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(54) **Title**: TIRE SPREADER FOR TIRE REPAIR

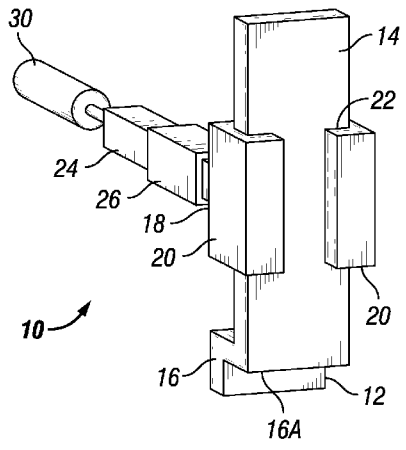


FIG. 1

(57) **Abstract**: The present invention concerns methods and apparatus for spreading beads in a tire. Particular embodiments of such methods include positioning a tire adjacent an automated material abrading tool, the tire having: a central opening bounded radially by an inner bead diameter; an interior tire cavity extending radially outward from the inner bead diameter; and an interior tire cavity opening extending between opposing an annular beads of the tire, the cavity being positioned between the central cavity and the interior tire cavity. Such methods may also include securing at least a portion of the first bead of the tire and positioning a tire spreader within the central opening of the tire, the tire spreader having a bead engaging portion for engaging a portion of the second bead generally opposite the secured portion of the first bead.

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TIRE SPREADER FOR TIRE REPAIR

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates generally to methods and apparatus for spreading a tire in preparation for repair of an inside tire surface.

Description of the Related Art

[0002] To apply a patch along an inside surface of a tire, various treatments are generally required. While typically a certain amount of tire material or other features must be removed from the inside of the tire, several different preparations are employed depending upon the patch and application. For example, applying a patch requires removal of a non-stick coating from the interior surface of the tire, removal of dirt or debris, removal of a bladder imprint, removal of a sufficient depth of material desired for installing the patch, applying a texture to the surface for receipt of the patch, removal of an old patch or other features, and/or other treatments. As used herein, "patch" shall be understood to include a material being added to the interior surface of the tire for purposes of repair as well as a device carrying various components such as e.g., electronic sensors, RFIDs, etc.

[0003] In preparing for patch application, various material removal tools and manual techniques may be used for treating the inside surface of the tire. For example, removal of tire material may be performed manually using a material removal tool, such as a grinding or abrading tool, e.g., an abrasive wheel or similar tool. Such material removal operations can be particularly challenging when preparing an interior tire surface, which requires operating the grinding tool inside the tire. This can cause a problem when a smaller tire does not provide sufficient clearance to allow the tire to receive the material removal tool.

[0004] Therefore, advantageous solutions that allow for automation and other improvements in treatment preparations for patch application along the inside of various tires are needed. Advantageous solutions that can be used with a variety of tools and treatment techniques as mentioned above would be particularly beneficial.

SUMMARY OF THE INVENTION

[0005] Particular embodiments of the present invention include a method for preparing an inside tire surface for repair. Particular embodiments of such method include

the step of providing a tire having: a central opening extending axially through the tire along a rotational axis of the tire being bounded radially by an inner bead diameter; an interior tire cavity extending radially outward from the inner bead diameter and being bound by an interior surface of the tire; and an interior tire cavity opening extending between opposing an annular beads of the tire, the cavity being positioned between the central cavity and the interior tire cavity. A further step of such methods may include securing at least a portion of the first bead of the tire. Such methods may include a step of positioning a tire spreader within the central opening of the tire, the tire spreader having a bead engaging portion for engaging a portion of the second bead, the tire engaging portion having a surface for engaging the portion of the second bead, the surface extending in a direction biased relative to a translation direction of the tire spreader. Embodiments of such methods may further include the step of automatically translating the bead engaging portion of the tire spreader generally in an axial direction of the tire to displace the engaged portion of the second bead a desired distance to increase the distance between the opposing beads to form a widened interior cavity opening.

[0006] Additional embodiments of the present invention include a machine for spreading the interior of a tire. Particular embodiments of such machine may include a tire spreader translatably mounted to the machine, the tire spreader being in communication with a translation means for forcefully translating a tire engaging portion of the tool a predetermined distance in a translation direction, the tire engaging portion having a surface for engaging a bead of a corresponding tire, the surface extending in a direction biased relative to the translation direction of the tire spreader.

