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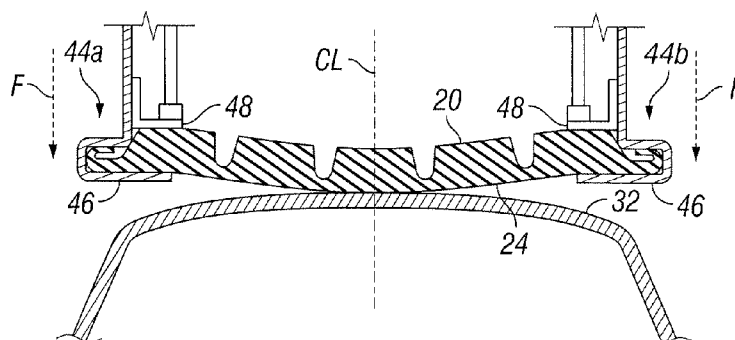


FIG. 4C

(57) Abstract: Exemplary embodiments of the subject invention comprise methods and apparatus for mounting a tread ring onto a tire carcass. Such methods may include the step of providing an annular tread ring having a tread width extending laterally between opposing side edges; engaging the annular tread ring about each opposing side edge at locations distal from a lateral centerline of the tread width; expanding the tread ring radially outward from an initial arrangement to an expanded arrangement at the engaged locations about the side edges of the tread ring; arranging the expanded tread ring about an outer side of a tire carcass; and contracting the tread ring into an installed arrangement about the outer side of the tire carcass, whereby the lateral centerline of the tread width on an inner side of the tread ring engages the tire carcass before the tread ring side edges engage the tire carcass.



METHODS AND APPARATUS FOR INSTALLING A TREAD RING
UPON A TIRE CARCASS

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates generally to methods and apparatus for mounting a tread ring onto a tire carcass or casing.

Description of the Related Art

[0002] It is known to mount tire treads, such as heavy duty truck tires and trailer tires, onto tire casings during tire retread operations. For example, a length of tread may be wrapped around a tire carcass, whereby terminal ends of the tread length meet at a joint. Elastomeric joining material may be applied as necessary to fill any gap between the opposing terminal ends. The terminal ends may be stapled to retain the arrangement.

[0003] By further example, a tread forming a ring may be applied to a tire carcass, such as for retreading purposes, by expanding the tread ring outwardly. For example, a plurality of fingers spaced annularly about the tread ring are inserted into the central opening of the tread ring to engage an underside of the tread. The fingers, which extend across a width of the tread, are displaceable in a radial direction to deflect and thereby expand the tread ring as necessary to arrange the tread ring about the outer circumference of the tire carcass. In its expanded form, the tread ring generally may form a polygon corresponding to the finger arrangement. After the tire carcass is arranged within the central cavity or opening of the tread ring, and elastomeric joining material arranged between the tread ring and the tire carcass, the plurality of fingers displace to contract the expanded tread ring about the tire carcass. The fingers are then removed laterally from the retreaded tire carcass to release the tread ring onto the tire carcass. The lateral removal of fingers from between the tread ring and tire carcass could have a tendency to displace the tread ring from the centerline of the tire carcass causing lateral variations about the tread ring. Other abnormalities may result that may affect assembly of the retread tire.

[0004] Another exemplary process for mounting a tread ring utilizes centrifugal forces to expand the tread ring during a spinning operation. Once the tread ring expands, the tire carcass is inserted centrally. Thereafter, the rotational speed of the tread ring is slowed until the tire is mounted onto a carcass spinning at a similar speed such that there is little if

any relative rotation between the tread ring underside and the outer surface of the tire carcass. Because there are imbalances inherent in each of the tread ring and the tire carcass, rotation of each produces inexact shapes as the imbalances act upon each rotational body, which results in a less-than perfect assembly and interface between non-symmetrical components.

[0005] Accordingly, there is a need to provide improved methods and apparatus for mounting a tread ring onto a tire carcass.

