented to be orthogonal to the axis 11. Thus, to achieve predetermined crossing angles 48, the fibers 45 of each ply 13 of unidirectional material 46 are oriented relative to the direction in which the circumference 12 extends.

As Figure 1 illustrates, the rim 10 is provided with upstanding walls 49 and a support upon which a tire 55 is placed (hereinafter referred to as the "tire support"). The tire support 50 is bounded by multiple surfaces. The upstanding walls 49 extend radially from the tire support 50 to form an open cavity. The rim 10 is provided with another support which secures the spokes 41 (hereinafter referred to as the "spoke support 52"). In the embodiment shown in FIG. 1, the spoke support 52 is curved; however, in an alternative embodiment, the spoke support 52 is shaped to function as an air foil and hence tapers to a sharply angled annulus 83 that measures less than 20 degrees, as is depicted in FIG. 7.

Braking surfaces 54 are located where the upstanding walls 49 extend radially from the tire support 50. The tire support 50 is also provided with a surface that faces the tire 55 when the tire 55 is fitted within the open cavity 51 (referred to as the "tire-accommodating surface 15"). Opposite the tire-accommodating surface 15, the underside of the tire support

50 is provided with curved surfaces 53, 57 that extend away from the tire-contacting surface 56 towards the spoke support. The curved surfaces 53, 57 blend into two rim walls 85, 86 that extend to the spoke support. As shown in Figure 1, a closed cavity 60 is bounded by the spoke support, the tire support 50, and the two rim walls 85, 86.

As Figure 2 illustrates, the rim 10 is provided with an outer surface. This outer surface 61 begins at one of the upstanding walls, extends around the spoke support, and then extends radially from the spoke support 52 towards the other upstanding wall. In the presently preferred embodiment, the outer surface is generally smooth; however, in an alternative embodiment, the outer surface is provided with a plurality of dimples (such as those found on a golf ball) which take advantage of Bernoulli's principle to reduce air drag. In such an alternative embodiment, the dimples are located on the outer surface that extends radially from the spoke support to the braking surface.

The rim 10 also includes a tire accommodating surface 15, which is shown in greater detail in FIG. 3. In the preferred embodiment, is provided with a plurality of curved surfaces (referred to hereinafter as "central" and "peripheral" surfaces). At least one of the foregoing surfaces is in the shape of an arc measuring approximately 10 degrees. As FIG. 3 illustrates, the tire accommodating surface 15 includes a central surface 16 that directly extends along the circumference 12 of the rim 10, as well as peripheral surfaces 17, 18, each of which is located on either side of the central surface 15. In alternative embodiments, the arc measures between 5 and 35 degrees. In yet another alternative embodiment, the central surface 16 is curved while the peripheral surfaces 17, 18 are frustoconically shaped. Extending from the peripheral surfaces 17, 18 are transition surfaces 19, 20 that are curved and that terminate at a pair of ridges 21, 22.

Each of the ridges 21, 22 is shaped to seat a bead found on a tire and provided, at least in part, with a radially-extending surface 23 and an axially-extending surface 25. As FIG. 3 illustrates, a radially extending surface 23 begins at a transition surface 20 and extends radially to an axially extending surface 25. The axially extending surface 25 then extends axially to a side wall 27. Because the ridges 21, 22 and hence the radially and axially extending surfaces 23, 25 are provided in pairs to match structures provided on the tire 55 (as will be explained in greater detail hereinafter), each of the ridges 21, 22 and radially and axially extending surfaces 23, 25 shall be distinguished from one another by being referred to as a "first" ridge 21 and a "second" ridge 22, a "first" radially extending surface 23, and a "second" radially extending surface 24, a "first" axially extending surface 25, and a "second" axially extending surface 26.

Referring now to FIG. 4, a tire 55 with an inner tube 58 are shown on a rim 10. As illustrated, the beads 62, 63 of the tire 55 are located on the tire accommodating surface 15. As the inner tube 58 is inflated with air, the tire 55 expands thereby pushing the beads 62, 63 both axially and radially. Inflation of the inner tube 58 thus pulls the beads 62, 63 of the tire 55 up over the radially extending surfaces 23, 24 of the ridges 21, 22 and pushes the beads 62, 63 across the axially extending surfaces 25, 26 where the beads 62, 63 are pressed against the sidewalls 27, 28 of the rim 10, as is depicted in FIG. 5. Thus, the beads 62, 63 and hence the tire 55 are held in place within the rim 10.

Advantageously, the rim 10 is contoured so that, in cross-section, the rim 10 is provided with an air foil shape. In the presently preferred embodiment, the rim 10 is provided with a radial dimension 59 that extends from the spoke support 52 to the tire support 50 and an axial dimension 64 that extends across the widest part of the rim 10 when the rim 10 is viewed cross-sectionally. The axial and radial dimensions 64, 59 of the rim 10

are dimensioned according to one another. According to one aspect, the axial dimension 64 of the rim 10 measures 33% of the length of the radial dimension 59 of the rim 10. According to another aspect, the axial dimension 64 is greater than 33%. As shown in FIG. 6, the axial dimension 64 measures between 40% and 44% of the radial dimension 59 of the rim 10.

In the embodiment shown in FIG. 10 and in FIG. 11, the rim 10 is provided with a pair of lips 65, 66 (referred to herein as a "first lip 65" and a "second lip 66" to distinguish one from the other). The lips 65, 66 are located on either side of the spoke support 52 and are shaped to create air turbulence that enables separated air to re-attach and minimize drag from air pressure. The lips 65, 66 are also shaped to reduce the air turbulence and pressure drag generated on the low-pressure side of the rim 10 when cross winds are encountered (which reduces the steering force required to keep the bicycle wheel 40 in line with the bicycle in a crosswind).

In manufacturing the rim 10, a circular mold 47 is used. The mold 47 is provided with a plurality of pieces, including an inner diameter portion and an outer diameter portion. The inner diameter portion of the mold 47 is provided with an inner molding cavity that is shaped in part according to the outer surface 61 of the rim 10 while the outer diameter portion is shaped in part according to the rim's open cavity 51 (as will be described hereinafter).

While much of the outer surface 61 is formed within the inner diameter portion of the mold, the outer diameter portion forms at least a portion of the upstanding walls 49 and the open cavity. The outer diameter portion of the mold 47 is connected to the inner diameter portion so that the outer diameter portion extends around the inner diameter

portion. In addition to the mold, various hand tools are used to press composite material 43 into the inner molding cavity during wheel manufacture.