[0007] The foregoing and other objects, features and advantages of the invention will be apparent from the following more detailed descriptions of particular embodiments of the invention, as illustrated in the accompanying drawing wherein like reference numbers represent like parts of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a front perspective view of a tire bead spreader, according to an embodiment of the invention;

[0009] FIG. **2** is a side view of the bead spreader of FIG. **1**, in accordance with an embodiment of the invention;

[0010] FIG. **3** is an top view of the bead spreader of FIG. **1**, according to an embodiment of the invention and,

[0011] FIG. **4** is a side view of a tire grinding machine including the bead spreader of FIG. **1**, according to an embodiment of the invention.

DETAILED DESCRIPTION OF PARTICULAR EMBODIMENTS

[0012] Particular embodiments of the present invention provide a tire spreader, which increases the distance between opposing beads of a tire to thereby allow access for a material removal tool, such as an abrading tool, to pass between the opposing beads and into an interior tire cavity for preparation of an interior tire surface. Other embodiments include a machine having a tire spreader, and in particular embodiments, a machine also having a material removal tool.

[0013] Such methods for preparing an interior tire surface for repair may include the step of providing a tire having: a central opening extending axially through the tire along a rotational axis of the tire being bounded radially by an inner bead diameter; an interior tire cavity extending radially outward from the inner bead diameter and being bound by an interior surface of the tire; and an interior tire cavity opening extending between opposing an annular beads of the tire, the cavity being positioned between the central cavity and the interior tire cavity. Generally, tires have a torus shape, whereby an outer diameter of the torus is generally flat to form an annular tire tread. Along an inner diameter of the torus is an annular opening extending between axially offset bead portions. The annular opening provides access to an annular interior tire cavity, which forms a pressurization chamber when the tire is mounted on a rim. The tire surface lining the interior chamber is referred to herein as the interior tire surface. The tire also includes a central opening extending through the tire, the opening extending axially between the opposing beads and radially inward from the beads between the beads and a rotational axis of the tire. In order to prepare the interior tire surface for repair, a material removal tool is first inserted into the central opening of the tire to ultimately access the interior cavity of the tire. Once in the interior cavity, the tool may be used to remove any foreign material from the interior tire surface and/or any tire material to prepare the tire for receiving a tire patch or any other repair material.

[0014] Methods for preparing an interior tire surface for repair may also include the step of securing at least a portion of the first bead of the tire. In order to prepare the interior tire surface, the tire is retained in a desired position, which may better allow for more

accurate removal of tire material using the material removal tool. Retaining the first bead in a desired position may prevent lateral translation of the first bead and/or rotation of the first bead about the rotational axis of the tire, for example. Because the opening into the interior tire cavity occurs at the bead area, the first of two beads is secured in particular embodiments. Any means known to one of ordinary skill may be employed, including using a hook or clamp, for example, to secure the first bead.

[0015] Such methods may also include the step of positioning a tire spreader within the central opening of the tire, the tire spreader having a bead engaging portion for engaging a portion of the second bead. In particular embodiments, the bead engaging portion engages a portion of the second bead generally opposite the secured portion of the first bead. In order to forcefully displace the second bead away from the first bead to create an enlarged opening through which a material removal tool may pass, structure is provided to engage the second bead. To properly force the bead in an outward direction of the tire, the structure is arranged to engage the interior side of the bead. In particular embodiments, the tire engaging portion includes a surface for engaging the portion of the second bead, the surface extending in a direction biased relative to a translation direction of the tire spreader.

[0016] The step of positioning may include, in particular embodiments, manually positioning the bead engaging portion of the bead spreader against the portion of the second bead before performing the step of automatically translating the bead engaging portion, the tire spreader being independently moveable from a tire spreader actuator used to translate the bead engaging portion of the tire spreader. When the tire spreader is independently moveable from a tire spreader actuator, the actuator is not attached to the tire spreader. Because different tire types and sizes may be used in association with the present invention, the present invention includes a means for altering the position in which the tire engaging portion of the tire spreader engages a tire bead. In an effort to accommodate potential bead locations, the step of positioning the spreader includes translating the bead engaging portion generally in a radial direction of a tire to engage the second bead. This may be accomplished by substantially translating tire spreader (as is achieved with the material removal tool assembly as discussed below) or by translating the tire engaging portion relative to other portions of the tire spreader. (For example, see the discussion below concerning the slideable connection between a mount and a base of the tire spreader). In other embodiments, wherein the tire is arranged vertically, whereby the rotational axis of the tire is generally parallel with a ground plane.