SUMMARY OF THE INVENTION

[0006] Particular embodiments of the present invention include methods and apparatus for mounting a tread ring onto a tire carcass. Particular embodiments of such methods include a method for applying a ring tread onto a tire carcass including the step of providing an annular tread ring having a tread width extending laterally between opposing side edges, and engaging the annular tread ring about each opposing side edge at locations distal from a lateral centerline of the tread width. Further steps may include expanding the tread ring radially outward from an initial ring arrangement to an expanded arrangement at the engaged locations about the side edges of the tread ring. Yet further steps may include arranging the expanded tread ring about an outer side of a tire carcass. Such methods may further include the step of contracting the tread ring into an installed arrangement about the outer side of the tire carcass, whereby the lateral centerline of the tread width on an inner side of the tread ring engages the tire carcass before the tread ring side edges engage the tire carcass.

[0007] Particular embodiments of such apparatus include a tread ring expansion assembly. The tread ring expansion assembly may include a first plurality of expansion members on one side of the tread ring expansion assembly arranged radially about an axis central to a tread ring receiving cavity, the first plurality of expansion members adapted to engage a first lateral side edge of a tread ring. Additionally, the tread ring expansion assembly may include a second plurality of expansion members arranged radially about the axis on an opposite side of the tread ring expansion assembly adapted to engage a second lateral side edge of the tread ring. The first and second plurality of expansion members are operably positioned to engage each tread ring side edge at locations distal from the lateral centerline of the tread ring width. Each of the expansion members may be movable between a first radial position and a second radial position, wherein the first radial position

corresponds to an initial tread ring arrangement and the second radial position corresponds to an expanded tread ring arrangement.

[0008] The foregoing and other objects, features and advantages of the invention will be apparent from the following more detailed descriptions of particular embodiments of the invention, as illustrated in the accompanying drawing wherein like reference numbers represent like parts of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of a tread ring and a tire carcass according to an exemplary embodiment of the invention.

[0010] FIG. 2A is a cross-sectional view of the exemplary tread ring of FIG. 1 taken along line 2-2, the tread including wings extending outwardly from each lateral tread side.

[0011] FIG. 2B is a cross-sectional view of an alternative embodiment to tread shown in FIG. 2A through an alternative tread ring.

[0012] FIG. 3 is a side view of a device for applying a tread ring to a tire carcass with a plurality of tread ring expansion members engaging the tread ring in an expanded arrangement during application of the tread ring to the tire carcass according to an exemplary embodiment of the invention.

[0013] FIG. 4A is a partial sectional view of a pair of tread ring expansion members taken along line 4B-4B prior to grasping the tread ring and arranging the tire carcass within the central cavity or opening of the tread ring, the pair of tread ring expansion members shown partially engaging the tread ring shown in FIG. 2A according to an exemplary embodiment of the invention.

[0014] FIG. 4B is a partial cross-sectional view of the pair of tread ring expansion members taken along line 4B-4B in FIG. 3, the tread ring expansion members being shown grasping the tread ring and maintaining the tread ring in an expanded arrangement after said tread ring expansion members have expanded the tread ring from an initial, unexpanded arrangement prior to installation of the tread ring onto a tire carcass according to an exemplary embodiment of the invention.

[0015] FIG. 4C is a partial cross-sectional view of the pair of tread ring expansion members shown in FIG. 4B, shown now moving the tread ring radially inward to contract the

tread ring about the tire carcass for installation of the tread ring upon the tire carcass according to an exemplary embodiment of the invention.

[0016] FIG. 5 is a partial cross-sectional view of a pair of tread ring expansion members in FIG. 4 taken along line 5-5 shown grasping the tread ring in an unexpanded arrangement.

[0017] FIG. 6 is an alternative partial cross-sectional view of the section in FIG. 5 of a pair of alternative tread ring expansion members, whereby the expansion members are arranged to engage a void arranged along an underside of the tread ring for the purposes of constraining the tread ring relative to each expansion member in accordance with an exemplary embodiment of the invention.