The fabrication of the rim 10 involves the successive layering of multiple plys of unidirectional material. As FIG. 12 illustrates, an initial ply 13 of unidirectional material 46 is laid within the inner diameter portion 32 of the mold 47 with the fibers 45 extending in the same direction as the circumference 12 of the rim 10 (though a layer of woven fibrous material can be laid into the mold before the initial layer of unidirectional material so as to provide the rim 10 with a pleasing cosmetic appearance). In such an orientation, the fibers 45 of the unidirectional material 46 are laid into the mold 47 at a 0° angle. Subsequent plys of unidirectional material 46 are laid upon the initial ply 13 at an angle relative to the circumference 12 of the rim 10. Thus, subsequent plys are laid upon the initial ply 13 at 0°, 0°, +45°, +45°, +45°, -45°, -45°, -45°, +90°, +90°, +90°, -90°, -90°, and -90° angles relative to the circumference 12. In an alternative embodiment, subsequent plys are laid upon the initial ply 13 at 0°, 0°, +33°, +33°, +33°, -33°, -33°, -33°, +45°, +45°, +45°, -45°, -45°, -45°, +90°, +90°, +90°, -90°, -90°, and -90° angles relative to the circumference 12 of the rim 10. A deviation of 10% from the precise angles recited herein is within the scope of the present invention.

The presently preferred embodiment is fabricated through bladder molding so that upon completion, the rim 10 is cured into one continuous rim without awkward seams or joints. However, other molding techniques may be employed. According to one aspect of the present invention, the rim 10 is fabricated through injection molding. According to another aspect of the present invention, the rim 10 is fabricated through transfer molding. According to yet another aspect of the present invention, the rim 10 is fabricated through compression molding. According to still another aspect of the present invention, the rim 10

is fabricated through vacuum bag molding. Other molding techniques may be employed without departing from the scope or spirit of the present invention.

After the plies of carbon fiber material have been pressed into the mold 47, an inflatable bladder is placed within the inner molding cavity so that the carbon fiber material is between the bladder and the inner surface of the mold, as Figure 13 illustrates.

As shown in FIG. 14, the mold 47 includes an inlet body 33 in addition to the inner diameter portion and the outer diameter portion. The composite material 43 is placed within the inner diameter portion 32 of the mold. A bladder 34 is employed so that the composite material 43 is between the bladder 34 and the inner diameter portion 32.

The bladder 34 is a tube composed of an elastomer material and is of sufficient length so that it is longer than the circumference of the rim 10. The bladder 34 is placed inside the composite material 43 so that the ends are outside mold 47 while the remaining portion of the bladder 34 is in contact with the composite material. The outer ring 31 is placed over the composite material, the bladder 34, and the inner ring 32. The mold 47 is then placed in an oven and the bladder 34 is inflated via the inlet 33.

The inlet 33 is provided with a first plate 35 and a second plate 36. Holes for a plurality of fasteners are defined within the plates 35, 36 so that the first plate 35 and the second plate 36 are fastened together compressing the bladder 34 which is disposed thereinbetween. The inlet body 33 is fixed to the mold 47 via a fastener. The bladder 34 is connected to a pressured line so that a gas or a liquid is pumped into the bladder 34 while the mold 47 is being heated and the composite material 43 is being cured. Thus, the composite material 43 is compressed by the expanding bladder within the mold.

After the composite material 43 is cured, the mold 47 is removed from the oven, and the rim 10 is removed from the mold. The bladder 34 is removed from the rim 10 via an opening in the composite material.

As shown in FIG. 9, the rim 10 forms a wheel 40 when the rim 10 is provided with a spoke 41 and a hub 42. FIG. 15 depicts a cross-sectional view of the spoke 41. As shown therein, the spoke provided with an ovoid shape that includes a spoke cross-sectional thickness 81 and a spoke cross-sectional length 82. In the preferred embodiment, the spoke cross-sectional thickness 81 and the spoke cross-sectional length 82 are dimensioned according to one another. Advantageously, the spoke cross-sectional thickness 81 measures 29% of the spoke cross-sectional length 82. Deviations of 10% are within the scope of the present invention.

The hub 42 is provided with a hub shell 84 provided with three flanges, a center flange 72, and two peripheral flanges 73, 74, as is depicted in FIG. 9. The flanges 72, 73, 74 are shaped to connect to a plurality of spokes 41. The center flange 72 is positioned so that the spokes 41 extend radially along the center 75 of the rim 10 when viewed in cross-section (as illustrated in FIG. 6).

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A rim, comprising:
   a) a plurality of plys of unidirectional material with at least two plys forming a crossing angle with respect to one another;
   b) a closed cavity bounded by a tire support, a first rim side wall, a second rim side wall, and a spoke support;
   c) an open cavity located on an opposing side of the tire support and provided with a tire-accommodating surface that includes a first ridge, a second ridge; and
   d) each of the ridges is shaped to seat a bead of a tire and are located axially within two upstanding walls.
2. A rim according to claim 1, wherein the rim is formed to include a plurality of spokes, each of which is provided with an ovoid cross-sectional shape.
3. A rim according to claim 1, wherein the rim is formed of one piece.
4. A rim according to claim 1, wherein the rim is provided with a plurality of lips located on the outer surface of the rim before the outer surface extends around the spoke support.
5. A rim according to claim 1, wherein the rim is provided with a sharply angled annulus that measures less than 15 degrees.
6. A rim according to claim 1, further comprising a hub that includes a first flange, a second flange, and a third flange wherein each of the flanges is configured to attach spokes thereto and at least one of the flanges is located within a plane that extends through the center of the rim.
7. A wheel comprising:
   a) a rim that includes a plurality of plys of unidirectional material with at least two plys forming a crossing angle with respect to one another;
   b) a plurality of spokes;
   c) a hub provided with a hub shell that includes a first flange, a second flange, and a third flange, wherein at least one of the flanges is located so that the spoke extends through the center of the rim.
8. A rim according to claim 7, wherein the rim is formed to include a plurality of spokes, each of which is provided with an ovoid cross-sectional shape.
9. A rim according to claim 7, wherein the rim is formed of one piece.

10. A rim according to claim 7, wherein the rim is provided with a plurality of lips located on the outer surface of the rim before the outer surface extends around the spoke support.

11. A rim according to claim 7, wherein the rim is provided with a sharply angled annulus that measures less than 15 degrees.

12. A rim, comprising:

a) a plurality of plys of unidirectional material with at least two plys forming a crossing angle with respect to one another;

b) a closed cavity bounded by a tire support, a first rim side wall, a second rim side wall, and a spoke support;

c) an open cavity located on an opposing side of the tire support and provided with a tire-accommodating surface that includes a first ridge, a second ridge;

d) each of the ridges is shaped to seat a bead of a tire and are located axially within two upstanding walls;

e) a plurality of spokes; and

f) a hub provided with a hub shell that includes a first flange, a second flange, and a third flange, wherein at least one of the flanges is located so that the spoke extends through the center of the rim..

13. A rim according to claim 12, wherein the rim is formed to include a plurality of spokes, each of which is provided with an ovoid cross-sectional shape.