[0017] Methods for preparing an interior tire surface for repair may include the step of automatically translating the bead engaging portion of the tire spreader generally in an axial direction of the tire to displace the engaged portion of the second bead a desired distance to increase the distance between the opposing beads to form a widened interior cavity opening. In particular embodiments, the bead engaging portion is translated or displaced outwardly by a means for forcefully translating the tire engaging portion of the tire spreader, which may be achieved by pushing or pulling the tire engaging portion. Any means for forcefully translating the tire engaging portion of the tire spreader known to one of ordinary skill may be employed, such as, for example, an actuator. It is understood that "translation" or "translating" as used throughout this application refers to linear and/or curvilinear translation. Accordingly, in particular embodiments, the step of automatically translating the bead engaging portion is accomplished by linearly translating the bead engaging portion of the tire spreader. It is understood that in other embodiments the bead engaging portion may translate in any desired direction or path, including a non-linear or curvilinear path.

[0018] In particular embodiments, the means for forcefully translating the tire engaging portion of the tire spreader (also referred to as "the forceful translation means") generally provides an output translation displacement, which may be linear or curvilinear. The forceful translation means may translate the tire engaging portion a distance equal to the output displacement of the forceful translation means, or a distance less than or greater than output displacement. For example, when the forceful translation means is an actuator, the stroke of the actuator is the output displacement. It follows that the step of automatically translating the bead engaging portion may be accomplished automatically by configuring the means for forceful translation to provide (*i.e.*, generate) a constant output translation displacement, for example. In other examples, automatically translating the bead engaging portion may be accomplished automatically in whole or in part by employing any known controller, such as a programmable logic controller. In particular embodiments, such as controller includes any known logic processor, such as a microprocessor for example, and may utilize instructions and/or information stored on any known memory storage device, such as any hard disk drive, optical storage device, flash memory, or the like, to control the operation of any material removal tool. Controller may also utilize instructions and/or information received from any input device, such as a user interface for example, to control the operation of any material removal tool.

[0019] Particular embodiments of such methods may further include the step of the positioning the tire in a location adjacent a material removal tool. Because the interior tire cavity opening may receive a material removal tool, such as for preparing the interior tire surface for repair, the cavity opening must be of sufficient size to accept the tool. Since the tool size and the undeformed interior tire cavity opening are generally known, it is then known how the opening must be widened to receive the tool. Accordingly, additional embodiments of the step of automatically translating the bead engaging portion includes extending an actuator a sufficient distance to generate the widened interior cavity opening having a minimum width for receiving a material removal tool. When utilizing a tire spreader on various tire types and/or sizes, the narrowest possible interior tire cavity opening width may be known in addition to the minimum width required to receive a desired material removal tool, the actuator may have a constant length stroke to generate the widened interior cavity opening. And when the interior cavity opening of a target tire is sufficiently sized to receive a material removal tool without separating the opposing beads from an undeformed state, either the tire engaging portion may not engage the second bead or the actuator may not engage the tire spreader when the tire spreader is not attached to the actuator and is arranged to engage the second bead prior to actuation of the actuator (such as when manually positioning the tire engaging portion in the step of positioning a tire spreader within the central opening of the tire as noted above). Accordingly, in embodiment where the actuator is not attached to the tire spreader, the actuator engages the tire spreader as the actuator is extending.

[0020] Such methods may further include translating a material removal tool into the central opening of the tire, and positioning the material removal tool within the interior tire cavity by translating the tool through the widened interior cavity opening. The material removal tool may comprise any material removal tool known to one of ordinary skill in the art, such as, for example, a pneumatic grinding or abrading tool having a rotary grinding wheel (referred to more generally as a grinder), the grinding wheel having a texturized or bladed grinding surface. Other examples of material removal tools include the use of laser beams, sand blasters, and water jets.