[0018] FIG. 7A is yet another alternative partial cross-sectional view of the section in FIG. 5 of a pair of another alternative tread ring expansion members, where the tread ring includes grasping tabs extending outwardly from the tread ring and whereby the expansion members are shown in a disengaged position according to an exemplary embodiment of the invention.

[0019] FIG. 7B is a partial cross-sectional view of the pair of alternative tread ring expansion members in FIG. 7A with the expansion members grasping the tread ring by the grasping tabs and having radially displaced the tread ring into an expanded arrangement.

DETAILED DESCRIPTION OF PARTICULAR EMBODIMENTS

[0020] The present invention includes methods for installing a tread ring onto a tire casing and a tread ring installation device. In tire retreading operations, such as for retreading heavy duty truck or trailer tires, tread rings are applied to a pre-existing, cured tire casing to form a retreaded tire. It is understood, however, that the present invention may be used to install or apply a tread ring onto any cured or uncured tire carcass, such as during new tire manufacturing operations.

[0021] Methods of mounting or applying a tread ring onto a tire carcass may comprise a variety of steps. In particular embodiments, such methods include the step of providing an annular tread ring having a tread width extending laterally between opposing side edges. It is known that tires have a tread extending annularly there about. In the present step, a tread in the form of a tread ring is provided. The tread ring may comprise any desired tire tread of any design associated with any tire type. Further, the tread is formed of any

known elastomeric material, such as natural and/or synthetic rubber or polymeric material that is curable with the application of heat or more generally by vulcanization. The tread ring structure generally includes an outer side and an inner side, the tread thickness extending between the outer and inner sides. Opposing side edges (also referred to as “lateral side edges”) are arranged on opposing sides of a width of the tread, the tread width extending laterally in a direction perpendicular to both the tread thickness and a lengthwise direction of the tread. The width of the tread generally remains constant or narrows from the inner side to the outer side. Accordingly, the width of the tread ring outer side may be less than or equal to the width of the tread ring inner side. The outer side of the tread generally forms a ground-engaging side of the tread, which may or may not include a patterned arrangement of tread features. Tread features may comprise grooves, sipes, and other voids associated with ground-engaging ribs and or lugs. The inner side of the tread is configured for attachment to an outer surface of the tire carcass.

[0022] The tread and tread ring may be formed according to any known process. For example, the tread may be molded flat or extruded and cut to length as necessary. Thereafter, opposing terminal ends are joined to form a unitary, continuous ring. By further example, the tread may be molded into the shape of a unitary, continuous ring. The outer side of the tread generally forms the outer side of the tread ring, while the inner side of the tread forms the inner side of the tread ring. The tread ring may be provided in an uncured, cured, or at least partially cured state or condition.

[0023] The method of applying a tread ring onto a tire carcass may further comprise the step of engaging the annular tread ring about each opposing side edge at locations distal from a lateral centerline of the tread width. To prepare the tread ring for expansion, the ring is arranged in an initial ring arrangement, whereby each opposing side edge of the tread ring may be engaged by a plurality of expansion members arranged radially about each side edge. The expansion members are movable radially outward to expand the tread ring. The expansion members are described more fully below in association with the figures. The expansion members engage the tire tread adjacent each side edge distal from the lateral centerline of the tread. Stated another way, the plurality of expansion members may engage the tire tread adjacent each side edge without engaging a center portion of the tread width between the side edges. By expansion members not extending beyond the lateral centerline of the tread, the center of the tread may be applied to the tire carcass before any other portion of the tread is applied to the tire carcass. This facilitates removal of air from between the

tread ring and the tire carcass, and helps prevent any entrapment of air therebetween. For example, a first plurality of expansion members may be arranged radially about one side of the tread ring engaging the first side edge, and a second plurality of expansion members may be arranged radially about the other side of the tread ring engaging the second side edge. The expansion members on one side of the tread ring may be positioned axially opposite a corresponding expansion member on the opposite side of the tread ring, such that the expansion members are aligned in pairs about the tread ring. In another example, expansion members on one side of the tread ring are positioned offset from the expansion members on the opposite side of the tread ring, and in this example, there may be a different number of expansion members on one side of the tread ring than the other. In particular embodiments, from 8 to 12 expansion members may be spaced circumferentially about each side edge.

