US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250256370
Kind Code A1
Publication Date August 14, 2025
Inventor(s) Clark; Barry Allan et al.

System and Method for Pre-Conditioning Pneumatic Tires Prior to Mounting Same Onto a Wheel

Abstract

A tire pre-conditioning system for conditioning a bead of a tire includes a burnisher and a controller. The burnisher is attached to a shaft. The controller is in communication with at least one of the burnisher or the tire. The controller is configured to move one of the burnisher or the tire until the burnisher is opposing the bead of the tire. The controller is also configured to supply pressurized fluid into an internal cavity of the tire to cause the bead to contact the burnisher to burnish the bead of the tire.

Inventors: **Clark; Barry Allan (Ortonville, MI), Straitiff; Donald Graham (Howell, MI), Donnay; David Paul (Ortonville, MI)**

Applicant: **Android Industries LLC** (Auburn Hills, MI)

Family ID: **58446594**

Appl. No.: **19/023896**

Filed: **January 16, 2025**

Related U.S. Application Data

parent US continuation 15287312 20161006 parent-grant-document US 10160084 child US 16228408
parent US division 18524108 20231130 parent-grant-document US 12202096 child US 19023896
parent US division 16228408 20181220 parent-grant-document US 11865669 child US 18524108
us-provisional-application US 62237958 20151006

Publication Classification

Int. Cl.: **B24B5/36** (20060101); **B24B5/08** (20060101); **B24B5/40** (20060101); **B24B5/44** (20060101); **B24B27/00** (20060101); **B24B39/02** (20060101); **B24D5/02** (20060101);

B29D30/00 (20060101)

U.S. Cl.:

CPC **B24B5/366** (20130101); **B24B5/08** (20130101); **B24B5/44** (20130101); **B24B27/0076** (20130101); **B24B39/02** (20130101); **B24D5/02** (20130101); **B29D30/0061** (20130101); B24B5/40 (20130101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a divisional of U.S. patent application Ser. No. 18/524,108 filed Nov. 30, 2023, which is a divisional of U.S. patent application Ser. No. 16/228,408 filed Dec. 20, 2018, now U.S. Pat. No. 11,865,669 issued on Jan. 9, 2024, which is a continuation of U.S. patent application Ser. No. 15/287,312, now U.S. Pat. No. 10,160,084, issued on Dec. 25, 2018, and claims the benefit of U.S. Provisional Application 62/237,958 filed on Oct. 6, 2015. The entire disclosures of the above applications are incorporated by reference.

FIELD
[0002] This disclosure relates to pre-conditioning pneumatic tires, and more particular to a system and method for pre-conditioning a pneumatic tire prior to mounting the tire onto a wheel.
BACKGROUND
[0003] Wheel-tire assemblies support vehicles upon a ground surface and permit vehicles to move relative to the ground surface when the wheel-tire assemblies rotate. Pneumatic tires forming these wheel tire-assemblies are associated with inherent structural non-uniformities that may cause objectionable vibrations throughout the vehicle. To provide uniformity to a tire prior to mounting the tire onto a wheel, it is known, to burnish the beads of the tire, remove small pieces of mold flash and other surface anomalies from the tire, and generally condition an interface surface of the tire so that the tire may effectively seat onto the corresponding wheel.
SUMMARY
[0004] One aspect of the disclosure provides a tire pre-conditioning system including a first mandrel, a second mandrel axially spaced apart from the first mandrel, and a controller in communication with the first mandrel and the second mandrel. The first mandrel is fixedly attached to a first shaft for common rotation about a longitudinal axis. The first mandrel includes a first tapered sidewall. The second mandrel is fixedly attached to a second shaft for common rotation about the longitudinal axis. The second mandrel includes a second tapered sidewall. The controller is operable to axially move the first mandrel and the second mandrel toward one another until the first tapered sidewall of the first mandrel is in opposed contact with a first bead of a tire and the second tapered sidewall of the second mandrel is in opposed contact with a second bead of the tire. The tire is disposed between the first mandrel and the second mandrel and coaxial with the longitudinal axis. The controller is also operable to rotate the first mandrel and the second mandrel about the longitudinal axis relative to the tire to cause the first tapered sidewall to burnish the first bead of the tire and the second tapered sidewall to burnish the second bead of the tire.
[0005] Another aspect of the present disclosure provides a tire pre-conditioning system including a first mandrel fixedly attached to a first shaft and a second mandrel axially spaced apart from the first shaft and fixedly attached to a second shaft. The first mandrel includes a first tapered sidewall and the second mandrel includes a second tapered sidewall. A controller in communication with the first mandrel and the second mandrel is operable to axially move the first mandrel and the second mandrel toward one another until the first tapered sidewall of the first mandrel is opposing a first bead of a tire and the second tapered sidewall of the second mandrel is opposing a second bead of

the tire. The tire is disposed between the first mandrel and the second mandrel and coaxial with a longitudinal axis defined by the first shaft and the second shaft. The controller is further configured to supply pressurized fluid into an internal cavity of the tire to inflate the tire. The inflating of the tire causes the first bead to move relative to the first mandrel while contacting the first tapered sidewall to burnish the first bead of the tire, and the second bead to move relative to the second mandrel while contacting the second tapered sidewall to burnish the second bead of the tire.

[0006] Implementations of the disclosure may include one or more of the following optional features. In some implementations, the system includes a first linear actuator and a first rotary drive unit each in communication with the controller and the first shaft, and a second linear actuator and a second rotary drive unit each in communication with the controller and the second shaft. In these implementations, the first linear actuator is configured to axially move the first shaft in a first direction toward the second shaft and a second direction away from the second shaft, and the second linear actuator is configured to axially move the second shaft in the direction toward the first shaft and the first direction away from the first shaft. In these implementations, the first rotary drive unit is configured to rotate the first shaft about the longitudinal axis and the second rotary drive unit is configured to rotate the second shaft about the longitudinal axis.

