Title: IMPROVED RIM FOR RUN-FLAT TIRE ASSEMBLIES

Abstract: An improved rim for a run-flat tire assembly is provided that eliminates recesses or pockets along the radially inner surface of the rim where materials can accumulate undesirably during vehicle operation. One or more circumferential grooves are provided along the outer surface of the rim in order to offset any mass increase due to the elimination of the recesses. In certain embodiments, the radially inner surface may also be provided with certain characteristics that assist in evacuating materials from the inner surface.
Title of the Invention
Improved Rim for Run-Flat Tire Assemblies

Technical Field

[0001] The present invention relates generally to an improved rim for a run-flat tire assembly in which recesses or pockets upon the radially inner surface of the wheel rim can be eliminated without an undesirable increase in the mass of the rim or decrease in its strength.

Background

[0002] Fig. 1 illustrates an exemplary run-flat tire assembly. Such assembly includes a support ring 52 disposed on a rim 18. A tire 54 surrounds this support ring 52. When tire 54 loses air pressure, it will deform and contact support ring 52. The load of the vehicle and the dynamic load of the ride will then be borne by support ring 52.

[0003] The presence of a pocket 84 provides a recess where water, ice, mud, or other materials may collect and cause an imbalance in the rotation of the run-flat tire assembly. Previous rims (those not used for run-flat tire assemblies) typically lack a pocket 84 and instead have either a level or a downward sloping surface from which materials that accumulate on the inner surface of the rim may be removed through centrifugal force brought about by rotation. The undesirable accumulation of materials within a recess on the radially inner surface of a wheel rim is noted in U.S. Patent No. 6,035,913, which is owned by the assignee of the present invention and is incorporated by reference herein in its entirety for all purposes.

[0004] The present invention improves upon run-flat tire assemblies by providing for an improved run-flat tire assembly that eliminates pockets into which materials may build up without undesirably increasing the mass of the wheel rim or decreasing the strength of the wheel rim.

Summary

[0005] Various features and advantages of the invention will be set forth in part in the following description, or may be obvious from the description.

[0006] In one exemplary embodiment, the present invention provides a wheel that includes a wheel disk configured for removable connection with a wheel hub of a vehicle. The wheel disk has an axis about which the wheel disk rotates during operation. The axis extends in both an inboard and an outboard direction. A rim is integrally attached to this wheel disk and has a radially outer surface and a radially inner surface. The rim has a support ring seat located on the radially outer surface of the rim. At least one circumferential groove is located
along the support ring seat and extends around the entire circumference of the radially outer surface of the rim.

[0007] Instead of at least one circumferential groove, in certain embodiments a plurality of circumferential grooves may be used. These grooves would in turn define a plurality of circumferential ribs. Each of these circumferential ribs has a radially outer surface that provides a portion of the support ring seat, and each radially outer surface is located at the same radial distance from the axis. Alternatively, the radial distance between each radially outer surface and the axis may vary among the plurality of ribs. In certain embodiments, the circumferential grooves and the circumferential ribs have about the same axial width. The shape of the circumferential grooves may be varied. For example only, although generally the grooves are rectangular, the grooves may be non-rectangular in shape. In addition, the radially inner surface of the rim may be tapered such that the radial distance from the axis to the radially inner surface of the rim decreases along the outboard direction of the axis. This configuration could be used, for example, to assist with the evacuation of materials from the radially inner surface. Stepped configurations of the radially inner surface may also be used. In certain embodiments, the wheel may be configured to use a support ring that has a radially inner surface configured for complementary receipt by the support ring seat.

