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FITTING DEVICE FOR TIRE ASSEMBLY AND METHOD FOR MANUFACTURING TIRE ASSEMBLY

Abstract

The fit between a wheel and a tire is improved. A tire assembly fitting device fits a bead portion of a tire of a tire assembly, including a wheel and the tire mounted on the wheel, to a bead seat portion of the wheel. The fitting device includes a support portion configured to support the tire assembly, and a pressing portion. The pressing portion is configured to press a first surface portion in a surface of at least one of sidewalls of the tire. The support portion is configured to support the tire assembly so that a second surface portion located in the surface of the sidewall on the opposite side of the rotation axis of the tire assembly from the first surface portion is displaceable in a direction away from the rim center plane of the wheel.

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Background/Summary

[0001] This is a divisional application of application Ser. No. 16/966,644, filed Jul. 31, 2020,which is the national phase of international application no. PCT/JP2018/006414, filed Feb. 22, 2018, the contents of each of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD
[0002] A technique disclosed in this specification relates to a fitting device for a tire assembly.
BACKGROUND ART
[0003] For a tire assembly including a wheel and a tire mounted on the wheel, an improvement in the fit of the tire to the wheel is required. The improvement in the fit means approaching a state in which the positions of bead portions of the tire relative to bead seat portions of the wheel in the wheel axis direction are approximately uniform over the entire circumference of the tire assembly. When the fit of the tire assembly is poor, there is a possibility, for example, that force variation of the tire assembly (RFV (radial force variation; force that varies in the radial direction in variation of force that is generated in a contact area with the road surface when the tire is rotated) or LFV (lateral force variation; force that varies in the lateral direction in variation of force that is generated in a contact area with the road surface when the tire is rotated)) degrades, or that the mass distribution of the tire assembly in the circumferential direction cannot be accurately measured, resulting in that it is not possible to accurately perform balance correction of the tire assembly thereafter.
[0004] Conventionally, a fitting device for improving the fit of a tire assembly is known. For example, there is known a fitting device that alternately repeats, immediately after the air is filled in a tire assembly, a process of releasing contact between bead portions of a tire and a wheel by pressing sidewalls of the tire and a process of restoring the contact between the bead portions of the tire and the wheel by stopping the pressing (see Patent Document 1). Further, there is known a fitting device that, while holding a wheel of a tire assembly before the air is filled in the tire assembly, supports a bead portion of a tire so as to be descendible relative to the wheel, thus enabling the movement of the bead portion by a horizontal force that is generated due to the descent of the bead portion (see Patent Document 2).
PRIOR ART DOCUMENT
Patent Document
[0005] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2003-11629
[0006] Patent Document 2: Japanese Unexamined Patent Application Publication No. 2007-153112
SUMMARY OF THE INVENTION
Problem to be Solved by the Invention
[0007] However, with the conventional fitting devices described above, there are cases where the fit of a tire assembly cannot be sufficiently improved, and there is still room for further improvement.
[0008] This specification discloses a technique that can solve at least a part of the problem described above.
Means for Solving the Problem
[0009] The technique disclosed in this specification can be realized as the following modes. [0010] (1) A fitting device for a tire assembly disclosed in this specification is a fitting device configured to fit a bead portion of a tire of a tire assembly, including a wheel and the tire mounted on the

wheel, to a bead seat portion of the wheel. The fitting device includes a support portion configured to support the tire assembly, and a pressing portion. The pressing portion is configured to press a first surface portion in a surface of at least one of sidewalls of the tire, and the support portion is configured to support the tire assembly so that a second surface portion located in the surface of the sidewall on an opposite side of a rotation axis of the tire assembly from the first surface portion is displaceable in a direction away from a rim center plane of the wheel.