[0007] In some examples, the system further includes a first air pressure source in communication with the controller and configured to supply pressurized fluid to an internal cavity of the tire to inflate the tire when the first tapered sidewall is in opposed contact with the first bead and the second tapered sidewall is in opposed contact with the second bead. The first shaft may define a first slip sleeve configured to direct the pressurized air from the first air pressure source to the internal cavity of the tire. In some configurations, the system further includes a second air pressure source in communication with the controller and configured to pressurized fluid to the internal cavity of the tire to inflate the tire when the first tapered sidewall is in opposed contact with the first bead and the second tapered sidewall is in opposed contact with the second bead. In these configurations, the first and second air pressure sources supply the pressurized fluid to the internal cavity concurrently. The second shaft may define a second slip sleeve configured to direct the pressurized air from the second air pressure source to the internal cavity of the tire.

[0008] At least a portion of the first tapered sidewall and the second tapered sidewall may include abrasive materials that may be impregnated within the first tapered sidewall and the second tapered sidewall. Additionally or alternatively, an exterior surface of at least one of the first tapered sidewall or the second tapered sidewall is roughened. IN some examples, at least one of the first tapered sidewall or the second tapered sidewall includes a circumferential burnishing region defined by a series of apertures formed through the at least one of the first tapered sidewall or the second tapered sidewall. In these examples, one or more of the apertures may be defined by cambered walls configured to shave off excess tire material. In some implementations, a circumferential axial stop radially protrudes from at least one of the first tapered sidewall or the second tapered sidewall. The axial stop is configured to limit axial movement of the tire when the first tapered sidewall is in opposed contact with the first bead of the tire and the second tapered sidewall of the second mandrel is in opposed contact with the second bead of the tire.

[0009] Another aspect of the disclosure provides a method of pre-conditioning a pneumatic tire. The method includes positioning the tire in a tire vice between a first mandrel and a second mandrel axially spaced apart from the first mandrel. The first mandrel and the second mandrel are each fixedly attached to a respective shaft for common rotation about a longitudinal axis. The method further includes axially moving the first mandrel and the second mandrel toward one another in opposite directions until a first tapered surface of the first mandrel is in opposed contact with a circumferential first bead of the tire and a second tapered sidewall of the second mandrel is in opposed contact with a circumferential second bead of the tire. When the first tapered surface is in opposed contact with the first bead and the second tapered sidewall is in opposed contact with the second bead, the method includes rotating the first mandrel and the second mandrel about the longitudinal axis relative to the tire to remove excess tire material from the first bead and the second bead, axially moving the first mandrel and the second mandrel away from one another, and removing the tire from the tire vice.

[0010] Another aspect of the present disclosure provides a method of pre-conditioning a pneumatic tire. The method includes positioning the tire in a tire vice between a first mandrel and a second mandrel axially spaced apart from the first mandrel. The first mandrel and the second mandrel are each fixedly attached to a respective shaft defining a longitudinal axis. The method further includes axially moving the first mandrel and the second mandrel toward one another in opposite directions until a first tapered surface of the first mandrel is opposing a circumferential first bead of the tire and a second tapered sidewall of the second mandrel is opposing a circumferential second bead of the tire. When the first tapered surface is opposing the first bead and the second tapered sidewall is opposing the second bead, the method includes inflating the tire by providing pressurized fluid from an air pressure source in fluid communication with an internal cavity of the tire via a slip sleeve defined by the first shaft or the second shaft. The inflating of the tire removes excess tire material from the first bead and the second bead as the first bead moves relative to the first mandrel while in contact with the first tapered surface and the second bead moves relative to the second mandrel while in contact with the second tapered surface.

[0011] This aspect may include one or more of the following optional features. In some implementations, the circumferential first bead and the circumferential second bead of the tire each define a respective tire opening coaxial with the longitudinal axis when the tire is positioned in the tire vice between the first mandrel and the second mandrel. Positioning the tire in the tire vice may include positioning an uninflated tire in the tire vice.

[0012] In some examples, prior to rotating the first mandrel and the second mandrel about the longitudinal axis, the method further includes inflating the tire by providing pressurized fluid from an air pressure source in fluid communication with an internal cavity of the tire via a slip sleeve defined by the first shaft. Moreover, prior to axially moving the first mandrel and the second mandrel away from one another, the method may include deflating the tire by opening an air release valve disposed in an air conduit fluidly connecting the air pressure source and the slip sleeve.

[0013] The exterior surfaces of the first tapered sidewall and the second tapered sidewall may be at least one of roughened or comprise abrasive materials. In some examples, at least one of the first tapered sidewall or the second tapered sidewall defines a circumferential burnishing region defined by a series of apertures. Additionally or alternatively, at least one of the first tapered sidewall or the second tapered sidewall may include a circumferential axial stop that protrudes radially outward from the at least one of the first tapered sidewall or the second tapered sidewall.

[0014] The details of one or more implementations of the disclosure are set forth in the accompanying drawings and the description below. Other aspects, features, and advantages will be apparent from the description and drawings, and from the claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is an isometric view of an example tapered mandrel having a leading edge defined by a first radius, a trailing edge defined by a second radius greater than the first radius, and a tapered sidewall interconnecting the leading and trailing edges.

[0016] FIG. **2**A is an isometric view of an example tire pre-conditioning system including a pair of tapered mandrels axially spaced apart from one another and configured to move axially toward a central opening of a tire disposed axially between the tapered mandrels.

[0017] FIG. **2**B is an isometric view of the tire pre-conditioning system of FIG. **2**A showing the