14. A rim according to claim 12, wherein the rim is formed of one piece.

15. A rim according to claim 12, wherein the rim is provided with a plurality of lips located on the outer surface of the rim before the outer surface extends around the spoke support.

16. A rim according to claim 12, wherein the rim is provided with a sharply angled annulus that measures less than 15 degrees.

FIG. 1

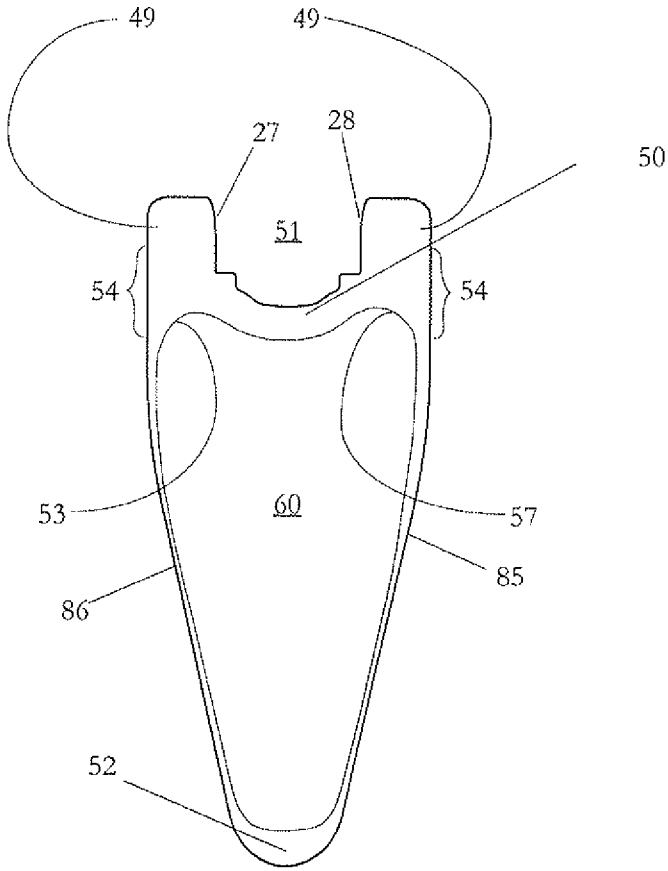


FIG. 2

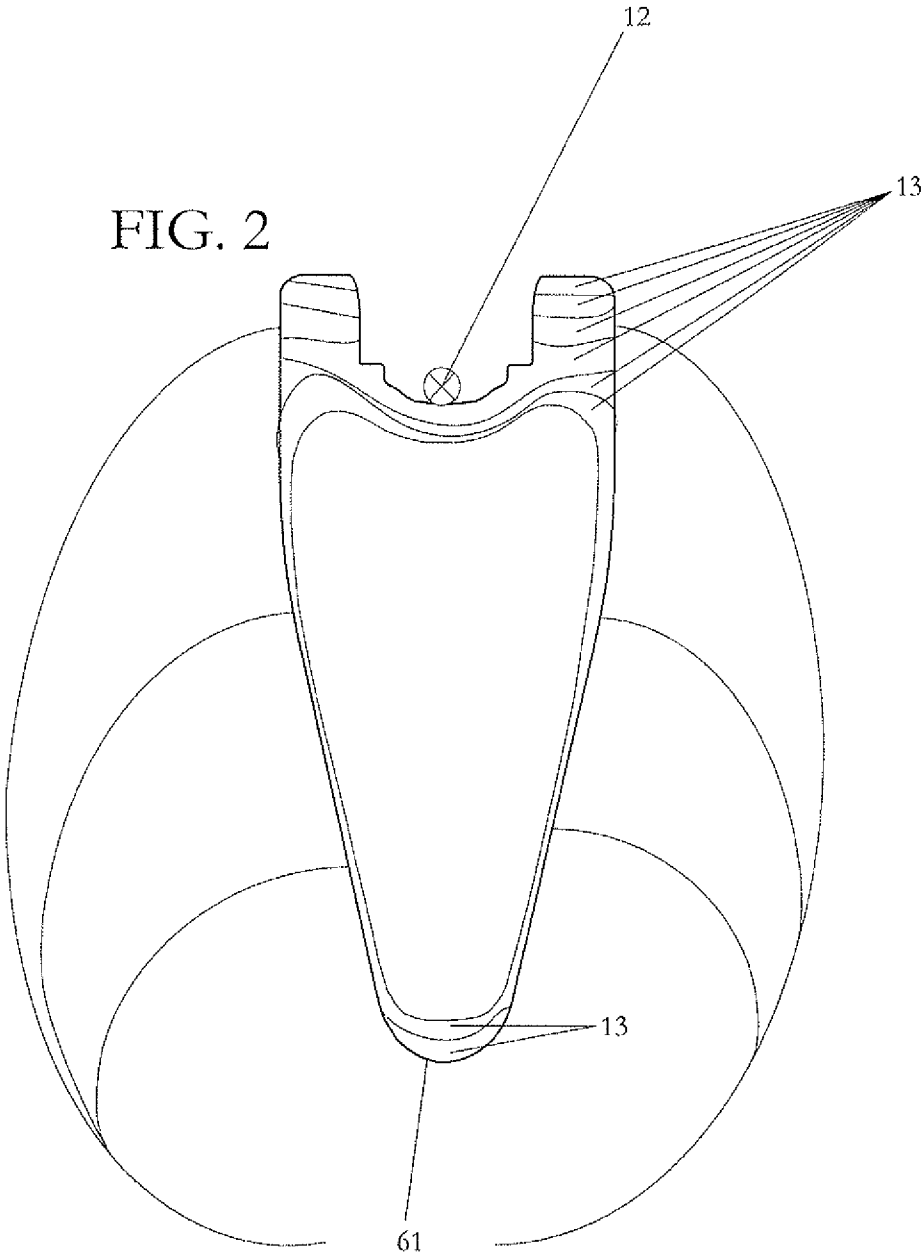


FIG. 3

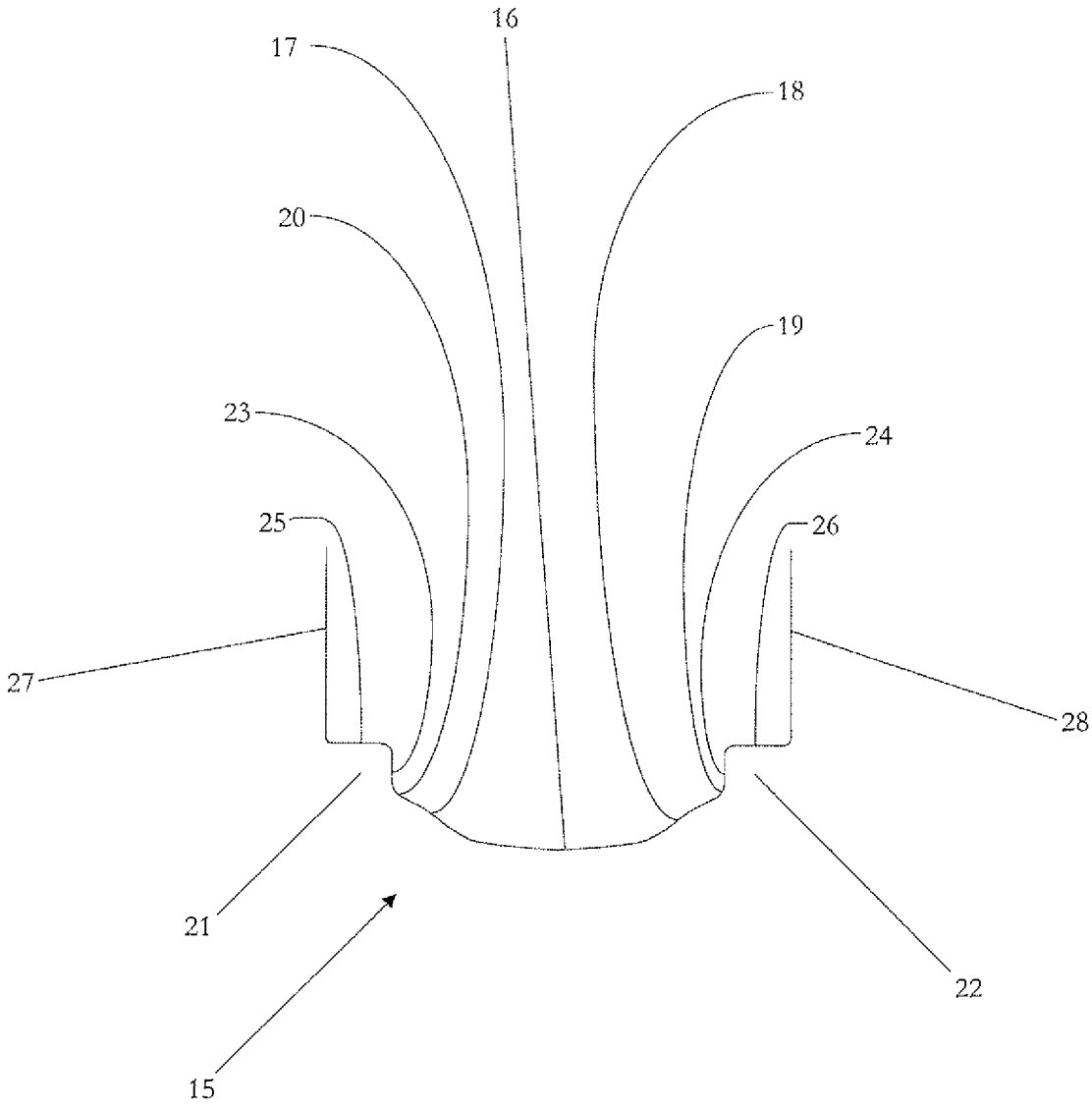


FIG. 4