[0011] In the tire assembly, there are cases where since the positions of the bead portion of the tire relative to the bead seat portion of the wheel in the wheel axis direction are not uniform over the entire circumference of the tire assembly, i.e. the fit between the bead seat portion of the wheel and the bead portion of the tire is low, a concave portion and a convex portion are present in the surface of the sidewall of the tire. In general, the concave portion and the convex portion are located on the generally opposite sides to the rotation axis of the tire assembly from each other. The inventor of this application has discovered for such a tire assembly with the low fit that the fit of the tire assembly is improved by pressing the surface on the convex portion side of the sidewall while allowing the concave portion side of the sidewall to be displaceable in the direction away from the rim center plane of the wheel (the direction in which the tire is inflated). Specifically, by a pressing force to the surface on the convex portion side of the sidewall and a restoring force of the tire, for example, the distal end of the bead portion of the tire, on the convex portion side, moves on the bead seat portion of the wheel toward the rim center plane side from the position on the flange side of the wheel. Following this, it is expected that, on the concave portion side, the distal end of the bead portion of the tire moves on the bead seat portion of the wheel toward the side opposite to the rim center plane from the position on the drop portion side of the wheel. Thus, in this fitting device for the tire assembly, the pressing portion is configured to press the first surface portion in the surface of at least one of the sidewalls of the tire. Further, the support portion is configured to support the tire assembly so that the second surface portion located in the surface of the sidewall on the opposite side of the rotation axis of the tire assembly from the first surface portion is displaceable in the direction away from the rim center plane. Therefore, while supporting the tire assembly by the support portion in the state where the concave portion side (the second surface portion) of the sidewall of the tire is displaceable in the direction in which the tire is inflated, it is possible to press the convex portion side (the first surface portion) of the sidewall of the tire by the pressing portion. Consequently, according to this fitting device, it is possible to improve the fit between the wheel and the tire. [0012] (2) The above-described fitting device for the tire assembly may be a configuration further including an application portion configured to apply, to the tire, a force in a direction in which the first surface portion of the sidewall is displaced toward the wheel side. With this fitting device, compared to a configuration in which the force by the application portion is not applied to the tire, the bead portion of the tire easily moves on the bead seat portion of the wheel on the first surface portion side of the sidewall of the tire, and therefore, it is possible to improve the fit between the wheel and the tire more reliably. [0013] (3) In the above-described fitting device for the tire assembly, the application portion may include two or more application members configured to respectively apply forces to portions in a tread surface of the tire, the portions being spaced apart from each other in a circumferential direction of the tire. With this fitting device for the tire assembly, compared to a configuration in which the force is applied to only one portion in the tread surface of the tire, the bead portion of the tire easily moves on the bead seat portion of the wheel more smoothly on the first surface portion side of the sidewall of the tire, and therefore, it is possible to further improve the fit between the wheel and the tire. [0014] (4) The above-described fitting device for the tire assembly may be a configuration further including a timing control part configured to: cause the force by the application portion to be applied to the tire; and in a state in which the force by the application portion is applied to the tire, cause the pressing portion to start pressing the first surface portion of the tire. With this fitting device for the tire assembly, by applying the force by the application portion to the tire in advance, the displacement of the wheel is suppressed by the force by the application portion and the supporting force by the support portion, and therefore, it is possible to suppress that the fit between the wheel and the tire is lowered due to the displacement of the wheel. [0015] (5) The above-described fitting device for the tire assembly may be a configuration further including a detection part configured to detect a concave-convex state in the surface of the sidewall of the tire of the tire assembly supported by the support portion; and an adjustment part configured to, based on a detection result of the detection part, adjust relative positions between the tire assembly and the pressing portion so that the pressing portion is able to press a surface portion on a convex portion side in the surface of the sidewall. With this fitting device, it is possible to automatically adjust the relative positions between the tire assembly and the pressing portion based on the detection result of the detection part so that the pressing portion is able to press the surface portion on the convex portion side of the sidewall. [0016] (6) In the above-described fitting device for the tire assembly, the surface portion on the convex portion side may be a surface portion located in the surface of the sidewall between the convex portion and a portion moved by 90 degrees from the convex portion in the circumferential direction of the tire. The inventor of this application has discovered that the fit between the wheel and the tire is improved more smoothly by pressing the surface portion located between the convex portion and the portion moved by 90 degrees from the convex portion than by pressing the convex portion itself of the sidewall. Therefore, with this fitting device, it is possible to improve the fit between the wheel and the tire more smoothly compared to the configuration of pressing the convex portion itself of the sidewall. [0017] (7) A tire assembly manufacturing method disclosed in this specification includes an assembly step of forming a tire assembly by mounting a tire having a bead portion on a wheel having a bead seat portion; and a pressing step of, while pressing a first surface portion located in a surface of at least one of sidewalls of the tire on a side of a convex portion where a distance from a rim center plane of the wheel is the longest, allowing a second surface portion to be displaceable in a direction away from the rim center plane, the second surface portion located in the surface of the sidewall on a side of a concave portion where the distance from the rim center plane is the shortest. With this tire assembly manufacturing method, it is possible to manufacture the tire assembly in which the fit between the wheel and the tire is high. [0018] The technique disclosed in this specification can be realized by various modes, and, for example, can be realized by modes such as a manufacturing method, a fitting method, and a fitting device for a tire assembly, a computer program for realizing each of the methods or the functions of the device, and a storage medium storing the computer program.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a YZ plan view schematically illustrating the external appearance configuration of a fitting device **10** in this embodiment.

[0020] FIG. **2** is an XY plan view schematically illustrating the external appearance configuration of the fitting device **10** in this embodiment.

[0021] FIG. **3** is a flowchart illustrating a part of a manufacturing method of a tire assembly **300**.

[0022] FIG. **4** is an explanatory diagram illustrating the top configuration of the tire assembly **300** before the fitting and rollers **240**L, **240**R.

[0023] FIG. **5** is an explanatory diagram illustrating the YZ sectional configuration of the tire assembly **300** before the fitting, the right roller **240**R, and pressing members **230**U, **230**D.

[0024] FIG. **6** is an explanatory diagram illustrating the top configuration of the tire assembly **300** immediately after the fitting, the rollers **240**L, **240**R, and the second pressing member **230**D.

[0025] FIG. **7** is an explanatory diagram illustrating the YZ sectional configuration of the tire assembly **300** immediately after the fitting, the right roller **240**R, and the pressing members **230**U,

230D.

[0026] FIG. **8** is an explanatory diagram illustrating the top configuration of the tire assembly **300** immediately after the fitting, the rollers **240**L, **240**R, and the second pressing member **230**D in a modification.

MODES FOR CARRYING OUT THE INVENTION

A. Embodiment

A-1. Configuration

[0027] FIG. **1** is a YZ plan view (a side view) schematically illustrating the external appearance configuration of a fitting device **10** in this embodiment, and FIG. **2** is an XY plan view (a top view) schematically illustrating the external appearance configuration of the fitting device **10** in this embodiment. XY Z-axes perpendicular to each other for identifying the directions are indicated in each of the figures. In this specification, for convenience, the Z-direction will be referred to as the up-down direction (the Z-axis positive direction will be referred to as the upward direction, and the Z-axis negative direction will be referred to as the downward direction), the X-direction will be referred to as the left-right direction (the X-axis positive direction will be referred to as the left direction, and the X-axis negative direction will be referred to as the right direction), and the Y-direction will be referred to as the front-rear direction (the Y-axis positive direction will be referred to as the rear direction, and the Y-axis negative direction will be referred to as the front direction). This also applies to FIG. **4** and subsequent figures.