pair of tapered mandrels axially moved against beads of the tire.
[0018] FIG. **3**A is an isometric cross-sectional view of an example tire pre-conditioning system including a pair of tapered mandrels axially spaced apart from one another and a pneumatic tire disposed between the tapered mandrels.
[0019] FIG. **3**B is an isometric cross-sectional view of the tire pre-conditioning system of FIG. **3**A showing the tapered mandrels axially moved against beads of the tire.
[0020] FIG. **3**C is an isometric cross-sectional view of the tire pre-conditioning system of FIG. **3**A showing air pressure sources supplying pressurized air into a cavity of the tire.
[0021] FIG. **3**D is an isometric cross-sectional view of the tire pre-conditioning system of FIG. **3**A showing the tapered mandrels rotating about a common axis of rotation relative to the tire to burnish the beads of the tire.
[0022] FIG. **3**E is an isometric cross-sectional view of the tire pre-conditioning system of FIG. **3**A showing air relief valves releasing the pressurized air from the cavity of the tire.
[0023] FIG. **3**F is an isometric cross-sectional view of the tire pre-conditioning system of FIG. **3**A showing the tapered mandrels axially moving in opposite directions away from the tire.
[0024] FIG. **4**A is an isometric view of an example mandrel including a burnishing region extending circumferentially around a tapered sidewall surface.
[0025] FIG. **4**B is a detailed view of the burnishing region of the mandrel of FIG. **4**A showing a series of apertures formed through the tapered sidewall surface to define the burnishing region.
[0026] FIG. **4**C is a cross-sectional view taken along line **4**C-**4**C of FIG. **4**B showing abrasive material impregnated into the surface of the sidewall within the burnishing region.
[0027] FIG. **5** is an isometric cross-sectional view of a tire pre-conditioning system including a pair of tapered mandrels each including a respective burnishing region for burnishing beads of a tire when the mandrels rotate about a common axis of rotation relative to the tire.
[0028] FIG. **6** is an isometric view of an example mandrel including an axial stop protruding radially outward from a tapered sidewall surface of the mandrel and circumferentially extending around the tapered sidewall surface.
[0029] FIG. **7** is an isometric cross-sectional view of a tire pre-conditioning system including a pair of tapered mandrels each including a circumferential axial stop protruding radially outward from a tapered sidewall surface for limiting axial movement of bead surfaces of a tire when a cavity of the tire receives pressurized air.
[0030] FIG. **8** provides an isometric cross-sectional view of a tire pre-conditioning system including a pair of tapered mandrels axially spaced apart from one another and a pneumatic tire disposed between the tapered mandrels.
[0031] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Introduction

[0032] Referring to FIG. **1**, in some implementations, a mandrel **10** for a tire pre-conditioning system **100** (FIGS. **2**A and **2**B) includes a leading edge **12** having a first radius, a trailing edge **14** having a second radius greater than the first radius, and a tapered sidewall **16** interconnecting the leading edge **12** and the trailing edge **14**. Accordingly, the mandrel **10** may define a conical or frusto-conical shape. The mandrel **10** may include a leading surface **18** having an outer periphery defined by the leading edge **12** and defining a shaft opening **20** for fixedly mounting the mandrel **10** to a rotatable shaft **22** (FIG. **2**A). The tapered sidewall **16**, or portion thereof, may be associated with a specific roughness and/or geometry for optimally burnishing a bead TBL, TBU (FIGS. **2**A and **2**B) of a tire T in contact therewith when the mandrel **10** rotates relative to the tire T while contacting the bead surface TBL, TBU. A pair of mandrels **10**, **10**′ (FIGS. **2**A and **2**B) may cooperate to burnish respective ones of a circumferential upper bead TBU and a circumferential lower bead TBL of the tire T when each of the mandrels **10**, **10**′ rotate relative to the tire while contacting the beads TBL, TBU.

[0033] A used herein, the terms “upper”, “lower”, “left”, “right”, and “side” may reference an exemplary tire T and/or components of a tire-preconditioning system **100**; although such nomenclature may be utilized to describe a particular portion or aspect of the tire T or system **100**, such nomenclature may be adopted due to the orientation of the tire T with respect to the system **100**. Accordingly, the above nomenclature should not be utilized to limit the scope of the claimed invention and is utilized herein for exemplary purposes in describing implementations of the present disclosure.

[0034] FIGS. **2**A and **2**B provide a tire pre-conditioning system **100** for burnishing beads TBL, TBU of a pneumatic tire T. The tire pre-conditioning system **100** includes an upper mandrel **10** and a lower mandrel **10′** axially aligned with one another and fixed to a respective shaft **22**, **22′** for common rotation about a longitudinal axis L. A portion of each shaft **22**, **22′** may extend through the respective opening **20**, **20′** and define a slip sleeve **24**, **24′** (FIG. **3**A) for directing pressurized air to inflate the tire T. Slip sleeve **24**, **24′** (also known as a slip coupling) is effective for transferring pressurized air from conduit **25**, **25′** into the tire to inflate the tire even when shaft **22**, **22′** rotates. The mandrels **10**, **10***a* each include the leading edge **12**, **12′**, the trailing edge **14**, **14′**, and the tapered sidewall **16**, **16′** interconnecting the leading edge **12**, **12′** and the trailing edge **14**, **14′**. In some examples, the first radius associated with each leading edge **12**, **12′** is substantially the same, while in other examples, the first radius associated with the leading edge **12** of the upper mandrel **10** is different than the first radius associated with the leading edge **12′** of the lower mandrel **10′**. Additionally, or alternatively, the second radius associated with the trailing edge **14** of the upper mandrel **10** and the second radius associated with the trailing edge **14′** of the lower mandrel **10′** may be the same or different. Thus, the length and/or slope of the tapered sidewalls **16**, **16′** may be the same or different.

[0035] The tire T includes an upper sidewall TSU, a lower sidewall TSL, and a thread surface TT joining the upper sidewall TSU to the lower sidewall TSL. The upper sidewall TSU may rise away from the tread surface TT to a peak and subsequently descend at a slope to terminate at and form the circumferential upper bead, TBU; similarly, the lower sidewall TSL may rise away from the tread surface TT to a peak and subsequently descend at a slope to terminate at and form the circumferential lower bead TBL. The upper bead TBU may form a circular, upper tire opening TOU, while the lower bead TBL may form a circular, lower tire opening TOL.

[0036] FIG. **2**A shows the mandrels **10**, **10′** axially spaced apart from one another such that the openings **20**, **20′** are coaxial with the longitudinal axis L and the shafts **22**, **22′** are substantially collinear with the longitudinal axis L. The tire T is disposed between the pair of mandrels **10**, **10′** such that the upper and lower tire opening TOU, TOL are coaxial with the longitudinal axis L. In some examples, the mandrels **10**, **10′** are configured to move axially toward one another in opposite directions. For instance, the upper mandrel **10** may move axially downward until the leading edge **12** passes through the upper tire opening TOU and the sidewall **16** is in opposed contact with the upper bead TBU. Similarly, the lower mandrel **10′** may move axially upward until the leading edge **12′** passes through the lower tire opening TOL and the sidewall **16′** is in opposed contact with the lower bead TBL.