[0008] In another exemplary embodiment of the present invention, a wheel disk is configured for removable connection with a vehicle. The wheel disk has an axis about which the wheel disk rotates during operation, the axis extending in an inboard and outboard direction. A rim is integrally attached to the wheel disk. The rim has an outer surface and an inner surface and has a support ring seat located on the outer surface of the rim. A plurality of circumferential grooves are defined by the rim and located upon the support ring seat. The grooves extend around the entire circumference of the outer surface of the rim such that the support ring seat is discontinuous in the axial direction at any point along the circumference of the support ring seat. The rim has an inboard bead seat and an outboard bead seat located on the radially outer surface of the rim. The support ring seat is intermediate the bead seats along the axial direction. A support ring is disposed on the support ring seat. A tire is provided that has an inboard and outboard bead. The inboard bead is disposed in the inboard bead seat of the rim, and the outboard bead is disposed in the outboard bead seat of the rim.

[0009] In still another exemplary embodiment, a component for a run-flat tire assembly is provided that includes a wheel rim having a radially outer surface and a radially inner surface. The rim also has a support ring seat located on the radially outer surface of the rim and has an axis about which rotation occurs during operation. The radially inner surface has a
mid-section located radially adjacent to the support ring seat. The radially inner surface has an inboard section located axially inboard of the mid-section. The radially inner surface also has an outboard section located axially outboard of the mid-section. The rim defines at least one circumferential groove that is located along the support ring seat and extends at least partially around the circumference of the radially outer surface of the rim. As a result, the support ring seat has at least one discontinuity in the axial direction for at least one point along the circumference of the support ring seat.

[0010] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

**Brief Description of the Drawings**

[0011] A full and enabling disclosure of the present subject matter, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0012] Fig. 1 is a partial cross-sectional view of a run-flat tire assembly.

[0013] Fig. 2 is a partial cross-sectional view of another run-flat tire assembly with a recess along the radially inner surface removed.

[0014] Fig. 3 is a partial cross-sectional view of a wheel having a plurality of circumferential grooves used in accordance with one exemplary embodiment of the present invention.

[0015] Fig. 4 is a partial cross-sectional view of a wheel having a plurality of circumferential grooves used in accordance with another exemplary embodiment of the present invention in which the circumferential grooves have varying widths.

[0016] Fig. 5 is a partial cross-sectional view of a tire assembly used in accordance with one exemplary embodiment of the present invention.

[0017] Fig. 6 is a partial cross-sectional view of a wheel having a plurality of circumferential grooves used in accordance with another exemplary embodiment of the present invention in which all points along the inner surface of the rim have the same radial distance from the axis of the wheel.

[0018] Fig. 7 is a partial cross-sectional view of a wheel having a plurality of circumferential grooves used in accordance with another exemplary embodiment of the present
invention in which the circumferential grooves define a plurality of ribs that are of varying heights.

[0019] Fig. 8 is a partial top view of the wheel of Fig. 3.

[0020] Fig. 9 is a partial cross-sectional view of a tire assembly used in accordance with one exemplary embodiment of the present invention.

[0021] Fig. 10 is an exploded assembly view of a tire assembly used in accordance with one exemplary embodiment of the present invention.

[0022] Fig. 11 is a perspective view of the tire assembly shown in Fig. 10. The tire assembly is configured for being attached to a wheel hub of a vehicle.

[0023] Repeat use of reference characters throughout the present specification and appended drawings is intended to represent same or analogous features or elements of the invention.

**Detailed Description**

[0024] Reference will now be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, and not meant as a limitation of the invention. For example, features illustrated or described as part of one embodiment can be used with another embodiment to yield still a third embodiment. It is intended that the present invention include these and other modifications and variations.

[0025] As previously discussed, for certain rim configurations such as that shown in Fig. 1, a pocket 84 is present on inner surface 22 of rim 18. This pocket 84 allows for material such as water, snow, mud, and the like to accumulate during operation of the vehicle. A rim that eliminates such accumulation is desirable. As shown in Fig. 2, pocket 84 can be eliminated through the addition of material or mass to inner surface 22 of rim 18. However, while so eliminating pocket 84 where accumulation occurs is desirable, accomplishing the elimination without unnecessarily increasing the mass of the rim is also desired.