[0021] In particular, the material removal tool is an automated material removal tool. Accordingly, the steps of extending and positioning the material removal tool may be automatically performed in whole or in part using a any known controller, such as a programmable logic controller, for example. Controller generally includes any known logic

processor, such as a microprocessor for example, and may utilize instructions and/or information stored on any known memory storage device, such as any hard disk drive, optical storage device, flash memory, or the like, to control the operation of any material removal tool. Controller may also utilize instructions and/or information received from any input device, such as a user interface for example, to control the operation of any material removal tool.

[0022] Exemplary embodiments of a tire or bead spreader for use in performing such methods are discussed in further detail below.

[0023] An exemplary embodiment of a tire spreader is shown in FIGS. **1-3**. The tire spreader includes a tire (or bead) engaging portion **12** for engaging a bead area of a tire. The tire engaging portion **12** extends from a base member **14** that is slideably connected to a mounting member **18**. A translation member **24** slideably maintained within a translation guide **26** attaches to a backside of mounting member **18** and facilitates guided translation of the tire engaging portion **12**. An actuator **30** forms a means for translating the tire engaging portion **12** (also referred to as the first translation means when discussing the machine below). In the embodiment shown, tire engaging portion **12** is configured to engage an interior side of a bead area of a tire for the purpose of further separating the engaged bead from an opposing, constrained bead of a tire. It is understood in other variations, however, tire engaging portion **12** is configured to engage the exterior side of a bead area.

[0024] Because tire spreader **10** may be used with different tire designs, tire engaging portion **12** is translatable to adapt to the bead location of differently designed tires. For example, tires may have different outer diameters associated with the tire tread and/or may have different bead diameters (see $\mathbf{d_B}$ in FIG. **4**) for mounting on differently sized wheels, each of which may affect the bead location of a tire relative to tire spreader **10**. In the embodiment shown, base **14** is able to slide along mount **18** by virtue of translation guide members **20** extending outwardly from mounting member **18** to surround at least a portion of base member **14** and form a passage **22** for translating base member **14**. In other variations, passage **22** may be formed by any structure capable of retaining base **14** in slideable constraint within passage **14**. Further, translation guide members **20** may fully extend to form a single translation guide **20** enclosing base **14** within passage **22**.

[0025] In the embodiment shown, a step **16** is provided between tire engaging portion **12** and base **14**. To resist gravitational forces acting on a free sliding base **14** arranged to slide in a vertical manner, step **16** provides a stop surface **16A** that rests atop a

tire to maintain base **14** in desired position relative to mount **18** and to position tire engaging portion **12** in a desired arrangement. In other variations, any other means for fixing the position of tire engaging portion **12** and sliding base **14** known to one of ordinary skill may be employed. For example, a locking pin may be inserted into an aperture extending through neighboring portions of base **14** and mount **18**.

[0026] With continued reference to FIGS. **1-3**, a means for translating tire engaging portion **12** and forceably applying tire engaging portion **12** against a tire includes a translation member **24** configured to translate within a translation guide **26**. In the embodiment shown, translation member **24** forms an elongate member adapted to slide within an elongate box structure **26**. It is understood that any known means for improving translation may be employed, such as bearings and/or lubricants, for example. Further, actuator **30** extends outwardly to engage translation member **24**, which thereby translates mount **18**, base **14**, and tire engaging portion **12**. Actuator **30**, or any other means for forceably translating tire engaging portion **12**, may be either operably attached or unattached to any component of tire spreader **10**, such as translation member **24**. In lieu of actuator **30**, means for forceably translating the tire engaging portion may comprise any known means for forceably translating tire engaging portion **12** to engage a tire and to apply a force capable of displacing the tire, regardless of whether such means pushes (*i.e.*, extends) or pulls (*i.e.*, retracts) translation member **24** and thereby mount **18**, base **14**, and tire engaging portion **12**. It is also understood that in other embodiments, the means for forceably translating the tire engaging portion may not engage any translation member **24**, and instead generally engage mount **18** or another member associated with mount **18**. Finally, the translation path of the various tire spreader components in the embodiment shown is generally linear, yet it is understood that non-linear translation of tire spreader components, including the tire engaging portion, may be employed as desired.