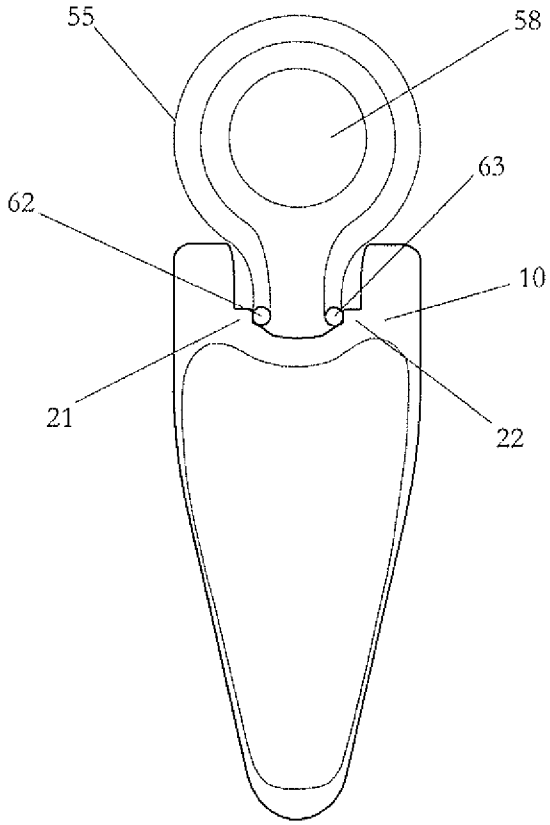


FIG. 5

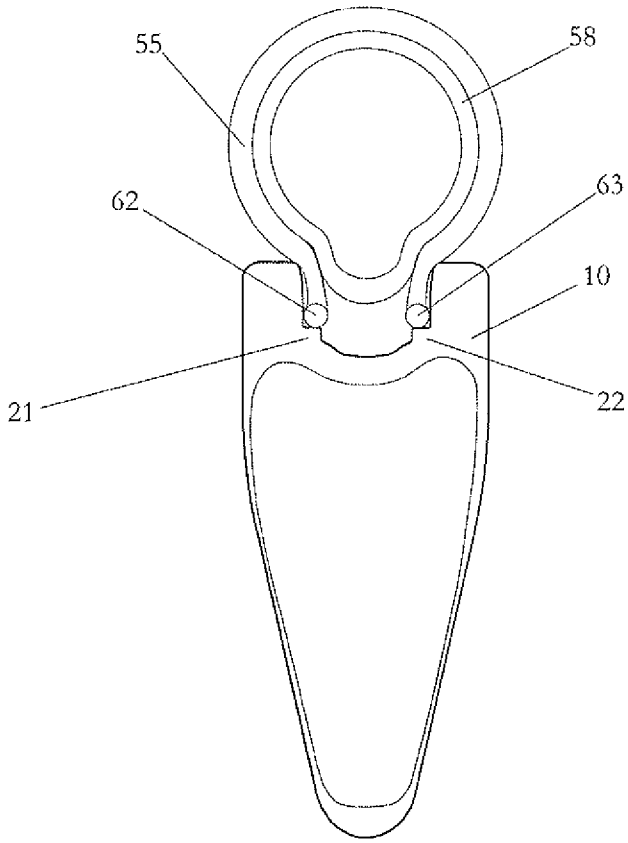


FIG. 6

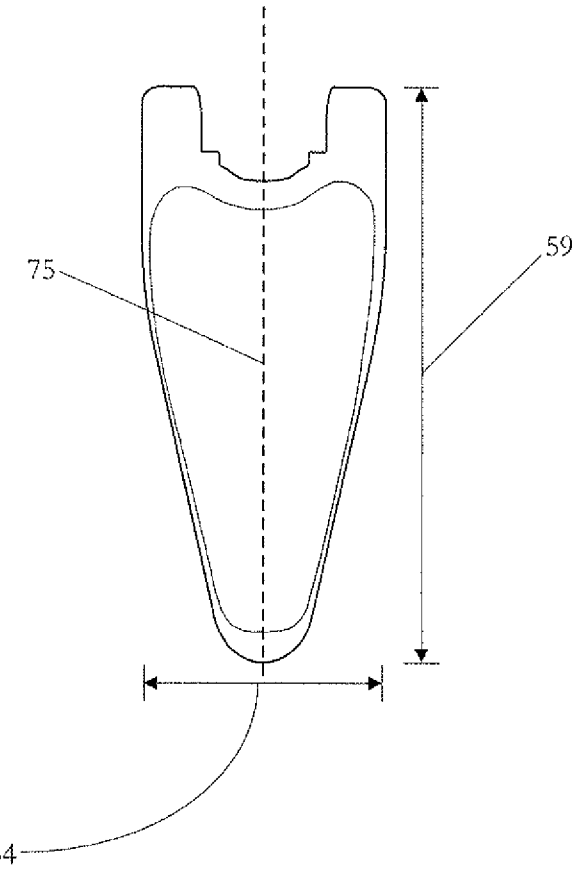


FIG. 7

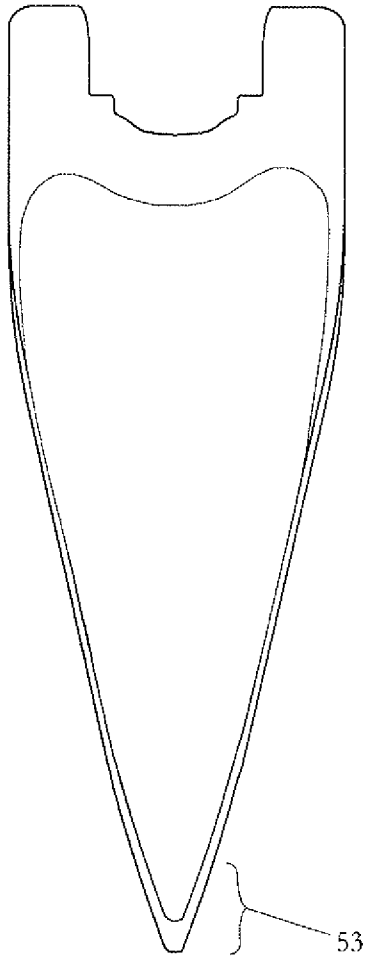


FIG. 8

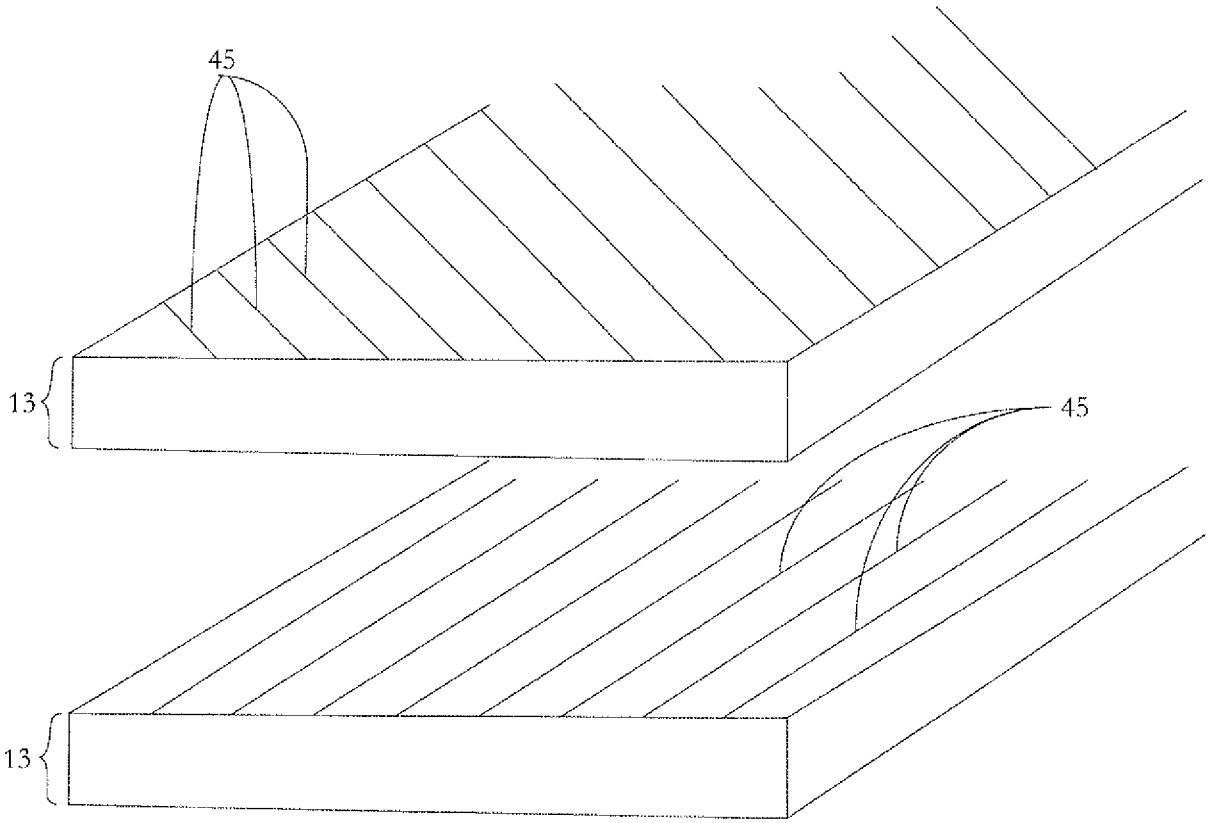


FIG. 9

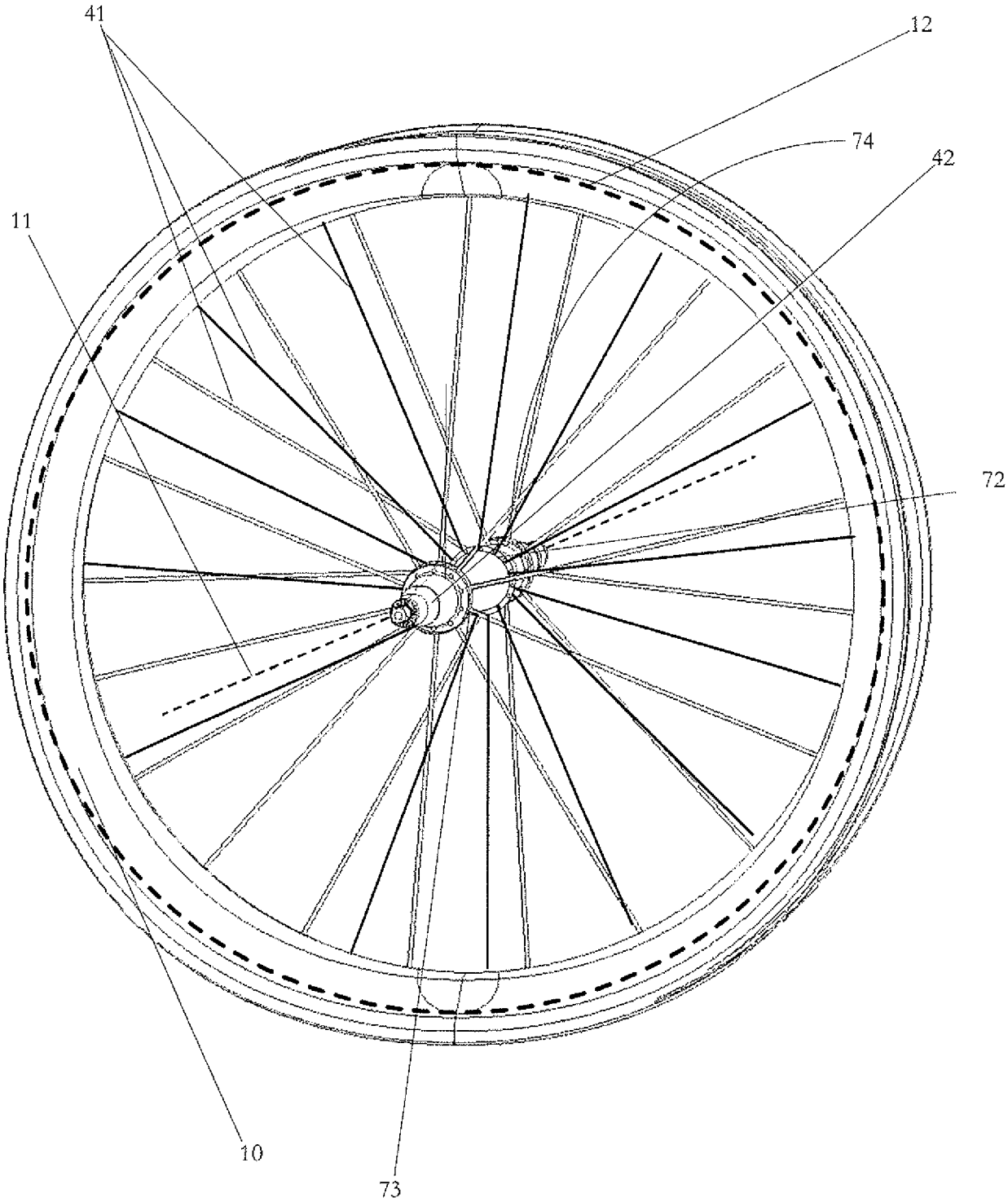