[0026] Fig. 3 shows an exemplary embodiment of a wheel 10 used in accordance with the present invention. Therein, rim 18 has been provided with additional material such that pocket 84 of Fig. 1 is eliminated or filled in as with the embodiment of Fig. 2. However, in Fig. 3, support ring seat 24, which is located on outer surface 20 of rim 18, is provided with one or more circumferential grooves 26. The circumferential grooves 26 form a plurality of ribs 38, which provide a surface for the seating of support ring 52 (Fig. 5) thereon. Through the addition of circumferential grooves 26, the mass of rim 18 is reduced in a manner that compensates for the mass needed in order to fill void 84 while still maintaining
the strength and structural integrity of rim 18. If desired, circumferential grooves 26 may also be sized and/or numbered such that a larger amount of mass is removed from rim 18 than is gained through the filling in of pocket 84. Alternatively, circumferential grooves 26 may be sized and/or numbered so that rim 18 has a larger mass after inclusion of circumferential grooves 26 and the filling in of pocket 84.

[0027] Circumferential grooves 26 may be formed in support ring seat 24 in any manner commonly known in the art. For instance, wheel 10 may be cast and then machined through subsequent processes into a final product. Circumferential grooves 26 may then be formed in wheel 10, for example, by a turning operation to thereby eliminate the use of more complicated and expensive castings. However, if preferred, circumferential grooves 26 may also be cast into wheel 10 during its initial forming. The present invention is not limited to a specific manufacturing process in the formation of circumferential grooves 26, and one of ordinary skill in the art will understand that several techniques may be used to form grooves 26 using the teachings disclosed herein. Also, circumferential grooves 26 are advantageous in that their inclusion results in a wheel 10 that is axially symmetric as opposed to other features that might be used to reduce the mass of rim 18 that could result in a lack of symmetry or that would require more complex techniques in order to achieve symmetry.

[0028] Fig. 4 shows an exemplary embodiment where circumferential grooves 26 form a plurality of ribs 38, and grooves 26 that have different axial widths 42. Also, as compared to Fig. 3, ribs 38 in Fig. 4 have a smaller axial width 40. By way of further example, Fig. 5 shows an exemplary embodiment in which the same axial width is used for both the plurality of circumferential grooves 26 (axial width 42) and ribs 38 (axial width 40). Fig. 6 shows an exemplary embodiment in which the same axial width 42 is used for each circumferential groove 26, the same axial width 40 is used for each rib 38, but axial width 42 and axial width 40 are not equal. Using the teachings disclosed herein, one of ordinary skill in the art will appreciate that different combinations of axial widths 40 and 42 for ribs 38 and grooves 26 can be used with the present invention.

[0029] While circumferential grooves 26 in the exemplary embodiments of the figures have a cross-section that is generally rectangular in shape with rounded edges, the shape of circumferential grooves 26 may be modified in a variety of ways and is not limited to only the shapes of circumferential grooves 26 shown. For example, the cross-sectional shape may be triangular, square shaped, and/or semi-circular in accordance with other exemplary embodiments. Also, the cross-sectional shape of all circumferential grooves 26 need not be uniform but may vary from one groove 26 to the next. As such, the present invention is not
limited to a particular configuration of the shape and/or size of either circumferential grooves 26 or ribs 38 and one of ordinary skill in the art will appreciate, using the teachings disclosed herein, that there are many variations for the present invention. Similarly, it should also be understood that any number of circumferential grooves 26 may be formed into support ring seat 24. For instance, a single circumferential groove 26 may be used in one exemplary embodiment of the present invention, while in another exemplary embodiment of the present invention ten circumferential grooves 26 may be employed.

[0030] Fig. 1 and Fig. 10 show run-flat tire assembly 44 as including a wheel 10 having a rim 18, a support ring 52, and tire 54. Rim 18 has a first bead seat 48 and a second bead seat 50 formed therein for seating a first and second bead 56 and 58 respectively. First bead seat 48 is formed by a pair of humps 86 and 88. Second bead seat 50 is formed by a pair of humps 90 and 92. As seen in Fig. 11, tire assembly 44 may be placed over wheel hub 14 such that wheel hub 14 is bolted onto a wheel disk 12 of tire assembly 44.