[0027] With reference to FIG. **4**, an exemplary embodiment of tire repair machine **40** is shown incorporating the tire spreader **10** described above. The machine **40** includes a tire receiving area **49** in which a tire **50** is secured along at least a portion of first bead **52**. A securing means **42** is provided, which may comprise any known means for securing bead **52**. Tire **50** includes an interior cavity **58** being bounded in part by interior tire surface $\mathbf{58_S}$ and an internal cavity opening **60** extending circumferentially between opposing beads. The tire also includes a central opening **62** extending axially through the tire, that is, extending axially inward between beads **52**, **54** and radially inward from beads **52**, **54** to the rotational axis of

the tire. Tire **50** has an outer diameter corresponding with the outer tread surface **56** and an inner bead diameter $\mathbf{d_B}$.

[0028] The machine further includes a material removal tool assembly **44** having a material removal tool **48** both moveable vertically by way of a means for translating vertically $\mathbf{46_V}$ and moveable in an axial direction of the tire by way of a means for translating axially $\mathbf{46_A}$. Each means for translating $\mathbf{46_A}$, $\mathbf{46_V}$ may comprise any known means for translating. Material removal tool assembly **44** and tire spreader **10** are generally operably attached to machine **10**, which may include attachment to any frame structure **41** of the machine **40**, for example. In the embodiment shown, both the material removal tool assembly **44** and the tire spreader **10** enter tire **50** from the same side of central opening **62** (*i.e.*, from the same axial side of the tire), whereby the tire spreader **10** is configured to push outwardly in an axial direction outer bead **54** to spread apart opposing beads **52**, **54** to create a wider interior tire cavity opening **60**. The pre-spread tire configuration is represented by $\mathbf{50_A}$ and the spread tire configuration represented by $\mathbf{50_B}$.

[0029] In other embodiments, it is understood that a machine **40** incorporating both a material removal tool **48** and a tire spreader **10** may enter tire **50** on opposing sides of the central cavity **62**, that is, from opposing axial sides of the tire. Further, it is understood that machine **40** may comprise separate, independent portions, whereby a material removal tool assembly **44** or material removal tool **48** may be operably attached to one independent, separate portion of the machine and the tire spreader **10** may be operably attached to another independent, separate portion of the machine. For example, when machine **40** comprises two separate portions, the portion including a material removal tool **48** or assembly **44** may be positioned on one axial side of the tire while the other machine portion including the tire spreader **10** is positioned on the opposing axial side of the tire.

[0030] With continued reference to FIG. **4**, actuator **30**, representing any possible means for forceably translating tire engaging portion **12** against a tire, has a stroke **S**. Stroke **S**, representing the translation distance of any means for forceably translating the tire engaging portion, may be predetermined regardless of the target tire to be spread, whereby the predetermined translation distance provides an opening **60** having a desired minimum width for receiving a material removal tool or the like. In other variations, the translation distance of any means for forceably translating the tire engaging portion (represented by stroke **S**) may be variable, where such translation distance may be manually controlled by an operator or may be logically controlled by a controller and/or processor associated with

machine **40**. The variable distance may be predetermined based upon the target tire type to be spread, where the predetermined distance may be stored on a computer readable medium in association with a tire type and/or size. The target tire type and/or size may be identified by an operator that may enter the information into a user interface, or may be determined by any known means for sensing the tire type or size using the physical dimensions of the tire or by reading any information physically or electronically stored on the tire, such as a barcode or a RFID tag, for example.

[0031] While this invention has been described with reference to particular embodiments thereof, it shall be understood that such description is by way of illustration and not by way of limitation. Accordingly, the scope and content of the invention are to be defined only by the terms of the appended claims.

CLAIMS

What is claimed is:

1. A method for preparing an interior surface of a tire for repair, the method comprising the steps of:

providing a tire having: a central opening extending axially through the tire along a rotational axis of the tire being bounded radially by an inner bead diameter; an interior tire cavity extending radially outward from the inner bead diameter and being bound by an interior surface of the tire; and an interior tire cavity opening extending between opposing an annular beads of the tire, the cavity being positioned between the central cavity and the interior tire cavity;

securing at least a portion of the first bead of the tire;

positioning a tire spreader within the central opening of the tire, the tire spreader having a bead engaging portion for engaging a portion of the second bead, the tire engaging portion having a surface for engaging the portion of the second bead, the surface extending in a direction biased relative to a translation direction of the tire spreader;

automatically translating the bead engaging portion of the tire spreader generally in an axial direction of the tire to displace the engaged portion of the second bead a desired distance to increase the distance between the opposing beads to form a widened interior cavity opening.