[0024] In any event, the step of engaging the tread ring may include engaging the inner side of the tread ring. In a particular embodiment, the tread ring may be engaged on the outer side of the tread ring, or may engage both the inner side and outer side of the tread ring. For example, the expansion members may engage the tread ring adjacent the side edge by grasping or clamping a portion of the tread. For further example, the expansion members may engage the tread ring by engaging an aperture on the inner side of the tread ring, or a tread recess on the inner side of the tread ring. In addition to, or in lieu of, engaging the annular tread ring about each opposing side edge, the step of engaging may include engaging one or more grasping tabs extending outwardly adjacent each side edge of the tread ring at the engaging locations about the side edges of the tread ring. In another example, apertures may be provided through the grasping tabs for engaging a hook, protrusion, fastener, or other engagement member. The expansion members may be adapted to engage the grasping tabs in preparation for expanding the tread ring. Optionally, when the tread ring includes wings extending from each side edge, and the expansion members may be adapted to grasp or clamp onto the wings. In other words, the wings may function as the grasping tabs for the expansion members to grasp or clamp.

[0025] The method of mounting a tread ring onto a tire carcass may further comprise the step of expanding the tread ring radially outward from an initial arrangement to an expanded arrangement at the engaged locations about the side edges of the tread ring. As discussed above, the expansion members facilitate expansion of the tread ring from an unexpanded initial arrangement to an expanded arrangement, where the circumference of the tread ring in the expanded arrangement is larger than the outer diameter of a tire carcass. In

operation, the expansion members engaged to the tread ring move radially outward to expand the tread ring outwardly. The expansion members engaging the tread ring adjacent the side edges expand the side edges of the tread ring more than the center portion of the tread width between the side edges. As such, the circumference of each tread ring side edge in the expanded arrangement is greater than the circumference of the tread ring at the lateral centerline of the tread width. As the tread ring expands, the width of the tread ring may narrow. In such situations, the expansion members on one side of the tread ring (or on both sides) may move axially inward relative to the tread ring as the tread ring expands to decrease the distance between the expansion members on one side of the tread ring and the expansion members on the other side of the tread ring as the tread narrows in width.

[0026] The method of mounting a tread ring onto a tire carcass may further comprise the step of arranging a joining material between the tread ring and the tire carcass. To attach the tread ring to the tire carcass, joining material may be arranged between the tread and carcass. The joining material may be placed along an outer side of the tire carcass and/or along the inner side of the tread ring (i.e., underside of the tread), which is the tread surface facing the tire carcass. Application to the inner side of the tread ring may occur when the tread ring is in an expanded state, but may also occur when in an unexpanded state. Such application may be performed by extending a means for applying the joining material onto the tread, such as a joining material applicator. For example, such means may apply the joining material by spray or as a film having a desired length, width, and thickness. The joining material may include any known material for joining the tread to the carcass. For example, the joining material may include a curable elastomeric material or an adhesive. The joining material may also be curable, such as by application of heat, to achieve vulcanization. It is also understood that any device, apparatus, or mechanism may be inserted into (and removed from) the central cavity of the expanded or unexpanded tread ring before any tire carcass is received therein to achieve a desired purpose. For example, such device, apparatus, or mechanism may comprise a means for applying heat to the joining material and/or tread ring or for preparing the inner side of the tread for receiving joining material or for attachment to the tire carcass, such as to score (lacerate) or abrade the inner side of the tread ring to improve adhesion.