FIG. 10

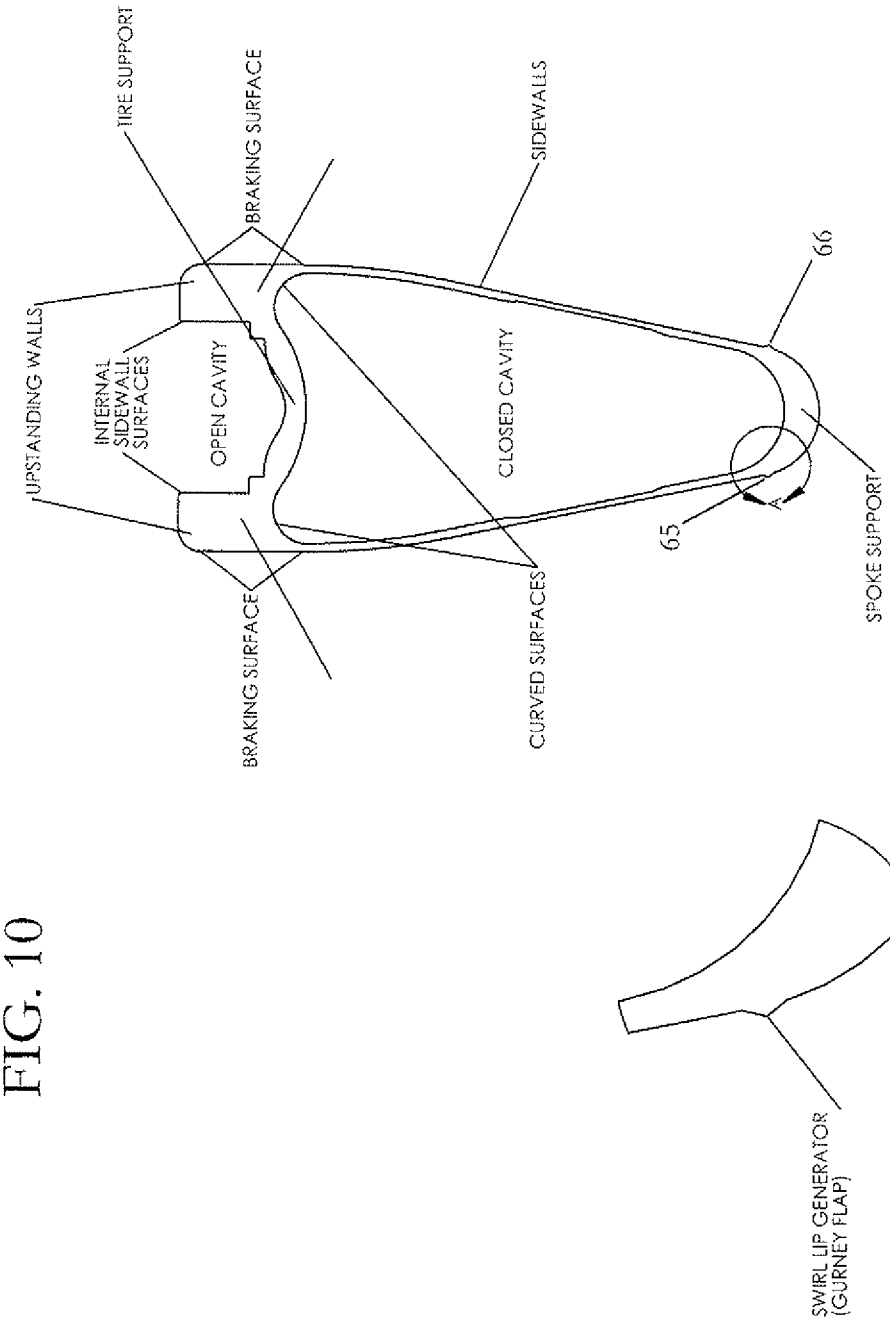

TIRE SUPPORT
BRAKING SURFACE
SIDEWALLS
UPSTANDING WALLS
INTERNAL SIDEWALL SURFACES
OPEN CAVITY
CLOSED CAVITY
66
65
BRAKING SURFACE
CURVED SURFACES
SPOKE SUPPORT
SWIRL LIP GENERATOR (GURNEY FLAP)
DETAIL A
SCALE 8 : 1