2. The method of claim 1, wherein the step of automatically translating the bead engaging portion provides a widened interior cavity opening having a minimum width sufficient for receiving a material removal tool.

3. The method of claim 2 further comprising the steps of:

positioning the tire in a location adjacent a material removal tool;

translating a material removal tool into the central opening of the tire; and,

positioning the material removal tool within the interior tire cavity by translating the material removal tool through the widened interior cavity opening.

4. The method of claim 1, wherein the step of automatically translating the bead engaging portion is accomplished by linearly translating the bead engaging portion of the tire spreader.

5. The method of claim 1, wherein the step of positioning a tire spreader within the central opening of the tire includes manually positioning the bead engaging portion of the bead spreader against the portion of the second bead before performing the step of automatically translating the bead engaging portion, the tire spreader being independently moveable from a tire spreader actuator used to translate the bead engaging portion of the tire spreader.

6. The method of claim 4, wherein the step of automatically translating the bead engaging portion includes extending an actuator having a stroke sufficient to generate the widened interior cavity opening to receive a material removal tool.

7. The method of claim 4, wherein the actuator engages the tire spreader as the actuator is extending.

8. The method of claim 4, wherein the actuator has a constant length stroke to generate the widened interior cavity opening.

9. The method of claim 1, wherein the step of positioning the spreader includes translating the bead engaging portion generally in a radial direction of the tire to radially position the bead engaging portion prior to the step of automatically translating the bead engaging portion.

10. The method of claim 9, wherein the tire is arranged vertically, whereby the rotational axis of the tire is generally parallel with a ground plane.

11. A machine for spreading the interior of a tire, the machine comprising:

a tire spreader translatably mounted to the machine, the tire spreader being in communication with a translation means for forcefully translating a tire engaging

portion of the tool a predetermined distance in a translation direction, the tire engaging portion having a surface for engaging a bead of a corresponding tire, the surface extending in a direction biased relative to the translation direction of the tire spreader.

12. The machine of claim 11 further comprising:

a tire receiving area having a means for securing at least a portion of a first tire bead, the tire spreader being arranged to engage a second tire bead positioned opposite the first tire bead in an axial direction of a tire.

13. The machine of claim 11, wherein the translation means is a linear actuator.

14. The machine of claim 13, wherein the linear actuator is arranged to independently engage and disengage a translation member of the tire spreader, the translation member extending longitudinally in a translation direction of the tire spreader, the tire engaging portion of the tire spreader extending generally in a radial direction of the tire, the translation member of the tire spreader being slideably retained by a translation guide.

15. The machine of claim 11, wherein the tire spreader further includes a base generally extending perpendicular to the translation direction of the tire spreader, the tire engaging portion extending outwardly from a portion of the base.

16. The machine of claim 15, wherein the tire engaging member is offset from the base member to create a stop surface for radially engaging an associated tire bead.

17. The machine of claim 15, wherein the base is slideably retained within a mount member of the tire spreader to slide generally in a radial direction of the tire.

18. The machine of claim 17, wherein the base slideably extends through an aperture within the mount.

19. The machine of claim 17, wherein the mount is operably attached to the translation member.

20. The machine of claim 11 further comprising:

an abrading tool translatably mounted to the machine, the tool being in operable communication with a first translation means for translating the abrading tool into a central opening of a tire, the central opening extending through the tire within an inner bead diameter of a pair of opposing first and second tire beads.