[0037] FIG. **2**B shows the pair of frusto-conical mandrels **10**, **10′** each axially moved toward one another such that the exterior of each sidewall **16**, **16′** is in opposed contact with the respective bead TBU, TBL of the tire T. The leading edges **12**, **12′** may be axially spaced apart from one another or may touch. A distal end of each shaft **22**, **22′** may be substantially flush with the respective leading edge **12**, **12′** or may axially extend thru the respective opening **22**, **22′** and away from the respective leading edge **12**, **12′**. FIG. **2**B shows the tire in an un-inflated state and the exterior surfaces of the sidewalls **16**, **16′** each simulating a bead seat surface of a road wheel. Accordingly, the axial movement of the mandrels **10**, **10′** into contact with the beads TBU, TBL of the tire T simulates the mounting of the uninflated tire T onto a road vehicle wheel. In some implementations, one or both of the shafts **22**, **22′** defines the slip sleeve **24**, **24′** (FIGS. **3**A-**3**F) for directing pressurized air into a circumferential air cavity TAC (FIGS. **3**A-**3**F) of the tire T for inflating the tire T. The tire T may be inflated to a pressure that provides sufficient tension between each circumferential bead TBU, TBL of the tire T and the respective mandrel **10**, **10′** in contact therewith. In some examples, a portion of at least one of the sidewalls **16**, **16′** may be roughened and/or include abrasive materials to help facilitate the burnishing of the beads TBU, TBL of the tire T. Additionally or alternatively, at least one of the sidewalls **16**, **16′** may include an axial stop **616** (FIGS. **6** and **7**) that protrudes radially outward for limiting axial movement of the tire T when the mandrels **10**, **10′** move toward one another and the tire T is inflated. Once inflated, the mandrels **10**, **10′** may rotate about the longitudinal axis L relative to the tire T to cause the exterior of each tapered sidewall **16**, **16′** to burnish excess material from the beads TBU, TBL of the tire T in contact therewith.

[0038] FIGS. **3**A-**3**F provide isometric cross-sectional views of the tire pre-conditioning system **100** for burnishing/removing excess material from upper and lower beads TBU, TBL of the tire T prior to mounting the tire T onto a vehicle wheel. The system **100** includes the pair of mandrels **10**, **10′** axially opposing one another and fixed for common rotation with respective shafts **22**, **22′**, and the tire T disposed between the mandrels **10**, **10′**. More specifically, the system **100** may include an upper portion **200** associated with the upper mandrel **10** and a lower portion **200′** associated with the lower mandrel **10′**. In some configurations, the upper portion **200** includes the following components: the upper mandrel **10**, an upper rotary drive unit **202**, an upper linear drive unit **204**, an upper air pressure source **206**, and an upper relief valve **208**. Similarly, the lower portion **200′** may include the following components: the lower mandrel **10′**, a lower rotary drive unit **202′**, a lower linear drive unit **204′**, a lower air pressure source **206′**, and a lower relief valve **208′**. Linear drive unit **204**, **204′** can be any type of linear drive mechanisms including hydraulically, electrically, or pneumatically powered mechanism that effectuate linear motion. In some examples, the upper and lower air pressure sources **206**, **206′** are associated with a single air pressure source. Air pressure source **206**, **206′** can include any number of mechanisms used to generate pressurized air including electrically, pneumatically, or hydraulically powered air pressure generating mechanisms. The system **100** includes a controller **210** in communication with each of the components **202-208** of the upper portion **200** and each of the components **202′-208′** of the lower portion **200′**. Controller **210** can be any type of controller used to control industrial processes such as an electronic controller (digital, microprocessor, or analog).

[0039] In some implementations, each shaft **22**, **22′** defines a respective slip sleeve **24**, **24′** for directing pressurized fluid therethrough. For instance, the slip sleeve **24** of the upper shaft **22** is in fluid communication with the upper air pressure source **206** via an upper air conduit **25**, while the slip sleeve **24′** of the lower shaft **22′** is in fluid communication with the lower air pressure source **206′** via a lower air conduit **25′**. In some examples, each relief valve **208**, **208′** is disposed within the respective air conduit **25**, **25′** and operative between a closed state for retaining pressurized fluid **306** (FIG. **3**C) within the respective conduit **25**, **25′** and an open state for releasing pressurized fluid **306** out of the respective conduit **25**, **25′**. The controller **210** may control each of the valves **208**, **208′** between the open and closed states. Moreover, the controller **210** may control the air pressure source **206**, **206** for supplying pressurized air through the respective slip sleeve **24**, **24′**.

[0040] The system **100** may also include a tire vice **214** configured to support the tire T between the pair of mandrels **10**, **10′**. Specifically, the tire vice **214** may enclose the tread TT of the tire T and a portion of the upper and lower sidewalls TSU, TSL. A linear actuator **216** in communication with the controller **210** may move the tire vice **214** radially inward and against the sidewalls TSU, TSL to retain the tire T in a stable position such that the lower tire opening TOL and the upper tire opening TOU are both coaxial with the longitudinal axis L.

[0041] Linear actuator **216** can be any type of linear actuator mechanisms including hydraulically, electrically, or pneumatically powered mechanisms that effectuate linear motion. As will become apparent, the tire vice **214** also limits radial expansion of the tire T when the tire T is inflated.