[0031] During operation of a vehicle with low tire pressure, support ring 52 may be urged against support ring seat 24 such that a portion of support ring 52 is urged into circumferential grooves 26. This may help for better gripping and functioning of support ring 52. Alternatively, in other exemplary embodiments during run-flat operation, support ring 52 may only be disposed on support ring seat 24 and not into circumferential grooves 26.

[0032] As will now be discussed, grooves 26 and ribs 38 can also be varied to improve the gripping between support ring 52 and support ring seat 24. With the embodiments discussed in Figs. 3 through 6, support ring seat 24 has been depicted as having a uniform radial distance across its surface from axis 16. However, support ring seat 24 may be configured in other exemplary embodiments to have a varying distance from axis 16. One such exemplary embodiment is shown in Fig. 7 in which ribs 38 formed by circumferential grooves 26 are of different heights. Support ring 52 may be placed onto support ring seat 24 such that ribs 38 dig into support ring 52 in order to retain support ring 52 thereon. Alternatively, corresponding grooves may be formed in support ring 52 in order to accommodate raised ribs 38, in accordance with other exemplary embodiments of the present invention.

[0033] Fig. 8 is a top view of the exemplary embodiment of wheel 10 shown in Fig. 3. Here circumferential grooves 26 may be seen as a plurality of grooves 26 in outer surface 20 of rim 18 that cause support ring seat 24 to be a discontinuous surface along the axial direction from the inboard side of support ring 24 to the outboard side of support ring 24. More specifically, support ring seat 24 is discontinuous at each of the circumferential grooves
such that at no point around the circumference of rim 18 does support ring seat 24 form a continuous surface along the axial direction; each groove 26 creates a discontinuity. However, in accordance with other exemplary embodiments of the present invention, circumferential grooves 26 need not be formed around the entire circumference of rim 18, but may instead circumvent a portion of the circumference of rim 18. In this instance, support ring seat 24 may be a continuous surface along the axial direction from the outboard side to the inboard side of rim 18 at only certain locations along the circumference of rim 18 or at no location along the circumference (depending upon the positioning of grooves 26). Alternatively, in certain embodiments, ribs 38 need not be formed around the entire circumference of rim 18, but instead may circumvent only a portion of rim 18. By having portions of ribs 38 removed, the overall weight of rim 18 can be further decreased while still maintaining its structural integrity and providing a surface for support ring seat 24.

[0034] Fig. 9 shows an exemplary embodiment of tire assembly 44 where support ring 52 has a plurality of reinforcement bands 66 disposed therethrough. Reinforcement bands 66 may be present in order to provide for an increased strength of support ring 52. Additionally, reinforcement bands 66 may be tensioned to hold support ring 52 onto support ring seat 24. In the exemplary embodiment shown in Fig. 9, a plurality of reinforcement bands 66 are positioned at the same axial location along axis 16 as the plurality of ribs 38 formed by circumferential grooves 26. As such, none of reinforcement bands 66 are positioned at the same axial location along axis 16 as any of circumferential grooves 26. Such a configuration is advantageous in that ribs 38 of support ring seat 24 act to support reinforcement bands 66 and hence maintain support ring 52 onto rim 18. Reinforcement bands 66 may include reinforcing materials that have a high tensile modulus such that they are essentially inextensible. By way of example only, such materials may include fiberglass, steel, and polyamides.