FIG. 11

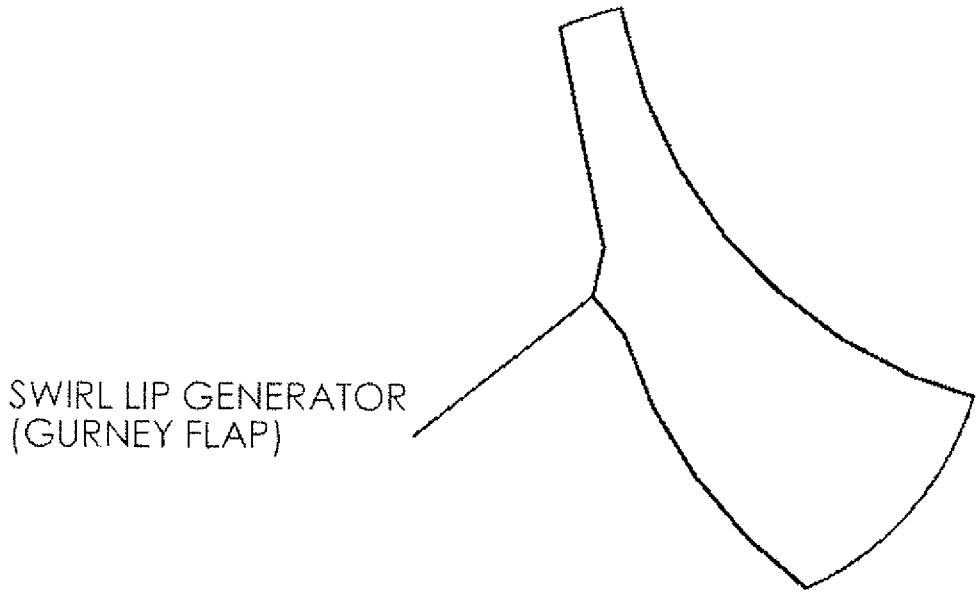


FIG. 12

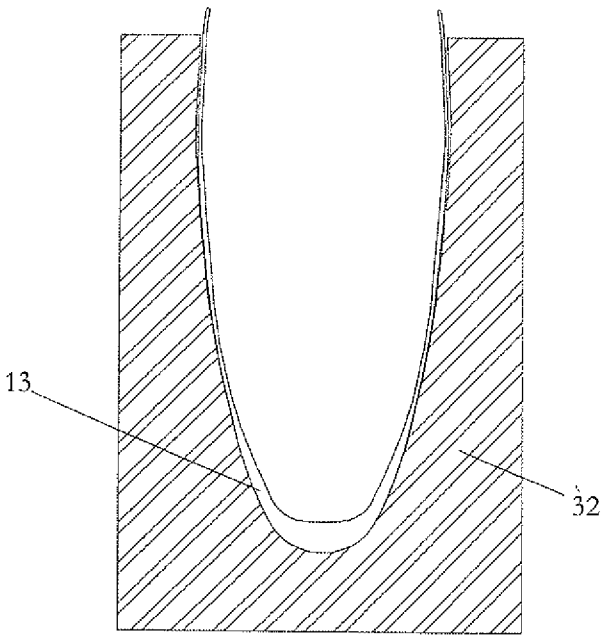


FIG. 13

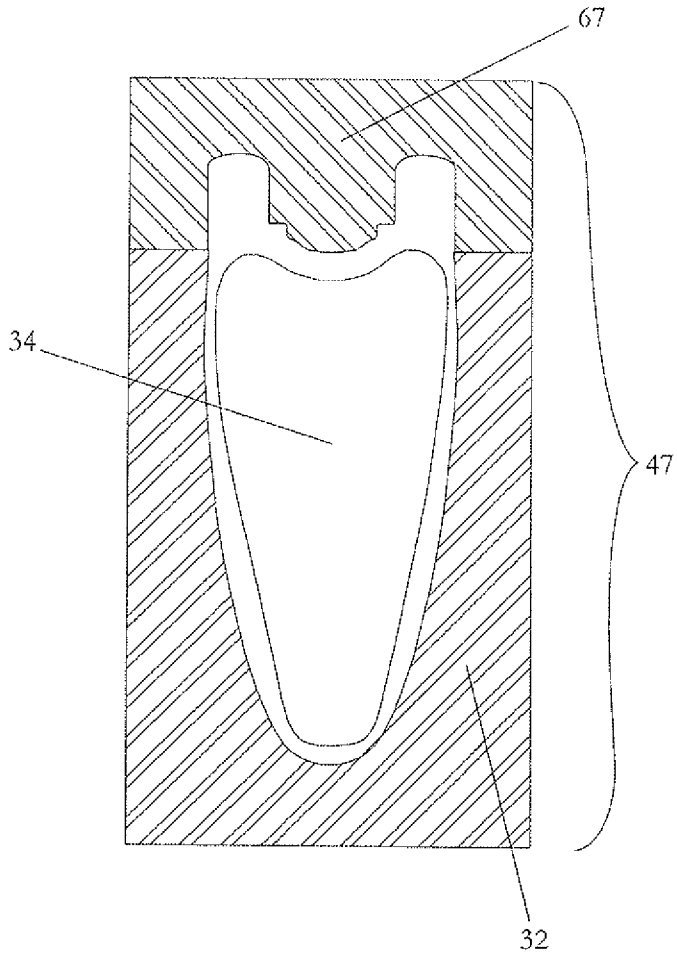


FIG. 14

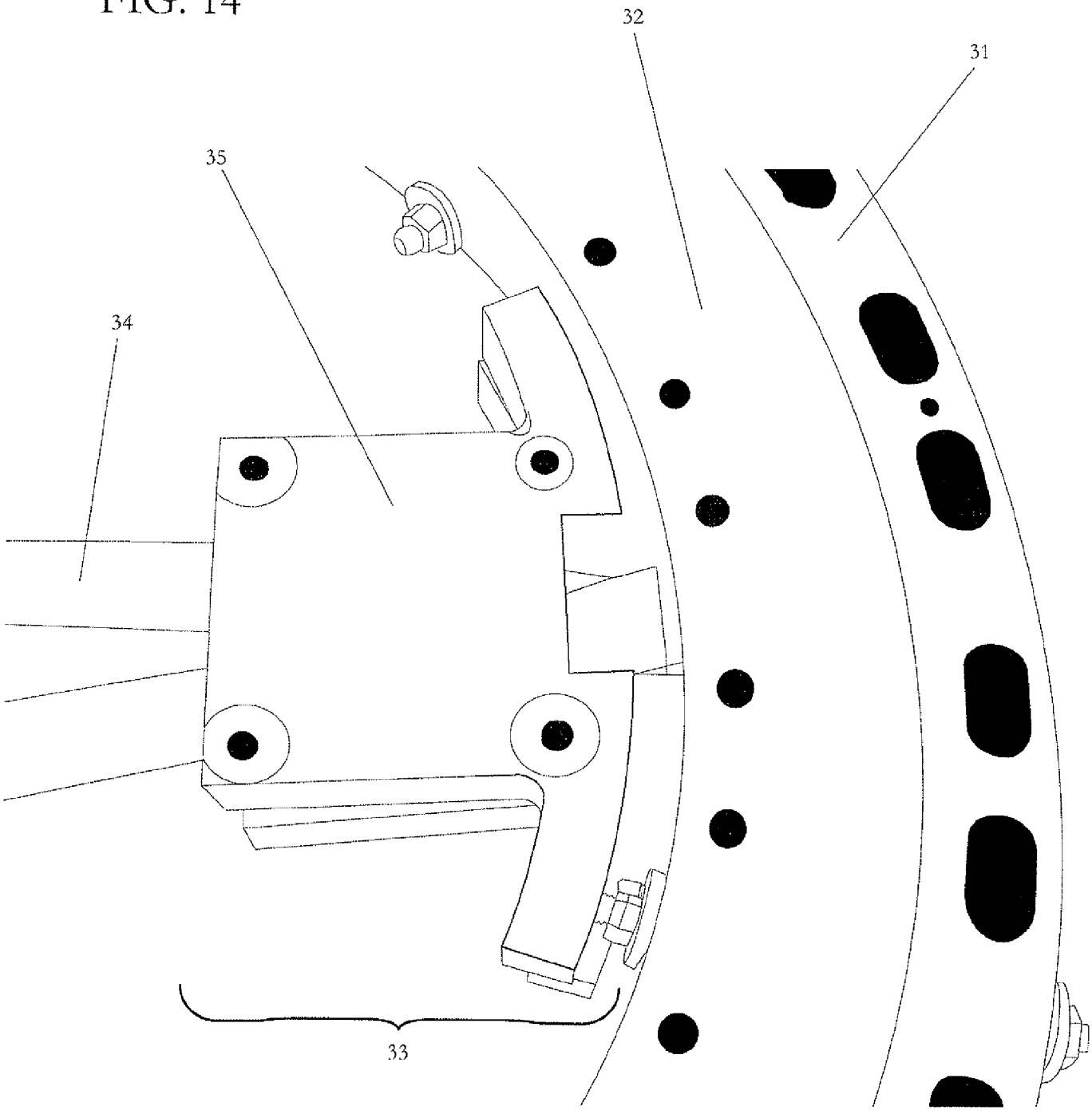


FIG. 15

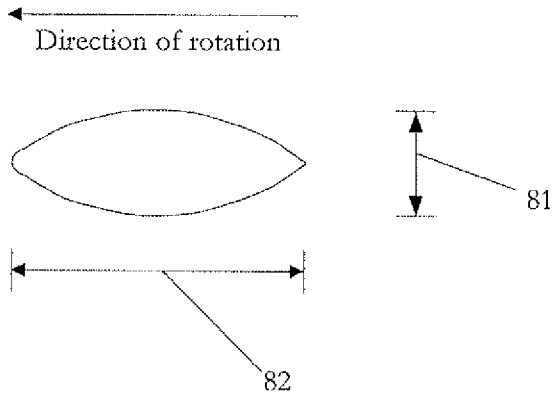
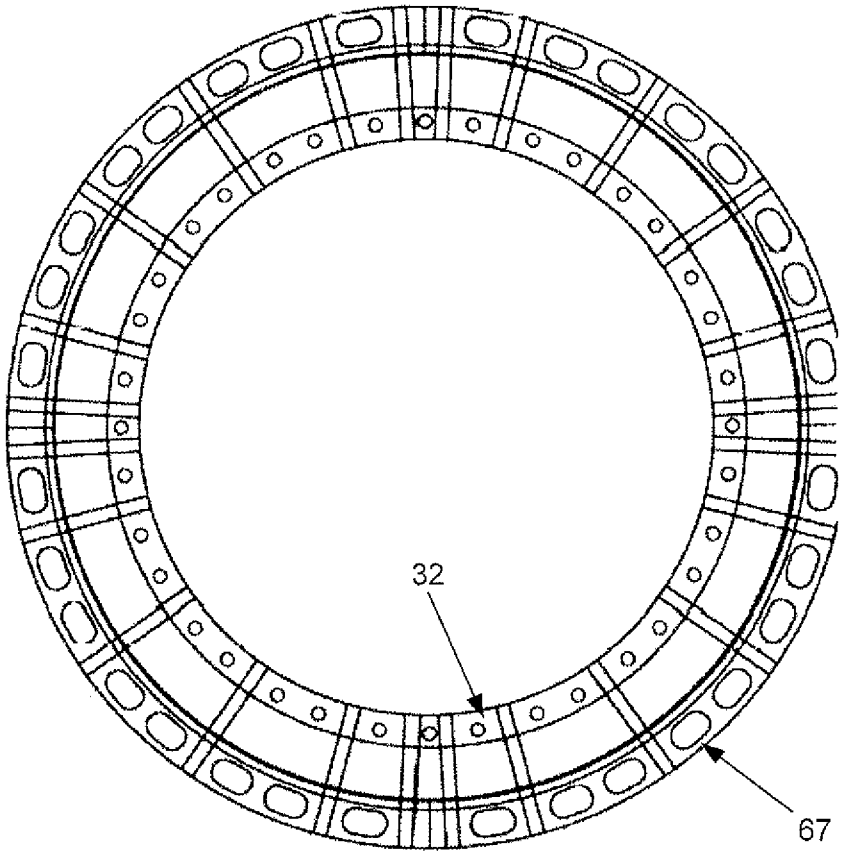


FIG. 16



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/036564

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60B 5/02 (2010.01)
USPC - 301/95.103
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60B 5/02 (2010.01)
USPC - 301/95.102, 95.103, 95.104

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,398,313 B1 (LEW) 04 June 2002 (04.06.2002) entire document	1-16
Y	US 7,258,402 B2 (MEGGIOLAN) 21 August 2007 (21.08.2007) entire document	1-6, 9, 12-16
Y	US 5,332,295 A (VOGEL et al) 26 July 1994 (28.07.1994) entire document	2, 8, 13
Y	US 7,114,785 B2 (ORDING et al) 03 October 2006 (03.10.2006) entire document	4, 10, 15
Y	US 6,871,915 B2 (CHIANG et al) 29 March 2005 (29.03.2005) entire document	6-16

☐ Further documents are listed in the continuation of Box C. ☐

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 July 2010	30 JUL 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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