Moreover, the linear actuator **216** may control the tire vice **214** to maintain a desirable degree of tension between the beads TBL, TBU and the sidewalls **16**, **16**′ of each respective mandrel **10**, **10**′.
[0042] FIG. **3**A shows the upper mandrel **10** and the lower mandrel **10**′ axially spaced apart from one another such that the openings **20**, **20**′ are coaxial with the longitudinal axis L and the shafts **22**, **22**′ are substantially collinear with the longitudinal axis L. The tire T is disposed between the pair of mandrels **10**, **10**′ such that the upper and lower tire opening TOU, TOL are coaxial with the longitudinal axis L. In some examples, the mandrels **10**, **10**′ are configured to move axially toward one another in opposite directions.
[0043] FIG. **3**B shows the upper linear drive unit **204** axially moving the upper shaft **22** and upper mandrel **10** fixedly attached thereto in a first direction **301** toward the tire T underneath (e.g., relative to the view of FIG. **3**B), while the lower linear drive unit **204**′ axially moves the lower shaft **22**′ and lower mandrel **10**′ fixedly attached thereto in an opposite second direction **302** toward the tire T above (e.g., relative to the view of FIG. **3**B). Here, the controller **210** may send linear displacement signals to each of the linear drive units **204**, **204**′ that command the axial displacement of the mandrels **10**, **10**′ toward one another. For instance, the upper mandrel **10** may move axially downward until the leading edge **12** passes through the upper tire opening TOU and the sidewall **16** is in opposed contact with the upper bead TBU. Similarly, the lower mandrel **10**′ may move axially upward until the leading edge **12**′ passes through the lower tire opening TOL and the sidewall **16**′ is in opposed contact with the lower bead TBL.
[0044] Alternatively, one or both of the mandrels **10**, **10**′ may move in their axial directions toward the tire opening TOU until the sidewalls **16**, **16**′ are opposing their respective bead TBU, TBL, but separated therefrom by a gap.
[0045] Here, a rapid supply of pressurized fluid **306** (FIG. **3**C) into the circumferential air cavity TAC of the tire T from one or both of the air pressure sources **206**, **206**′ may cause the upper bead TBU to expand axially upward and into contact with the tapered sidewall **16**, and the lower bead TBL to expand axially downward and into contact with the tapered sidewall **16**′.
[0046] Referring to FIG. **3**C, the tire T includes the circumferential air cavity TAC in fluid communication with each of the slip sleeves **24**, **24**′ and also the air pressure sources **206**, **206**′. Once the upper bead TBU is in opposed contact with upper sidewall **16** of the upper mandrel **10** and the lower bead TBL is in opposed contact with the lower sidewall **16**′ of the lower mandrel **10**′, the circumferential air cavity TAC of the tire T is effectively sealed so that one or both of the air pressure sources **206**, **206**′ may supply pressurized fluid **306** (e.g., air) to the circumferential air cavity TAC to inflate the tire T to a desired pressure. In view of the foregoing, the air pressure source(s) **206**, **206**′ may rapidly supply the pressurized fluid **306** (e.g., air) while a gap exists between each bead TBU, TBL and the corresponding opposing sidewall **16**, **16**′, thereby causing the tire T to expand until the beads TBU, TBL contact the sidewalls **16**, **16**′ to seal the circumferential air cavity TAC of the tire T. In some examples, the pressurized fluid **306** is nitrogen or another gas. Additionally, the linear actuator **216** may move the tire vice **214** radially inward (e.g., in a radial direction **316** toward the tire T) to maintain tension between each bead TBL, TBU and the respective sidewall **16**, **16**′ of each mandrel **10**, **10**′.
[0047] In some examples, the system **100** uses both air pressure sources **206**, **206**′ to supply the pressurized fluid **306** for decreasing the inflation time. In other examples, the system **100** only includes one of the air pressure sources **206**, **206**′ for supplying the pressurized fluid to inflate the tire T. In some implementations, the system **100** includes both air pressure sources **206**, **206**′ but the controller **210** opts to only supply the pressurized fluid from one of the air pressure sources **206**, **206**′. Each relief valve **208**, **208**′ is in the closed state to prevent the pressurized fluid **306** from escaping out of the conduits **25**, **25**′ when inflating the tire T with the pressurized fluid **306**.
[0048] Once the tire T is inflated with the pressurized fluid **306** (e.g., air), the system **100** may burnish the tire T by rotating the mandrels **10**, **10**′ relative to the tire T, and thereby remove excess material from the upper bead TBU and the lower bead TBL and/or roughen the surfaces of the

beads TBU, TBL. FIG. 3D shows the upper rotary drive unit **202** rotatably moving the upper shaft **22** about the longitudinal axis L in a first rotatable direction **303** and the lower rotary drive unit **202′** rotatably moving the lower shaft **22′** about the longitudinal axis L in a second rotatable direction **304**. The rotatable directions **303**, **304** may be the same (e.g., both clockwise or both counterclockwise) or different (e.g., one clockwise and the other counter clockwise). In some configurations, the controller **210** may rotate at least one of the shafts **22**, **22′** one direction for a predetermined period of time and then rotate the at least one shaft **22**, **22′** in the opposite direction.
[0049] As the mandrels **10**, **10′** are fixed to the shafts **22**, **22′**, rotation by the shafts **22**, **22′** causes the mandrels **10**, **10′** to commonly rotate and burnish the tire. Here, the upper sidewall **16** of the upper mandrel **10** removes excess material from the upper bead TBU when the upper mandrel **10** rotates in the first rotatable direction **303** relative to the tire T. In some examples, rotation by the upper mandrel **10** while in contact with the upper bead TBU is effective to roughen the surface of the upper bead TBU to condition the upper bead TBU when mounting the tire to a wheel.
[0050] Similarly, the lower sidewall **16′** of the lower mandrel **10′** removes excess material from the lower bead TBL when the upper mandrel **10′** rotates in the second rotatable direction **304** relative to the tire T. In some examples, rotation by the lower mandrel **10′** while in contact with the lower bead TBL is effective to roughen the surface of the lower bead TBL to condition the lower bead TBL when mounting the tire T to a wheel.
[0051] In the alternative (i.e., see FIG. **8**), the system **100** may burnish the tire T simply due to the expansion of the tire when the pressurized air **306** is received within the air cavity TAC without rotating the mandrels **10**, **10′** relative to the tire T. Rather, the expanding tire T is moving relative to the mandrels **10**, **10′**. For instance, the pressurized circumferential air cavity TAC may cause the upper bead TBU to move axially upward against the sidewall **16** of the upper mandrel **10**, while similarly causing the lower bead TBL to move axially downward against the sidewall **16′** of the lower mandrel **10′**. Here, the axial movement of the beads TBU, TBL relative to, and in contact with, the corresponding sidewalls **16**, **16′** is sufficient to remove excess material from the upper bead TBU and the lower bead TBL and/or roughen the surfaces of the beads TBU, TBL.
[0052] Referring to FIG. 3E, the controller **210** commands the rotary drive units **202**, **202′** to cease rotating the shafts **22**, **22′** and respective mandrels **10**, **10′** fixedly attached thereto when the burnishing process is complete. In some examples, the controller **210** sets a timer once the shafts **22**, **22′** commence rotation about the longitudinal axis L and commands the rotary drive units **202**, **202′** to cease rotating the shafts **22**, **22′** at the end of a predetermined burnishing time period. Accordingly, when the burnishing process is complete, the controller **210** may command the relief valves **208**, **208′** to transition to the open state, and thereby permit the pressurized fluid **306** (e.g., air) to release from the circumferential air cavity TAC via each of the respective air conduits **25**, **25′**. Here, the tire is deflated to release the tension between each bead TBU, TBL and the respective mandrel **10**, **10′** so that the mandrels **10**, **10′** can be axially moved away from one another for removing the tire T from the system **100**.
[0053] FIG. 3F shows the upper linear drive unit **204** axially moving the upper shaft **22** and upper mandrel **10** fixedly attached thereto in the second direction **302** away from the tire T underneath (e.g., relative to the view of FIG. 3F), while the lower linear drive unit **204′** axially moves the lower shaft **22′** and lower mandrel **10′** fixedly attached thereto in the opposite first direction **301** away from the tire T above (e.g., relative to the view of FIG. 3F). Here, the controller **210** may send linear displacement signals to each of the linear drive units **204**, **204′** that command the axial displacement of the mandrels **10**, **10′** away from one another. For instance, the upper mandrel **10** may move axially upward to pull the leading edge **12** out of the air cavity TAC via the upper tire opening TOU and disengage the sidewall **16** from contact with the upper bead TBU. Similarly, the lower mandrel **10′** may move axially downward to pull the leading edge **12′** out of the air cavity TAC via the lower tire opening TOL and disengage the sidewall **16′** from contact with the lower bead TBL. The controller **210** may also command the linear actuator **216** to move the tire vice **214**