A-1-1. Configuration of Tire Assembly **300**

[0028] As illustrated in FIG. **1**, a tire assembly **300** includes a wheel **320** for a vehicle and a tire **310** mounted on the wheel **320**. In FIG. **1**, the tire assembly **300** is disposed so that the rotation axis direction of the tire assembly **300** generally coincides with the up-down direction (the Z-direction). Hereinafter, the upper side (the Z-axis positive direction side) with respect to the tire assembly **300** will be referred to as “the outer side”, and the lower side (the Z-axis negative direction side) will be referred to as “the inner side”. When the tire assembly **300** is attached to a vehicle body (not illustrated), the outer side of the tire assembly **300** faces a direction opposite to a direction toward the vehicle body, and the inner side of the tire assembly **300** faces the direction toward the vehicle body. The mode of the tire assembly **300** illustrated in FIG. **1** is only by way of example and may be one of various other modes.

[0029] The wheel **320** is made of a light alloy such as, for example, an aluminum alloy or a magnesium alloy. The wheel **320** includes a generally cylindrical wheel rim **330** and a wheel disc **340** disposed on the inner peripheral side of the wheel rim **330**. The wheel rim **330** includes a pair of flange portions **332**U, **332**D, a pair of bead seat portions **334**U, **334**D, and a drop portion **336** recessed to the radially inner side of the wheel **320** than the bead seat portions **334**U, **334**D. The wheel disc **340** is located in the wheel rim **330** on the upper side (the outer side) and includes a hub attaching portion **342** (a center bore) and a plurality of spoke portions **344**. The wheel **320** may be of a so-called one-piece type in which the wheel rim **330** and the wheel disc **340** are formed integrally with each other, or a so-called two-piece type in which the wheel rim **330** and the wheel disc **340** are separate members. Hereinafter, the flange portion **332**U and the bead seat portion **334**U located on the upper side (the outer side) in FIG. **1** will be referred to as the upper flange portion **332**U and the upper bead seat portion **334**U, and the flange portion **332**D and the bead seat portion **334**D located on the lower side (the inner side) will be referred to as the lower flange portion **332**D and the lower bead seat portion **334**D.

[0030] The tire **310** is formed by including, for example, raw material rubber (natural rubber or synthetic rubber), tire cords, reinforcing members, bead wires, and compounding agents. The tire **310** includes a pair of sidewalls **312**U, **312**D, a pair of bead portions **314**U, **314**D, and a tread surface **316**. Hereinafter, the sidewall **312**U and the bead portion **314**U located on the upper side (the outer side) will be referred to as the upper sidewall **312**U and the upper bead portion **314**U, and the sidewall **312**D and the bead portion **314**D located on the lower side (the inner side) will be referred to as the lower sidewall **312**D and the lower bead portion **314**D.

A-1-2. Configuration of Fitting Device **10**

[0031] The fitting device **10** is a device for improving the fit of the tire **310** to the wheel **320** in the tire assembly **300** described above. Specifically, the fitting device **10** causes the tire assembly **300** to approach a state in which the positions of the upper bead portion **314**U of the tire **310** relative to the upper bead seat portion **334**U of the wheel **320** in the up-down direction (the Z-direction) are approximately uniform over the entire circumference of the tire assembly **300**, and the positions of the lower bead portion **314**D of the tire **310** relative to the lower bead seat portion **334**D of the wheel **320** in the up-down direction are approximately uniform over the entire circumference of the tire assembly **300**.

[0032] As illustrated in FIGS. **1** and **2**, the fitting device **10** includes a support portion **100** that supports the tire assembly **300**, and a posture correction portion **200** that corrects the posture of the tire **310** with respect to the wheel **320** in the tire assembly **300** supported by the support portion **100**, i.e. that fits the tire **310** to the wheel **320**. The support portion **100** and the posture correction portion **200** are fixed on a base plate **12**.

(Support Portion **100**)

[0033] The support portion **100** includes a lifting unit **110** and a support portion body **120**.

[0034] In FIG. **1**, in addition to the fitting device **10**, a carry-in device **124** and a carry-out device **112** are illustrated.

[0035] As illustrated in FIG. **2**, the carry-in device **124** and the carry-out device **112** each include a pair of tables that are disposed so as to sandwich the lifting unit **110** and the support portion body **120** in the front-rear direction in a view in the up-down direction (the Z-direction). As will be described later, the carry-in device **124** carries in the tire assembly **300** before the fitting, in which the tire **310** is mounted on the wheel **320** in an upstream assembly process, to a position just above the support portion **100** (see S**110** and S**120** in FIG. **3** which will be described later). The carry-out device **112** carries out the tire assembly **300** after the fitting from the position just above the support portion **100** to a subsequent process.

[0036] The lifting unit **110** vertically raises and lowers the support portion body **120** while supporting the support portion body **120**. Specifically, as illustrated in FIG. **2**, the lifting unit **110** includes a servomotor **116** (omitted in FIG. **1**) and a support cylinder **114**. The lifting unit **110** automatically raises the support portion body **120** by a driving force of the servomotor while supporting the weight of the support portion body **120** by the pressure of the support cylinder.

[0037] The support portion body **120** has a holding mechanism that holds the wheel **320** of the tire assembly **300**. Specifically, the support portion body **120** includes a pole **132** extending in the up-down direction (the Z-direction), a chuck **130** provided at an upper end of the pole **132**, and a chuck cylinder **134**. The chuck **130** is displaceable from a state in which its outer diameter is smaller than the diameter of a hub hole formed in the hub attaching portion **342** of the wheel **320**, to a state in which its outer diameter is slightly greater than the diameter of the hub hole. When a force from the chuck cylinder **134** is applied to the chuck **130** through the pole **132**, the outer diameter of the chuck **130** is increased. With this configuration, when the support portion body **120** is raised by the lifting unit **110**, the chuck **130** is inserted into the hub hole of the wheel **320** of the tire assembly **300** disposed in the carry-in device **124**. Then, when the outer diameter of the chuck **130** is increased by the force from the chuck cylinder **134**, the hub hole of the wheel **320** is held by the chuck **130** (see FIG. **1**). In this event, the tire assembly **300** is spaced apart from the carry-in device **124**.