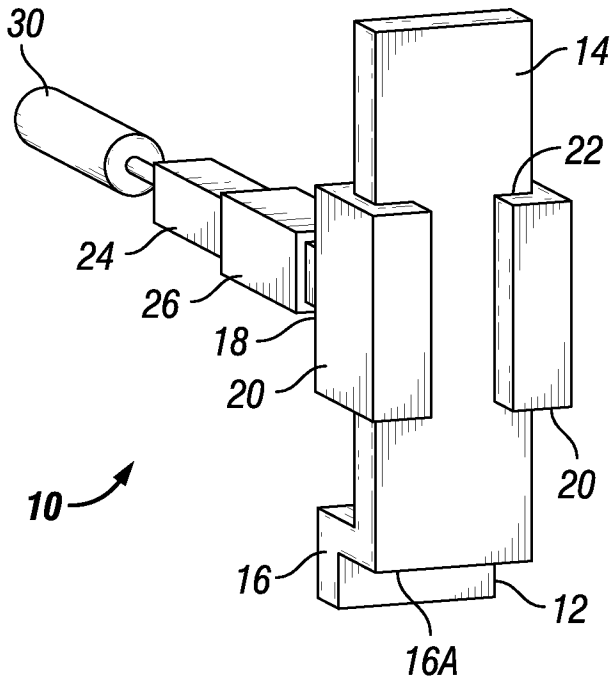


FIG. 1

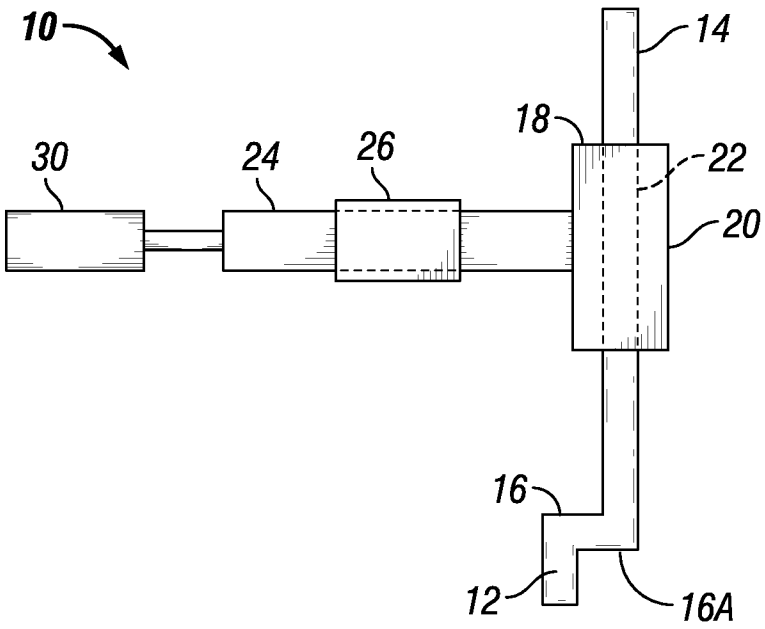


FIG. 2

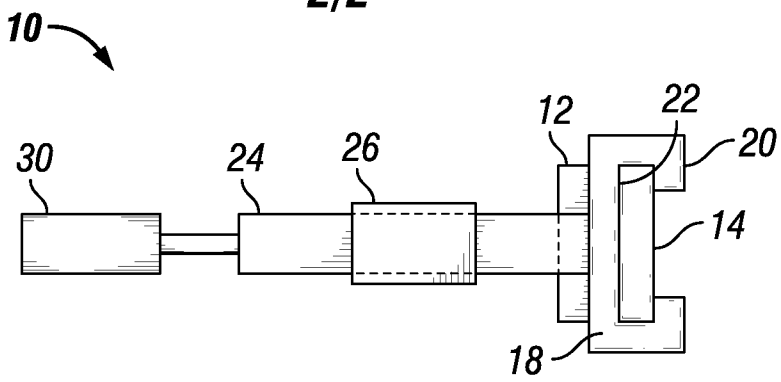

10
30
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26
12
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14
18