radially outward and away from the tread TT of the tire T so that the burnished tire T may be removed from the system **100**. A new uninflated tire T requiring burnishing may then be disposed axially between the upper and lower mandrels **10**, **10**′, inflated, burnished, deflated, and removed as described above in FIGS. **3**A-**3**F.

[0054] While the orientation of the system **100** in FIGS. **2**A-**3**F depicts an orientation with “upper” and “lower” portions **200**, **200**′, respectively, the system **100** is not limited to the orientation depicted in FIGS. **2**A-**3**F. In other configurations, the system **100** may be adapted such that the linear drive units **204**, **204**′ move the shafts **22**, **22**′ and mandrels **10**, **10**′ horizontally/laterally toward one another to place the respective sidewalls **16**, **16**′ in opposed contact with the beads TBU, TBL.

[0055] Referring to FIGS. **4**A-**4**C, a mandrel **10***a* is provided that may be used by a tire pre-conditioning system **100***a* (FIG. **5**) in place of the upper mandrel **10** and/or the lower mandrel **10**′ of FIGS. **2**A-**3**F. In view of the substantial similarity in structure and function of the components associated with the mandrel **10** with respect to the mandrel **10***a*, like reference numerals are used hereinafter and in the drawings to identify like components while like reference numerals containing letter extensions are used to identify those components that have been modified.

[0056] FIG. **4**A shows the mandrel **10***a* including the leading edge **12** having the first radius, the trailing edge **14** having the second radius greater than the first radius, and a tapered sidewall **16***a* interconnecting the leading edge **12** and the trailing edge **14**. As with the mandrel **10** of FIG. **1**, the mandrel **10***a* defines a conical or frusto-conical shape and includes the leading surface **18** having the outer periphery defined by the leading edge **12** and defining the shaft opening **20** for fixedly mounting the mandrel **10** to the rotatable shaft **22** (FIG. **5**). The tapered sidewall **16***a* includes a burnishing region **416** axially disposed between the leading edge **12** and the trailing edge **14** and circumferentially extending around the tapered sidewall **16***a*. The burnishing region **416** is configured to axially align with the respective upper bead TBU or lower bead TBL of the tire T for removing excess material therefrom when the mandrel **10***a* rotates relative to the tire T.

[0057] Referring to FIG. **4**B, a detailed view within circle **4**B of FIG. **4**A shows the burnishing region **416** defined by a series of apertures **418** formed through the sidewall **16***a* and including an abrasive material **420** for facilitating the removal of excess material from the respective bead TBU, TBL. The abrasive material **420** may be impregnated with the material forming the mandrel **10***a* or may be deposited thereon using any suitable technique.

[0058] FIG. **4**C provides a cross-sectional view taken along line **4**C-**4**C of FIG. **4**B. In some examples, the surface of sidewall **16***a* within the burnishing region **416** may be roughened to further facilitate the removal of excess material from the tire bead. Accordingly, the surface of the sidewall **16** may be include the abrasive material **420** and/or be roughened for removing excess material from the respective upper bead TBU or lower bead TBL in contact therewith when the mandrel **10***a* rotates relative to the tire T. Moreover, one or more of the apertures **418** formed through the sidewall **16***a* may be defined by cambered walls **419** for shaving off the excess material from the tire T. In some examples, the walls **419** may be sharpened. In some examples, one or more of the apertures **418** are defined by straight/perpendicular walls **419** for shaving off the excess material from the tire T.

[0059] FIG. **5** provides a tire pre-conditioning system **100***a* for burnishing the beads TBL, TBU of the pneumatic tire T using an upper mandrel **10***a* and a lower mandrel **10***a*′ each having the burnishing region **416**, **416**′ circumferentially extending around the respective sidewall **16***a*, **16***a*′. The example shows the pair of frusto-conical mandrels **10***a*, **10***a*′ each axially moved toward one another such that the exterior of each sidewall **16***a*, **16***a*′ is in opposed contact with the respective bead TBU, TBL of the tire T. The mandrels **10***a*, **10***a*′ may be axially displaced so that the burnishing regions **416**, **416**′ are each axially aligned and in opposed contact with the respective bead TBU, TBL of the tire T. The tire T has been inflated (e.g., by directing pressurized air via one or both of the slip sleeves **24**, **24**′ into the circumferential air cavity TAC) to provide sufficient tension between the each circumferential bead TBU, TBL of the tire T and the respective mandrel **10***a*, **10***a*′ in contact therewith. Accordingly, the upper shaft **22** and upper mandrel **10***a* fixedly attached thereto may rotate about the longitudinal axis L (e.g., first rotatable direction **303**) relative to the tire T to remove excess material from the upper bead TBU. Similarly, the lower shaft **22**′ and lower mandrel **10***a*′ fixedly attached thereto may rotate about the longitudinal axis L (e.g., second rotatable direction **304**) relative to the tire T to remove excess material from the lower bead TBL.