[0038] The support portion body **120** further includes a servomotor **122**, and the pole **132** and the chuck **130** are rotated by a driving force of the servomotor **122**. Consequently, the support portion **100** can rotate the tire assembly **300** supported by the support portion body **120** about the rotation axis of the tire assembly **300**.

[0039] (Posture Correction Portion **200**)

[0040] The posture correction portion **200** is disposed rearward (on the Y-axis positive direction side) of the support portion **100** and includes a slide unit **210** and a posture correction portion body **220**.
[0041] The slide unit **210** includes a unit body **212** fixed to the base plate **12**, a movable stage **214** provided to be movable on the unit body **212** in the front-rear direction (the Y-direction), and a servomotor **216**. The slide unit **210** moves the movable stage **214** in the front-rear direction by a driving force of the servomotor **216**.
[0042] The posture correction portion body **220** is fixed on the movable stage
[0043] **214** of the slide unit **210**. The posture correction portion body **220** includes a pair of pressing members **230**U, **230**D and a distance change mechanism. The pressing members **230**U, **230**D in the pair protrude forward (in the Y-axis negative direction, to the support portion **100** side) from the posture correction portion body **220** and are disposed to face each other in the up-down direction (the Z-direction). The first pressing member **230**U located on the upper side is provided in the posture correction portion body **220** so as to be slidable in the up-down direction by a non-illustrated guide mechanism. On a lower surface of the first pressing member **230**U is provided a first pressing portion **232**U protruding generally downward. Specifically, the first pressing portion **232**U protrudes forward and obliquely downward from the lower surface of the first pressing member **230**U. The second pressing member **230**D located on the lower side is provided just below the first pressing member **230**U so as to be slidable in the up-down direction by a non-illustrated guide mechanism. On an upper surface of the second pressing member **230**D is provided a second pressing portion **232**D protruding generally upward. Specifically, the second pressing portion **232**D protrudes forward and obliquely upward from the upper surface of the second pressing member **230**D. The pressing portions **232**U, **232**D are generally arc-shaped in a view in the up-down direction so as to correspond to an annular shape of the tire **310** (see FIG. **2** etc.).
[0044] The distance change mechanism changes the spacing distance between the first pressing member **230**U and the second pressing member **230**D in the up-down direction (the Z-direction). Specifically, the distance change mechanism includes a pair of electric cylinders **222**L, **222**R and a pair of linking arms **224**L, **224**R. As illustrated in FIGS. **1** and **2**, the second pressing member **230**D is linked to the electric cylinder **222**L located on the left side through the linking arm **224**L located on the left side. When a rod of the electric cylinder **222**L extends upward, its push-up force is transmitted to the second pressing member **230**D through the linking arm **224**L so that the second pressing member **230**D is moved upward. As illustrated in FIG. **2**, the first pressing member **230**U is linked to the electric cylinder **222**R located on the right side through the linking arm **224**R located on the right side. When a rod of the electric cylinder **222**R contracts downward, its push-down force is transmitted to the first pressing member **230**U through the linking arm **224**R so that the first pressing member **230**U is moved downward.
[0045] The posture correction portion body **220** further includes a pair of rollers **240**L, **240**R and an advance mechanism. The rollers **240**L, **240**R in the pair protrude forward (in the Y-axis negative direction, to the support portion **100** side) from the posture correction portion body **220** and are disposed to face each other in the left-right direction (the X-direction). Each of the rollers **240**L, **240**R is generally cylindrical and is disposed with its axial direction along the up-down direction. The rollers **240**L, **240**R in the pair correspond to an application portion or application members in the claims.
[0046] The advance mechanism includes a roller frame **250**, a pair of roller guides **260**L, **260**R, and a pair of air cylinders **270** (omitted in FIG. **2**). The roller frame **250** includes a base portion **254**, a pair of left frames **252**L, and a pair of right frames **252**R. The base portion **254** is located rearward (on the Y-axis positive direction side) of the posture correction portion body **220**. The left frames **252**L in the pair are disposed to protrude forward from left end portions of the base portion **254**. The left frames **252**L in the pair face each other and are spaced apart from each other in the up-down direction, and support the left roller **240**L between distal end portions of the left frames **252**L

in the pair via a rotary shaft **242**L in such a way that the left roller **240**L is rotatable. Likewise, the right frames **252**R in the pair are disposed to protrude forward from right end portions of the base portion **254**. The right frames **252**R in the pair face each other and are spaced apart from each other in the up-down direction, and support the right roller **240**R between distal end portions of the right frames **252**R in the pair via a rotary shaft (not illustrated) in such a way that the right roller **240**R is rotatable.

[0047] The left roller guide **260**L supports the left frames **252**L in the roller frame **250** in such a way as to be able to guide the left frames **252**L in the front-rear direction (the Y-direction), and the right roller guide **260**R supports the right frames **252**R in the roller frame **250** in such a way as to be able to guide the right frames **252**R in the front-rear direction. The air cylinders **270** in the pair are disposed side by side in the left-right direction (the X-direction) on the upper side of the roller frame **250**. Rods **272** of the air cylinders **270** are linked to the roller frame **250** so that when the rods **272** contract, the rollers **240**L, **240**R in the pair are advanced, and when the rods **272** extend, the rollers **240**L, **240**R in the pair are retreated.