[0027] The method of mounting a tread ring onto a tire carcass may further comprise the step of arranging the expanded tread ring about an outer side of a tire carcass, or alternatively, inserting a tire carcass within a central opening of the tread ring while in the

expanded arrangement, such that the tread ring is centered around the tire carcass. A tire carcass can be described as having approximately the shape of a torus having a central opening concentric with a rotational axis of the tire, whereby an outer diameter of the torus is arranged along an annular surface to form the tread-engaging surface. In arranging the tire carcass within the tread ring, the inner side of the tread ring may be arranged adjacent the tread-mounting surface of the tire carcass and the rotational axes of the tread ring and the tire carcass arranged coaxially. It is understood that the step of inserting or arranging may be accomplished by translating either or both of the tread ring and tire carcass relative to the other to achieve the desired arrangement. Translation is defined to include linear and non-linear movement, such as rotational movement.

[0028] The method of applying a tread ring onto a tire carcass may further include the step of contracting the tread ring into an installed arrangement about the outer side of the tire carcass, whereby the lateral centerline of the tread width on an inner side of the tread ring engages the tire carcass before the tread ring side edges engage the tire carcass. Once the expanded tread ring is properly positioned relative the tire carcass, the tread ring contracts until reaching an installed arrangement upon the tire carcass. In the expanded arrangement, the circumference of each tread ring side edge is greater than the circumference of the tread ring at the lateral centerline of the tread width. As such, as the tread ring relaxes onto the tire carcass, the first contact between the inner side of the tread and the outer side of the tire carcass is at the center portion of the tread width. With further contraction of the tread ring, the inner side of the tread contacts the outer side of the tire carcass from the center of the tread progressively outward until the tread ring side edges contact the tire carcass, inhibiting entrapment of air between the tread and the tire carcass.

[0029] Contraction of the tread ring may be achieved by translating any structure used to expand the tread ring radially inward toward the tire carcass, such as the tread expansion members. Quite simply, contraction may occur by generally reversing the process employed to expand the tread ring according to prior steps. Contraction generally continues until the tread ring is mounted or arranged onto the tire carcass in an installed arrangement.

[0030] The method of mounting a tread ring onto a tire carcass may further comprise the step of releasing the engagement members from the tread ring. After the tread ring has been arranged along the tire carcass, the engagement members are released from the tread

ring. Releasing the engagement members may be performed as part of the step of contracting the tread ring into an installed arrangement about the outer side of the tire carcass.

[0031] A further step of the method of mounting a tread ring onto a tire carcass may comprise at least partially curing joining material arranged between the tread ring and the tire carcass to form a retreaded tire. After applying the tread ring onto the tire carcass with joining material arranged there between, according to particular embodiments, the joining material may be partially or substantially cured. Such partial or substantial curing may be performed before or after removing the treaded tire carcass from any apparatus in which it is formed, and may be achieved by applying heat to the joining material using any known means for heating the joint material. Means for heating may be achieved through conduction, convection, or radiation. For example, the assembled tire may be placed within a curing membrane and together placed within an autoclave as is traditional done. It is understood that any other means of curing or applying heat to the assembled tire known to one of ordinary skill in the art may be employed.

[0032] These methods for mounting or applying a tread ring onto a tire carcass may be achieved manually or automatically, in whole or in part. Exemplary embodiments of a tread ring installation device for use in performing such methods are discussed in further detail below. The device(s) shown in the figures are only exemplary of any of a variety of ring tread mounting devices that may be employed within the scope of this invention.

[0033] With reference to FIGS. 1-2A, a tread ring generally includes an outer side **22** and an inner side **24**, the tread thickness extending between the outer and inner sides. Opposing side edges **26, 28** (also referred to as “lateral side edges”) are arranged on opposing sides of a width of the tread, the tread width shown in FIG. 2A by reference dimension “W,” the tread width extending laterally in a direction perpendicular to both the tread thickness and a lengthwise direction of the tread. Optionally, the tread ring may include wings **29** extending from each side edge **26, 28** such as shown in FIG. 2A arranged for attaching to a portion of the sides of the tire carcass in the installed arrangement. The tread ring **20** is prepared for installing onto a tire carcass **30** having an outer side **32** prepared for receiving the tread ring. The inner side **24** of the tread ring **20** has a circumference corresponding to the circumference of the outer side **32** of the tire carcass **30**. In particular embodiments, the inner side **24** of the tread ring **20** may have a circumference larger than, the same as, or smaller

than the circumference of the outer side **32** of the tire carcass **30** as desired for the application.