[0060] Referring to FIG. **6**, a mandrel **10***b* is provided that may be used by a tire pre-conditioning system **100***b* (FIG. **7**) in place of the upper mandrel **10** and/or the lower mandrel **10**′ of FIGS. **2**A-**3**F. In view of the substantial similarity in structure and function of the components associated with the mandrel **10** with respect to the mandrel **10***b*, like reference numerals are used hereinafter and in the drawings to identify like components while like reference numerals containing letter extensions are used to identify those components that have been modified.

[0061] The mandrel **10***b* may include the leading edge **12** having the first radius, the trailing edge **14** having the second radius greater than the first radius, and a tapered sidewall **16***b* interconnecting the leading edge **12** and the trailing edge **14**. As with the mandrel **10** of FIG. **1** and the mandrel **10***a* of FIG. **4**A, the mandrel **10***b* defines a conical or frusto-conical shape and includes the leading surface **18** having the outer periphery defined by the leading edge **12** and defining the shaft opening **20** for fixedly mounting the mandrel **10***b* to the rotatable shaft **22** (FIG. **7**). The tapered sidewall **16***b* includes an axial stop **616** protruding radially outward from, and circumferentially extending around, the tapered sidewall **16***b* between the leading edge **12** the trailing edge **14**. In some examples, the axial stop **616** is disposed closer to the trailing edge **14** than the leading ledge of the mandrel **10***b*. The axial stop **616** is configured to limit axial movement of the tire T when the mandrel **10***b* is in contact with the tire T and the tire T is inflated.

[0062] The tapered sidewall **16***b*, or portion thereof, may be associated with a specific roughness and/or geometry for optimally burnishing the bead TBL, TBU (FIG. **7**) of the tire T in contact therewith when the mandrel **10***b* rotates relative to the tire T while contacting the bead surface TBL, TBU. For instance, the sidewall **16***b* may be roughened between the axial stop **616** and the leading edge **12** of the mandrel **10***b*. In some configurations, the mandrel **10***b* incorporates the burnishing region **416** of the mandrel **10***a* of FIGS. **4**A-**4**C. For instance, the burnishing region **416** may extend circumferentially around the sidewall **16***b* between the axial stop **616** and the leading edge **12**. A pair of mandrels **10***b*, **10***b*′ (FIG. **7**) may cooperate to burnish respective ones of the circumferential upper bead TBU and the circumferential lower bead TBL of the tire T when each of the mandrels **10***b*, **10***b*′ rotate relative to the tire while contacting the beads TBL, TBU.

[0063] FIG. **7** provides a tire pre-conditioning system **100***b* for burnishing the beads TBL, TBU of the pneumatic tire T using an upper mandrel **10***b* and a lower mandrel **10***b*′ each having the axial stop **616** protruding radially outward from, and extending circumferentially around, the respective sidewall **16***b*, **16***a*′. The example shows the pair of frusto-conical mandrels **10***b*, **10***b*′ each axially moved toward one another such that the exterior of each sidewall **16***b*, **16***b*′ is in opposed contact with the respective bead TBU, TBL of the tire T. The tire T has been inflated (e.g., by directing pressurized air via one or both of the slip sleeves **24**, **24**′ into the circumferential air cavity TAC) to provide sufficient tension between the each circumferential bead TBU, TBL of the tire T and the respective mandrel **10***b*, **10***b*′ in contact therewith. The upper axial stop **616** is configured to prevent the upper bead TBU from riding up the respective sidewall **16***b* past a location of the axial stop **616** as the leading edge **12** of the upper mandrel **10***b* moves axially downward into the circumferential air cavity TAC. Similarly, the lower axial stop **616**′ is configured to prevent the lower bead TBL from riding down the respective sidewall **16***b*′ past a location of the axial stop **616**′ as the leading edge **12**′ of the lower mandrel **10***b*′ moves axially upward into the circumferential air cavity TAC. Accordingly, the upper shaft **22** and upper mandrel **10***b* fixedly attached thereto may rotate about the longitudinal axis L (e.g., first rotatable direction **303**) relative to the tire T to remove excess material from the upper bead TBU. Similarly, the lower shaft **22**′ and lower mandrel

10*b*′ fixedly attached thereto may rotate about the longitudinal axis L (e.g., second rotatable direction **304**) relative to the tire T to remove excess material from the lower bead TBL.

[0064] In view of the foregoing, the upper and lower mandrels **10**, **10**′ of FIGS. **2**A-**3**F may incorporate the burnishing regions **416**, **416**′ of the mandrels **10***a*, **10***a*′ of FIGS. **4**A-**5** and/or the axial stops **616**, **616**′ of the mandrels **10***b*, **10***b*′ of FIGS. **6** and **7**. The tire pre-conditioning system **100**, **100***a*, **100***b* may be adapted to remove excess material from tires of different sizes and/or different types. Two air pressure sources **206**, **206**′ may be used to decrease the inflation time of the tire T, and hence, decrease the overall time of the burnishing process. However, a single pressure source may be used to inflate the tire. Moreover, the mandrels **10**, **10**′ used by the system **100**, **100***a*, **100***b* may be interchangeable to accommodate different size/type tires and/or based on burnishing specifications for the given tire.

[0065] FIG. **8** provides a tire pre-conditioning system **100***c* for burnishing/removing excess material from the upper and lower beads TBU, TBL of the tire T without rotating the upper mandrel **10** and the lower mandrel **10**′relative to the tire T. In view of the substantial similarity in structure and function of the components associated with the tire pre-conditioning system **100** with respect to the tire pre-conditioning system **100***c*, like reference numerals are used hereinafter and in the drawings to identify like components while like reference numerals containing letter extensions are used to identify those components that have been modified.