[0035] While the addition of material to pocket 84 is desirable to eliminate the accumulation of various materials, inner radial surface 22 can also be further modified to move or evacuate such materials during operation. Referring again to the exemplary embodiment of Fig. 6, wheel disk 12 has an axis 16 about which rotation occurs during operation. For the embodiment of Fig. 6, the radial distance between axis 16 and radially inner surface 22 of rim 18 is substantially constant at all points along surface 22. More specifically, rim 18 has a mid-section 46, which is that portion of radially inner surface 22 radially adjacent to support ring seat 24. The radial distance 28 from axis 16 to all points along the surface of mid-section 46 is constant. Also, rim 18 has an inboard section 62, which is that portion of radially inner surface 22 inboard of, and axially adjacent to, mid-section 46. Rim 19 has an outboard section, 68,
which is that portion of radially inner surface 22 that is on the outboard side of mid-section 46. For the embodiment of Fig. 6, the radial distance 28 from axis 16 to the surface of mid-section 46 is the same as the radial distance 64 from axis 16 to the surface of inboard section 62 and the same as radial distance 70 from axis 16 to the surface of outboard section 68. To facilitate the removal of material during operation, radially inner surface 22 may be sloped or tapered either continuously or at stepped portions. For example, the radial distance between axis 16 and radially inner surface 22 could be gradually increased along the inboard direction 30 (thus decreasing in the outboard direction 32). Alternatively, radially inner surface 22 could have a stepped profile in which radial distance 64 is slightly larger than radial distance 28, which in turn is slightly larger than radial distance 70. Using the teaching disclosed herein, one of ordinary skill in the art will understand that numerous other variations of radially inner surface 22 can be used to evacuate materials during operation.

[0036] It should be understood that the present invention includes various modifications that can be made to the exemplary embodiments of wheel 10 and tire assembly 44 as described herein that come within the scope of the appended claims and their equivalents.
CLAIMS

1. A wheel, comprising:
   a wheel disk configured for removable connection with a wheel hub of a vehicle, the wheel disk having an axis about which the wheel disk rotates, the axis extending in an inboard and outboard direction; and
   a rim integrally attached to the wheel disk, the rim having a radially outer surface and a radially inner surface, the rim having a support ring seat located on the radially outer surface of the rim, the rim defining a plurality of circumferential grooves that define a plurality of circumferential ribs, each of the plurality of circumferential ribs having a radially outer surface that provides a portion of the support ring seat, and each circumferential groove extending around the entire circumference of the radially outer surface of the rim.

2. The wheel as set forth in claim 1, wherein the circumferential grooves and the circumferential ribs have about the same axial width.

3. The wheel as set forth in claim 1, wherein the radial distance between each radially outer surface and the axis varies from among the plurality of ribs.

4. The wheel as set forth in claim 3, wherein the circumferential grooves and the circumferential ribs have about the same axial width.

5. The wheel as set forth in claim 1, wherein the rim has a radially inner surface that tapers such that the radial distance from the axis to the radially inner surface of the rim decreases along the outboard direction of the axis.

6. The wheel as set forth in claim 1, wherein the at least one circumferential groove is non-rectangular in shape.

7. The wheel as set forth in claim 1, further comprising a support ring, the support ring having a radially inner surface that is configured for complementary receipt by the support ring seat.

8. The wheel as set forth in claim 7, where the support ring includes a plurality of reinforcement bands configured for strengthening the support ring.

9. A tire assembly, comprising:
   a wheel disk configured for removable connection with a vehicle, the wheel disk having an axis about which the wheel disk rotates during operation, the axis extending in an inboard and outboard direction;
   a rim integrally attached to the wheel disk, the rim having an outer surface and an inner surface, the rim having a support ring seat located on the outer surface of the rim, the rim defining a plurality of circumferential grooves located upon the support ring seat and extending
around the entire circumference of the outer surface of the rim such that the support ring seat is discontinuous in the axial direction at any point along the circumference of the support ring seat, the rim having an inboard bead seat and an outboard bead seat located on the radially outer surface of the rim, the support ring seat intermediate the bead seats along the axial direction;

a support ring disposed on the support ring seat; and

a tire having an inboard and outboard bead, the inboard bead disposed in the inboard bead seat of the rim, and the outboard bead disposed in the outboard bead seat of the rim.