(Management Part **400**)

[0048] The fitting device **10** further includes a management part **400**. The management part **400** includes a timing control part **410**, an adjustment part **420**, and a detection part **430**. As will be described later, the timing control part **410** controls the posture correction portion body **220** to start pressing the tire **310** of the tire assembly **300** by the pressing portions **232**U, **232**D in the pair in the state where forces by the rollers **240**L, **240**R in the pair are applied to the tire **310** in advance (see S**140** and S**150** in FIG. **3** which will be described later). The detection part **430** detects concave-convex states in the surfaces of the sidewalls **312**U, **312**D of the tire **310** of the tire assembly **300** supported by the support portion **100**. The detection part **430** detects the concave-convex states in the surfaces of the sidewalls **312**U, **312**D by, for example, an optical measurement method, a technique of image analysis of the surfaces of the sidewalls **312**U, **312**D of the tire **310**, or the like. The adjustment part **420** controls the posture correction portion body **220** to adjust the relative positions between the tire assembly **300** and the pressing portions **232**U, **232**D based on the detection results of the detection part **430** so that the pressing portions **232**U, **232**D can press surface portions on the convex portion side in the surfaces of the sidewalls **312**U, **312**D of the tire **310** (see

[0049] S**130** in FIG. **3** which will be described later). The management part **400** may be disposed outside the support portion **100** and the posture correction portion **200** or may be incorporated in either of the support portion **100** and the posture correction portion **200**.

A-2. Manufacturing Method of Tire Assembly **300** Using Fitting Device **10**

[0050] FIG. **3** is a flowchart illustrating a part of a manufacturing method of the tire assembly **300**. FIG. **4** is an explanatory diagram illustrating the top configuration of the tire assembly **300** before the fitting and the rollers **240**L, **240**R, and FIG. **5** is an explanatory diagram illustrating the Y Z sectional configuration of the tire assembly **300** before the fitting, the right roller **240**R, and the pressing members **230**U, **230**D. FIG. **6** is an explanatory diagram illustrating the top configuration of the tire assembly **300** immediately after the fitting, the rollers **240**L, **240**R, and the second pressing member **230**D, and FIG. **7** is an explanatory diagram illustrating the Y Z sectional configuration of the tire assembly **300** immediately after the fitting, the right roller **240**R, and the pressing members **230**U, **230**D.

(Assembly Process)

[0051] As illustrated in FIG. **3**, first, an assembly process of the tire assembly **300** is performed (S**110**). In the assembly process, the tire **310** is mounted on the wheel **320** by a non-illustrated assembly device to form the tire assembly **300** before the fitting.

[0052] Herein, since the fit of the tire assembly **300** before the fitting is low, there are cases where the tire **310** is slightly deformed from the original shape as the single product so that a convex portion P and a concave portion Q are present in each of the surfaces of the sidewalls **312**U, **312**D of the tire **310**. The convex portion P is, in each of the surfaces of the sidewalls **312**U, **312**D, a surface portion where the distance from a rim center plane S of the wheel **320** is the longest, and the concave portion Q is, in each of the surfaces of the sidewalls **312**U, **312**D, a surface portion where the distance from the rim center plane S of the wheel **320** is the shortest. The rim center plane S is a virtual plane that passes through the center of the wheel **320** in its rotation axis direction and is perpendicular to the rotation axis of the wheel **320**. The convex portion P and the concave portion Q are located on the sides generally opposite to each other with respect to the rotation axis of the tire assembly **300**. A main cause of the presence of the convex portions P and the concave portions Q is, for example, as follows. That is, the distance between the upper bead portion **314**U and the lower bead portion **314**D at one portion of the tire **310** in its circumferential direction becomes relatively long, and correspondingly, the distance between the upper bead portion **314**U and the lower bead portion **314**D at a portion of the tire **310** in its circumferential direction on the side opposite to the one portion becomes relatively short. Consequently, the convex portions P are respectively formed in the upper sidewall **312**U and the lower sidewall **312**D at the one portion of the tire **310**, and the concave portions Q are respectively formed in the upper sidewall **312**U and the lower sidewall **312**D at the portion of the tire **310** on the opposite side. Hereinafter, as illustrated in FIG. **4**, in a pair of half-arc-shaped regions formed by dividing the annular surface of each of the sidewalls **312**U, **312**D by a virtual straight line V perpendicular to the rotation axis O of the tire assembly **300** and passing through the rotation axis O of the tire assembly **300**, the half-arc-shaped region in which the convex portion P is located at the approximate center in the circumferential direction will be referred to as a convex region **312**H, and the half-arc-shaped region in which the concave portion Q is located at the approximate center in the circumferential direction will be referred to as a concave region **312**L.

(Support Process)

[0053] Next, a support process of the tire assembly **300** before the fitting is performed (S**120**). In the support process, for example, the tire assembly **300** before the fitting is carried from the assembly device to the fitting device **10** side by the carry-in device **124** and disposed at the position just above the support portion **100**. Then, for example, as described above, the management part **400** causes the support portion **100** to support the tire assembly **300** before the fitting (see FIG. **1**).

(Adjustment Process of Position)

[0054] Next, an adjustment process of the relative positions between the tire assembly **300** and the posture correction portion body **220** is performed (S**130**). In the adjustment process, for example, the management part **400** detects, based on the detection results of the detection part **430**, at least one of the convex portions P and the concave portions Q in the outer surfaces of the sidewalls **312**U, **312**D of the tire **310**, and controls the support portion **100** to rotate the tire assembly **300** so that the convex regions **312**H in the sidewalls **312**U, **312**D of the tire **310** are located on the posture correction portion body **220** side (see FIGS. **4** and **5**).