[0066] The system **100***c* may include an upper portion **200***c* associated with the upper mandrel **10** and a lower portion **200***c*′ associated with the lower mandrel **10**′. More specifically, the upper portion **200***c* and the lower portion **200***c*′ are substantially identical to the upper portion **200** and the lower portion **200**′, respectively, of the system **100** of FIGS. **3**A-**3**F described above, except that the upper and lower portions **200***c*, **200***c*′ omit the rotary drive unit **202**, **202**′. Once the upper bead TBU is in opposed contact with upper sidewall **16** of the upper mandrel **10** and the lower bead TBL is in opposed contact with the lower sidewall **16**′ of the lower mandrel **10**′, the circumferential air cavity TAC of the tire Tis effectively sealed so that one or both of the air pressure sources **206**, **206**′ may supply pressurized fluid **306** (e.g., air) to the circumferential air cavity TAC to inflate the tire T to a desired pressure. In the alternative, the linear drive units **204**, **204**′ may axially move the mandrels **10**, **10**′ toward the tire T until the sidewalls **16**, **16**′ are opposing and spaced apart from the corresponding beads TBU, TBL, and the air pressure source(s) **206**, **206**′ rapidly supply pressurized fluid **306** to the air cavity TAC to cause the beads TBU, TBL to expand into contact with the corresponding sidewalls **16**, **16**′, and thereby effectively seal the circumferential air cavity TAC of the tire T while the tire T inflates to the desired pressure.

[0067] As the pressurized fluid **306** inflates the tire T, the upper bead TBU moves axially upward relative to the upper mandrel **10** while contacting the upper sidewall **16** thereof and the lower bead TBL moves axially downward relative to the lower mandrel **10**′ while contacting the lower sidewall **16**′ thereof. Here, the riding of the beads TBU, TBL against their corresponding sidewalls **16**, **16** is sufficient to burnish/remove excess material from the upper and lower beads TBU, TBL of the tire T without rotating the upper mandrel **10** and the lower mandrel **10**′relative to the tire T. The upper and lower mandrels **10**, **10**′ may incorporate the burnishing regions **416**, **416**′ of the mandrels **10***a*, **10***a*′ of FIGS. **4**A-**5** and/or the axial stops **616**, **616**′ of the mandrels **10***b*, **10***b*′ of FIGS. **6** and **7**. The tire pre-conditioning system **100***c* may be adapted to remove excess material from tires of different sizes and/or different types. Two air pressure sources **206**, **206**′ may be used to decrease the inflation time of the tire T, and hence, decrease the overall time of the burnishing process. However, a single pressure source may be used to inflate the tire. Moreover, the mandrels **10**, **10**′ used by the system **100***c* may be interchangeable to accommodate different size/type tires and/or based on burnishing specifications for the given tire.

[0068] A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. Accordingly, other implementations are within the scope of the following claims.

Claims

1. A tire pre-conditioning system for conditioning a bead of a tire, the tire pre-conditioning system comprising: a burnisher attached to a shaft; and a controller in communication with at least one of the burnisher or the tire, wherein the controller is configured to: move one of the burnisher or the tire until the burnisher is opposing the bead of the tire; and supply pressurized fluid into an internal cavity of the tire to cause the bead to contact the burnisher to burnish the bead of the tire.
2. The tire pre-conditioning system of claim 1, further comprising: a linear actuator in communication with the controller and the shaft, wherein the linear actuator is configured to move the shaft in a direction; and a rotary drive unit in communication with the controller and the shaft, wherein the rotary drive unit is configured to rotate the shaft.
3. The tire pre-conditioning system of claim 1, further comprising: an air pressure source in communication with the controller, wherein the air pressure source is configured to supply the pressurized fluid to the internal cavity of the tire to inflate the tire when the burnisher is in contact with the bead.
4. The tire pre-conditioning system of claim 1, wherein the burnisher includes a sidewall that is at least one of roughened or includes one or more abrasive materials.
5. The tire pre-conditioning system of claim 4, wherein the abrasive materials are impregnated within the burnisher.
6. The tire pre-conditioning system of claim 1, wherein an exterior surface of the burnisher is roughened.
7. The tire pre-conditioning system of claim 1, wherein the burnisher includes a circumferential burnishing region defined by a series of apertures formed through the burnisher.
8. The tire pre-conditioning system of claim 7, wherein one or more apertures of the series of apertures is defined by cambered walls configured to shave off excess tire material.
9. The tire pre-conditioning system of claim 1, further comprising: a circumferential axial stop radially protruding from the burnisher, wherein the axial stop is configured to limit axial movement of the tire when the burnisher contacts the bead of the tire.
10. The tire pre-conditioning system of claim 1, wherein the shaft includes a slip sleeve configured to direct the pressurized fluid from an air pressure source to the internal cavity of the tire.
11. A method of pre-conditioning a bead of a tire, the method comprising: positioning the tire proximate a burnisher; moving at least one of the tire or the burnisher toward the other of the tire or the burnisher until a surface of the burnisher is opposing the bead of the tire; providing pressurized fluid from an air pressure source to an internal cavity of the tire to urge the bead against the burnisher and remove tire material from the bead as the bead contacts the burnisher; and moving one of the tire or the burnisher away from the other of the tire or the burnisher.
12. The method of claim 11, wherein the bead of the tire defines a tire opening.
13. The method of claim 11, wherein the tire is an uninflated tire.
14. The method of claim 11, further comprising: after inflating the tire with the pressurized fluid, rotating one of the tire or the burnisher to remove tire material from the bead.
15. The method of claim 11, further comprising: prior to moving one of the tire or the burnisher, deflating the tire by opening an air release valve disposed in an air conduit.
16. The method of claim 11, wherein the burnisher includes a sidewall that is at least one of roughened or includes one or more abrasive materials.
17. The method of claim 11, wherein the burnisher includes a sidewall that define a circumferential burnishing region including a series of apertures.
18. The method of claim 11, wherein the burnisher includes a sidewall that includes a circumferential axial stop protruding at least partially radially outward from the sidewall.