10. The tire assembly as set forth in claim 9, wherein the plurality of circumferential grooves define a plurality of circumferential ribs, each of the plurality of circumferential ribs having a radially outer surface that provides a portion of the support ring seat, each radially outer surface being located at the same radial distance from the axis.

11. The tire assembly as set forth in claim 10, wherein the circumferential grooves and the circumferential ribs have about the same axial width.

12. The tire assembly as set forth in claim 9, wherein the plurality of circumferential grooves define a plurality of circumferential ribs, each of the plurality of circumferential ribs having a radially outer surface that provides a portion of the support ring seat, and wherein the radial distance between each radially outer surface and the axis varies from among the plurality of ribs.

13. The tire assembly as set forth in claim 12, wherein the circumferential grooves and the circumferential ribs have about the same axial width.

14. The tire assembly as set forth in claim 9, wherein the rim has a radially inner surface that tapers such that the radial distance from the axis to the radially inner surface of the rim decreases along the outboard direction of the axis.

15. The tire assembly as set forth in claim 9, wherein the at least one circumferential groove is non-rectangular in shape.

16. The tire assembly as set forth in claim 9, wherein the support ring has a radially inner surface that is configured for complementary receipt by the support ring seat.

17. The tire assembly as set forth in claim 9, wherein the plurality of circumferential grooves define a plurality of circumferential ribs, each of the plurality of circumferential ribs having a radially outer surface that provides a portion of the support ring seat, and wherein the support ring has a plurality of reinforcement bands disposed therein, the reinforcement bands each being located radially adjacent to at least one of the circumferential ribs.

18. A component for a run-flat tire assembly, comprising:
a wheel rim, the rim having a radially outer surface and a radially inner surface, the rim
having a support ring seat located on the radially outer surface of the rim, the rim having an
axis about which rotation occurs during operation, the radially inner surface having a mid-
section located radially adjacent to the support ring seat, the radially inner surface having an
inboard section located axially inboard of the mid-section, the radially inner surface having an
outboard section located axially outboard of the mid-section,

wherein the rim defines at least one circumferential groove located along the support
ring seat, the circumferential groove extending at least partially around the circumference of
the radially outer surface of the rim, whereby the support ring seat has at least one
discontinuity in the axial direction due to the circumferential groove for at least one point
along the circumference of the support ring seat, and

wherein the rim defines at least one circumferential rib located along the support ring
seat, the circumferential rib extending at least partially around the circumference of the radially
outer surface of the rim.

19. The component for a run-flat tire assembly as set forth in claim 18, wherein the radially
inner surface tapers such that the radial distance from the axis to the radially inner surface of
the rim decreases along the outboard direction of the axis.

20. The component for a run-flat tire assembly as set forth in claim 18, wherein the radial
distance from the axis to the inboard section of the radially inner surface is greater than the
radial distance from the axis to the mid-section, which in turn is greater than the radial distance
from the axis to the outboard section.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**
- IPC(7): B60B 21/02; B60C 15/02
- US CL: 152/381.3

According to International Patent Classification (IPC) or to both national classification and IPC

**B. DOCUMENTS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
- U.S.: 152/381.3, 520, 381.4, 381.5, 381.6, 379.3, 379.4, 301/95.101, 95.104, 95.105, 95.106, 95.108, 95.109

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)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Relevant to claim No.</th>
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[ ] Further documents are listed in the continuation of Box C.  [ ] See patent family annex.

* Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
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  - "O" document referring to an oral disclosure, use, exhibition or other means
  - "P" document published prior to the international filing date but later than the priority date claimed

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[ ] 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**

14 May 2004 (14.05.2004)

**Date of mailing of the international search report**

15 Jun 2004

**Name and mailing address of the ISA/US**

Mail Stop PCT, Attn: ISA/US Commissioner for Patents

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Form PCT/ISA/210 (second sheet) (July 1998)
C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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