(Application Process)

[0055] Next, an application process of applying forces by the rollers **240**L, **240**R in the pair to the tire assembly **300** supported by the support portion **100** is performed (S**140**). In the application process, for example, the management part **400** causes the posture correction portion body **220** to slide by the slide unit **210** so as to adjust the distance between the tire assembly **300** supported by the support portion **100** and the posture correction portion body **220** to a predetermined distance and, further, controls the posture correction portion body **220** to advance the roller frame **250**. As illustrated in FIGS. **4** and **5**, when the advancing rollers **240**L, **240**R in the pair are pressed against the tread surface **316** of the tire **310**, a force in the direction in which the convex region **312**H side of the tire assembly **300** is displaced toward the wheel **320** side (the concave region **312**L side) is applied to the tire **310** (see a black arrow in FIG. **5**; hereinafter, this force will be referred to as a “convex portion side application force”). Like in this embodiment, it is preferable that the forces by the rollers **240**L, **240**R be applied to the tread surface **316** continuously over its entire width in the up-down direction (the Z-direction). With this configuration, the forces by the rollers **240**L, **240**R can be applied to the entire tire **310**, and therefore, for example, compared to a configuration in which the forces are applied to the tread surface **316** at only a part in the up-down direction, it is possible to suppress that the tread surface **316** of the tire **310** is depressed to prevent the generation of the sufficient convex portion side application force.

(Pressing Process)

[0056] Next, a pressing process of pressing the tire **310** of the tire assembly **300**, supported by the support portion **100**, by the pressing portions **232**U, **232**D in the pair is performed (S**150**). In the pressing process, for example, the management part **400** controls the posture correction portion body **220** to shorten the spacing distance between the first pressing member **230**U and the second pressing member **230**D. Consequently, as illustrated in FIGS. **6** and **7**, the first pressing portion **232**U of the first pressing member **230**U comes in contact with and presses downward the convex region **312**H in the upper sidewall **312**U of the tire **310** of the tire assembly **300**. Further, the second pressing portion **232**D of the second pressing member **230**D comes in contact with and presses upward the convex region **312**H in the lower sidewall **312**D of the tire **310**. That is, the portion on the convex region **312**H side in the tire **310** is sandwiched in the up-down direction by the first pressing member **230**U and the second pressing member **230**D. Preferably, a pressing force by the first pressing member **230**U and a pressing force by the second pressing member **230**D are approximately equal to each other.

[0057] In the upper sidewall **312**U of the tire **310**, when the convex region **312**H is pressed by the first pressing portion **232**U, the distal end of the upper bead portion **314**U corresponding to the convex region **312**H is moved to the rim center plane S side. On the other hand, the concave region **312**L is not supported by the support portion **100** and is displaceable to the side opposite to the rim center plane S. Therefore, by the movement of the distal end of the upper bead portion **314**U corresponding to the convex region **312**H, the distal end of the upper bead portion **314**U corresponding to the concave region **312**L is made to easily move. Then, by a restoring force of the tire **310** to return to its original shape, the distal end of the upper bead portion **314**U corresponding to the convex region **312**H and the distal end of the upper bead portion **314**U corresponding to the concave region **312**L are located at approximately the same position in the up-down direction (the Z-direction) on the upper bead seat portion **334**U of the wheel **320**.

[0058] Likewise, in the lower sidewall **312**D of the tire **310**, when the convex region **312**H is pressed by the second pressing portion **232**D, the distal end of the lower bead portion **314**D corresponding to the convex region **312**H is moved to the rim center plane S side. On the other hand, the concave region **312**L is not supported by the support portion **100** and is displaceable to the side opposite to the rim center plane S. Therefore, by the movement of the distal end of the lower bead portion **314**D corresponding to the convex region **312**H, the distal end of the lower bead portion **314**D corresponding to the concave region **312**L is made to easily move. Then, by the restoring force of the tire **310** to return to its original shape, the distal end of the lower bead portion **314**D corresponding to the convex region **312**H and the distal end of the lower bead portion **314**D corresponding to the concave region **312**L are located at approximately the same position in the up-down direction on the lower bead seat portion **334**D of the wheel **320**. That is, the fit of the tire **310** to the wheel **320** is improved. Consequently, force variation (RFV and LFV) of the tire assembly **300** after the air filling is improved.

[0059] In FIGS. **4** and **6**, there is illustrated a mode in which the pressing portions **232**U, **232**D directly press the convex portions P in the convex regions **312**H of the tire **310**. However, not limited to this, the pressing portions **232**U, **232**D each may press a portion other than the convex portion P in the convex region **312**H. Specifically, the portion other than the convex portion P is a portion located between the convex portion P and a portion moved by about 90 degrees from the convex portion P in the circumferential direction of the tire **310**. Herein, FIG. **8** is an explanatory diagram illustrating the top configuration of the tire assembly **300** immediately after the fitting, the