FIG. 3

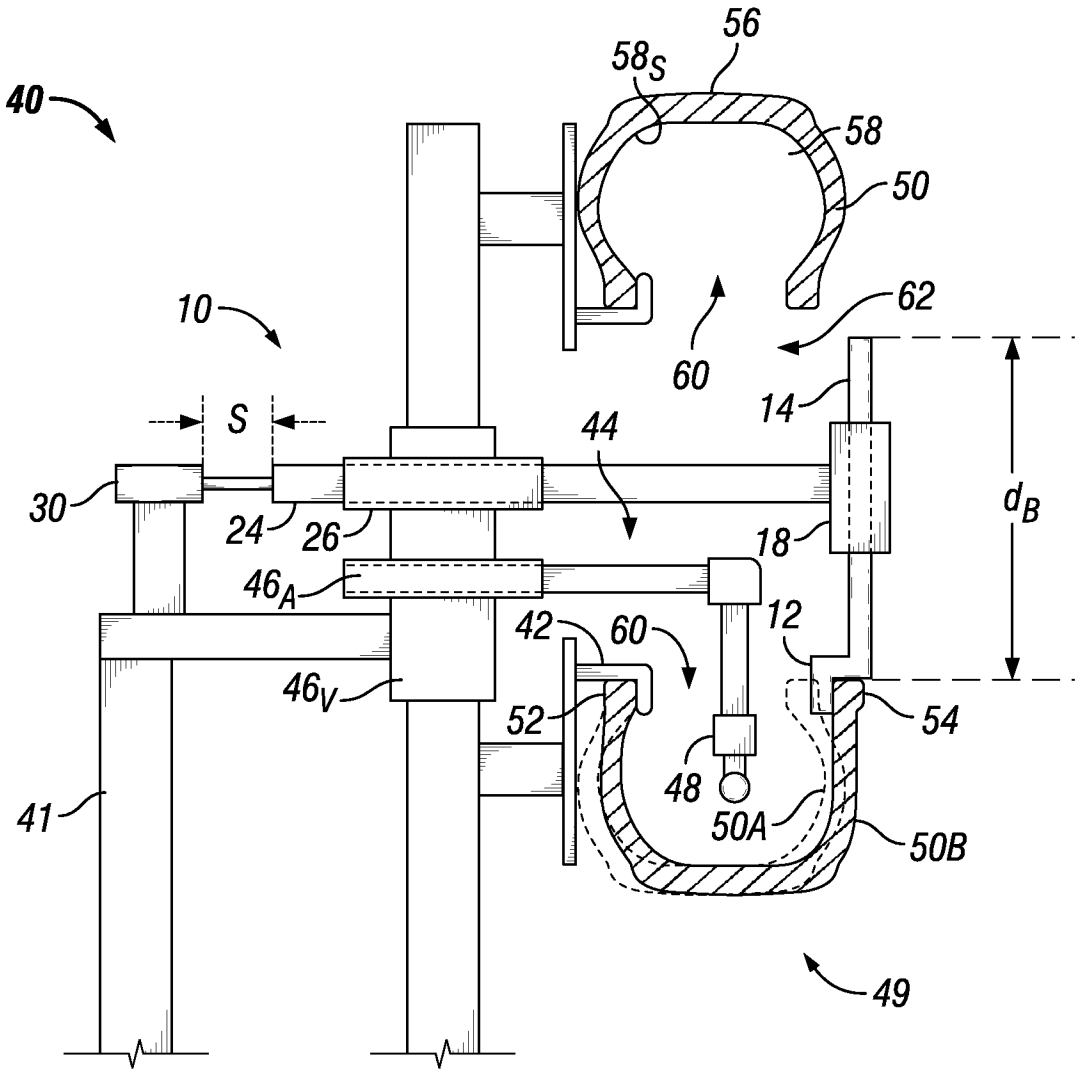

40
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56
58S
58
50
62
60
14
S
44
30
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26
18
46A
42
60
12
46V
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54
48
50A
50B
41
49
dB

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/023210

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60C 25/14 (2011.01)
USPC - 157/16; 254/50.3
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) - B60C 25/14 (2011.01)
USPC - 29/33T, 245, 277, 402.09, 402.11, 406, 559; 73/146; 81/ 15.2, 15.3, 15.5, 15.7; 134/8, 16, 45, 123; 152/368, 375, 397-400, Dig. 8, 157/ 1.26, 1.28, 1.3, 1.46, 14, 16, 21; 254/ 50.1-50.4, 113, 114, 131, 133R, 134, Dig. 1

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, Google Patent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 1,345,849 A (HARKINS) 06 July 1920 (06.07.1920) entire document	11, 12, 15-19 --- 1-10, 13, 14, 20
Y	US 2,784,937 A (LEFKE) 12 March 1957 (12.03.1957) entire document	1-10, 13, 14
Y	WO 09/070146 A1 (CHEBI et al) 04 June 2009 (04.06.2009) entire document	3, 20
A	US 1,954,031 A (WOOD) 10 April 1934 (10.04.1934) entire document	1-20
A	US 2,073,510 A (BISHMAN) 09 March 1937 (09.03.1937) entire document	1-20
A	US 2,928,119 A (FASSERO et al) 15 March 1960 (15.03.1970) entire document	1-20

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
17 March 2011	25 MAR 2011
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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