rollers **240**L, **240**R, and the second pressing member **230**D in a modification. In FIG. **8**, a first virtual straight line V**1** and a second virtual straight line V**2** are illustrated in addition to the virtual straight line V described above. The first virtual straight line V**1** is a straight line passing through the rotation axis O and passing through the convex portion P and the concave portion Q. The second virtual straight line V**2** is a straight line passing through the rotation axis O and forming an angle of 45 degrees with each of the virtual straight line V and the first virtual straight line V**1**. As illustrated in FIG. **8**, it is preferable that a pressing portion by each of the pressing portions **232**U, **232**D be a portion in the convex region **312**H between a position moved by 45 degrees from the convex portion P and a position moved by 90 degrees from the convex portion P (a portion defined by the virtual straight line V and the second virtual straight line V**2** in the convex region **312**H). In this case, compared to the configuration in which the pressing portions **232**U, **232**D directly press the convex portions P, the fit of the tire assembly **300** can be improved more smoothly. Compared to the configuration of directly pressing the convex portion P, it is expected that the degree of freedom of vertical movement of both the distal end of the lower bead portion **314**D corresponding to the convex region **312**H and the distal end of the lower bead portion **314**D corresponding to the concave region **312**L increases, resulting in that the fit of the tire **310** to the wheel **320** tends to be improved by the restoring force of the tire **310**. The pressing portion by each of the pressing portions **232**U, **232**D may alternatively be a portion in the convex region **312**H between the convex portion P and a position moved by 45 degrees from the convex portion P (a portion defined by the first virtual straight line V**1** and the second virtual straight line V**2** in the convex region **312**H).
(Other Processes)
[0060] Next, the tire assembly **300** after the fitting is carried by the carry-out device **112**, and an air filling process of filling compressed air in the tire **310** of the tire assembly **300** is performed (S**160**). Thereafter, a balance adjustment process is performed for the tire assembly **300** after the air filling (S**170**). In the balance adjustment process, first, the mass distribution of the tire assembly **300** in the circumferential direction is measured.
[0061] Herein, since the fit of the tire assembly **300** is high, it is possible to suppress a reduction in the measurement accuracy of the mass distribution that is otherwise caused due to the fit being low. Next, based on the measurement results of the mass distribution, processing, such as weighting, is applied to the tire assembly **300** so as to suppress variation in the mass distribution. Through the processes described above, the tire assembly **300** with high quality is manufactured in which the fit is high, and variation in the mass distribution and force variation (RFV and LFV) are suppressed after the air filling.
A-3. Effects of This Embodiment
[0062] As described above, in this embodiment, the pressing portion **232**U, **232**D is configured to press a first surface portion (a portion in the convex region **312**H, e.g. a portion including the convex portion P) in the surface of at least one of the sidewalls **312**U, **312**D of the tire **310**. The support portion **100** is configured to support the tire assembly **300** so that a second surface portion (a portion in the concave region **312**L) located on the side opposite to the first surface portion with respect to the rotation axis O of the tire assembly **300** in the surface of the sidewall **312**U, **312**D is displaceable in the direction away from the rim center plane S. Therefore, while supporting the tire assembly **300** by the support portion **100** in the state where the concave portion side (the second surface portion) of the sidewall **312**U, **312**D of the tire **310** is displaceable in the direction in which the tire **310** is inflated, it is possible to press the convex portion side (the first surface portion) of the sidewall **312**U, **312**D of the tire **310** by the pressing portion **232**U, **232**D. Consequently, according to this embodiment, it is possible to improve the fit of the tire **310** to the wheel **320**.
[0063] As described above, the first pressing portion **232**U protrudes forward and obliquely downward from the lower surface of the first pressing member **230**U. Further, the second pressing portion **232**D protrudes forward and obliquely upward from the upper surface of the second pressing member **230**D. Consequently, in the later-described pressing process (S**150**), for example,

by the pressing of the first pressing portion **232**U, the tire **310** is applied with a force that causes the upper bead portion **314**U to approach the rim center plane S, and in addition, a force directed toward the rotation axis O, and therefore, it is possible to improve the fit of the tire **310** to the wheel **320** more smoothly.

[0064] Further, in this embodiment, the forces by the rollers **240**L, **240**R in the pair are applied to the tire assembly **300** supported by the support portion **100** (S**140** in FIG. **3**). Consequently, compared to a configuration in which the forces by the rollers **240**L, **240**R are not applied to the tire **310**, the bead portions **314**U, **314**D of the tire **310** easily move on the bead seat portions **334**U, **334**D of the wheel **320** on the first surface portion side of the sidewalls **312**U, **312**D of the tire **310**, and therefore, it is possible to improve the fit of the tire **310** to the wheel **320** more reliably. Further, by applying the forces by the rollers **240**L, **240**R, it is possible to suppress the inclination of the wheel **320** due to the pressing forces by the pressing portions **232**U, **232**D. Further, since the forces by the rollers **240**L, **240**R in the pair are applied to the tire **310**, compared to a configuration in which the force by only one of the rollers **240**L, **240**R in the pair is applied to the tire **310**, the convex portion side application force described above can be reliably applied to the tire **310**, and as a result, it is possible to improve the fit of the tire **310** to the wheel **320** more effectively.

[0065] Further, in this embodiment, the pressing against the tire **310** of the tire assembly **300** by the pressing portions **232**U, **232**D in the pair is started in the state where the forces by the rollers **240**L, **240**R in the pair are applied to the tire **310** in advance (S**140** and S**150** in FIG. **3**). Consequently, the displacement of the wheel **320** is suppressed by the forces by the rollers **240**L, **240**R and the supporting force by the support portion **100**, and therefore, it is possible to suppress that the fit of the tire **310** to the wheel **320** is lowered due to the displacement of the wheel **320**. Further, as illustrated in FIGS. **6** and **8**, the rollers **240**L, **240**R in the pair are disposed so that the pressing positions of the pressing portions **232**U, **232**D are located between the rollers **240**L, **240**R in the pair (e.g. at the middle position therebetween) in the circumferential direction of the tire **310** in a view in the up-down direction (the Z-direction). Therefore, it is possible to perform the pressing by the pressing portions **232**U, **232**D and the application of the forces by the rollers **240**L, **240**R in the pair while suppressing the rotation of the tire assembly **300**.

[0066] Further, in the above-described embodiment, in the support process (S**120**), it is possible to automatically adjust the relative positions between the tire assembly **300** and the pressing portions **232**U, **232**D based on the detection results of the detection part **430** so that the pressing portions **232**U, **232**D can press the convex regions **312**H of the tire **310**.

B. Modifications

[0067] The technique disclosed in this specification is not limited to the embodiment described above and can be modified to various modes within the scope not departing from the gist thereof. For example, the following modifications are made possible.

[0068] The configuration of the fitting device **10** in the above-described embodiment is only one example and can be modified in various ways. For example, the fitting device **10** may be configured such that the support portion **100** and the posture correction portion **200** are individually operated without including the management part **400**. Further, the support portion **100** may be a configuration not including the lifting unit **110**. Further, the support portion **100** may be configured to hold the inner peripheral side of the wheel rim **330** of the wheel **320** of the tire assembly **300**. Further, the support portion **100** may be a configuration not including the configuration of rotating the tire assembly **300**.

[0069] The posture correction portion body **220** may be configured to include only one of the first pressing portion **232**U and the second pressing portion **232**D and to press only one of the sidewalls of the tire **310** by the one of the pressing portions. Further, the shape of the pressing portions **232**U, **232**D may be a shape other than the arc shape. Further, the posture correction portion body **220** may be a configuration not including either of the rollers **240**L, **240**R in the pair, or may be a configuration including only one of the rollers **240**L, **240**R in the pair or three or more rollers.

Further, as the application member, it is not limited to the roller and may be one having another shape such as, for example, a flat plate shape. Further, in the above-described embodiment, the convex portion side application force described above may be applied to the tire **310** by pulling the concave region **312**L side of the tire **310**.

[0070] The manufacturing method of the tire assembly **300** in the above-described embodiment is only one example and can be modified in various ways. For example, in the above-described embodiment, in the support process (S**120**), the support portion **100** may support the tire assembly **300** in a state in which the outer side faces downward. Further, the support portion **100** is not limited to supporting the tire assembly **300** in a transverse state in which the rim center plane S is horizontal. For example, the tire assembly **300** may be supported in an upright state in which the rim center plane S is vertical, and the correction process (S**130** to S**150**) by the posture correction portion body **220** may be performed for the tire assembly **300** in the upright state. Further, in the support process, the relative positions between the tire assembly **300** and the pressing portions **232**U, **232**D may be adjusted by rotating the posture correction portion body **220** side without rotating the tire assembly **300**.

[0071] In FIG. **3** of the above-described embodiment, the air filling process (S**160**) may be performed before S**120**. However, when the correction process (S**130** to S**150**) by the posture correction portion body **220** is performed for the tire assembly **300** before the air filling process like in the above-described embodiment, it is possible to improve the fit of the tire assembly **300** more effectively.

DESCRIPTION OF SIGNS

[0072] **10**: fitting device **12**: base plate **100**: support portion **110**: lifting unit **112**: carry-out device **114**: support cylinder **116**, **122**: servomotor **120**: support portion body **124**: carry-in device **130**: chuck **132**: pole **134**: chuck cylinder **200**: posture correction portion **210**: slide unit **212**: unit body **214**: movable stage **216**: servomotor **220**: posture correction portion body **222**L, **222**R: electric cylinder **224**L, **224**R: linking arm **230**U, **230**D: pressing member **232**U, **232**D: pressing portion **240**L, **240**R: roller **242**L: rotary shaft **250**: roller frame **252**L: left frame **252**R: right frame **254**: base portion **260**L, **260**R: roller guide **270**: air cylinder **272**: rod **300**: tire assembly **310**: tire **312**D: lower sidewall **312**H: convex region **312**L: concave region **312**U: upper sidewall **314**D: lower bead portion **314**U: upper bead portion **316**: tread surface **320**: wheel **330**: wheel rim **332**D: lower flange portion **332**U: upper flange portion **334**D: lower bead seat portion **334**U: upper bead seat portion **336**: drop portion **340**: wheel disc **342**: hub attaching portion **344**: spoke portion **400**: management part **410**: timing control part **420**: adjustment part **430**: detection part O: rotation axis P: convex portion Q: concave portion S: rim center plane V **1**: first virtual straight line V**2**: second virtual straight line V: virtual straight line

Claims

1. A method for manufacturing tire assembly comprising: mounting a tire on a wheel to form a tire assembly before fitting the tire to the wheel, the tire including a bead, a sidewall, and a tread surface, the bead including a first bead region and a second bead region, the sidewall including a first sidewall region and a second sidewall region, the tread surface including a first tread region; supporting the tire assembly before fitting the tire to the wheel by supporting the wheel with a supporting member; fitting the tire to the wheel including: applying force with a roller to a part of the first tread region toward a rotational axis of the wheel; and pressing a part of the first sidewall region with a pressing member toward a center plane of the wheel; determining that the fitting is finished when a first distance between an outer end of the first bead region in a rotational axis direction and the center plane and a second distance between an outer end of the second bead region in the rotational axis direction and the center plane are approximately the same while the roller and the pressing member are separated from the tire; and filling air in the tire assembly after the fitting is finished, wherein the center plane is centered in the wheel and perpendicular to the rotational axis, the first sidewall region is a region in which a distance between the sidewall and the center plane is longer than an average distance between the sidewall and the center plane, the second sidewall region is a region in which the distance between the sidewall and the center plane is shorter than the average distance between the sidewall and the center plane, the second sidewall region is on and opposite side of the rotational axis from of the first sidewall region, the first tread region is radially outward of the first sidewall region, the first bead region is radially inward of the first sidewall region, and the second bead region is radially inward of the second sidewall region.

2. The method according to claim 1, wherein the roller includes a first roller and a second roller, and the pressing member is between the first roller and the second roller in a circumferential direction of the tire.

3. The method according to claim 1, wherein the first sidewall region includes a first point that a distance between the sidewall and the center plane of the wheel is the longest.

4. The method according to claim 3, wherein a first line is virtual and passes through the rotation axis and the first point, a second line is virtual and passes through the rotation axis and forms an angle of 90 degrees to the first line, a third line is virtual and passes through the rotation axis and forms an angle of 45 degrees to the second line toward the first point, and in the pressing, the pressing member presses a pressing region in the first sidewall region defined by the second line and the third line. the roller includes a first roller and a second roller, the first roller is on the second line, the second roller is on the third line the pressing member is between the first roller and the second roller in a circumferential direction of the tire.

6. The method according to claim 3, wherein a first line is virtual and passes through the rotation axis and the first point, a second line is virtual and passes through the rotation axis and forms an angle of 45 degrees to the first line, and in the pressing, the pressing member presses a pressing region in the first sidewall region defined by the first line and the second line.