[0034] An exemplary installation device **40** is shown in FIG. **3** for mounting a tread ring onto a tire carcass. The device or system **40** generally includes a tread ring expansion assembly **42** for engaging, expanding, and mounting the tread ring **20** onto the tire carcass **30**. With reference to FIGS. **3** and **4A**, the tread ring expansion assembly **42** includes a first plurality of expansion members **44** on one side of the tread ring expansion assembly arranged radially about an axis central to a tread ring receiving cavity, the first plurality of expansion members adapted to engage the first lateral side edge **26** of the tread ring **20**. Additionally, a second plurality of expansion members **44** are arranged radially about the axis on the opposite side of the tread ring expansion assembly to engage the second lateral side edge **28** of the tread ring **20**. The expansion members **44** are operably positioned to engage each side edge **26**, **28** of the tread ring **20** at locations distal from the lateral centerline of the tread width, shown as centerline **CL** in FIG. **4A**. Each of the expansion members **44** are movable between a first radial position and a second radial position, wherein the first radial position corresponds to an initial tread ring arrangement and the second radial position corresponds to an expanded tread ring arrangement. Additionally, each of the expansion members **44** are movable between the second radial position and a third radial position, wherein the third radial position corresponds to an installed tread ring arrangement. In particular embodiments, the initial radial position and the installed radial position may be approximately the same position. In particular embodiments, from 5 to 18 expansion members may be spaced circumferentially about the tread ring receiving cavity. For example, from 6 to 12 expansion members may be spaced circumferentially about each side edge. For further example, from 8 to 12 expansion members may be spaced circumferentially about each side edge. Each expansion member may be formed of any one or more materials such as steel or aluminum, thermoset or thermoplastic materials, or combinations thereof.

[0035] To mount a tread ring onto the tire carcass such as shown in FIG. **3**, the tire carcass **30** is placed within a central opening or cavity of the tread ring **20** while the tread ring is in an expanded arrangement. Once the tire carcass is arranged within the expanded tread ring, the ring is contracted onto the tire carcass. With reference to FIG. **3**, the tread ring expansion assembly **42** is configured to receive the tread ring in an unexpanded initial arrangement and subsequently expand the tread ring into the expanded arrangement for receiving the tire carcass. As shown in FIG. **4A**, the expansion members **44a**, **44b** are

operably positioned to engage respective side edges **26**, **28** of the tread ring **20**. In the embodiment shown in FIGS. **4A-4C**, each expansion member **44a**, **44b** includes an inner engaging member **46** and an outer engaging member **48**. To engage the tread ring, the expansion members **44** translate axially inward relative to the tread ring, engaging the inner engaging members **46** with the inner side **24** of the tread ring, shown in FIG. **4A** by direction arrows “**A**.” The inner engaging member **46** may include an extended portion **49** adapted for accommodating the wings **29**, if present, on the tread ring. The extended portion **49** may be sized to accommodate the wings **29** in an extended arrangement. In particular embodiments, the wings **29** may be folded over or gathered in the extended portion **49** as shown in FIGS. **4A-4C**. When the inner engaging members **46** engage the inner side **24** of the tread ring, the outer engaging members **48** translate radially inward relative to the tread ring, engaging the outer engaging members **48** with the outer side **22** of the tread ring, shown in FIG. **4A** by direction arrows “**B**.” In the example in FIG. **4A**, a compression force may be applied to the tread thickness between the inner engaging member **46** and the outer engaging member **48** to securely engage the tread side edge in the expansion member. To expand the tread ring, the engaged expansion members **44a**, **44b** translate radially outward, shown in FIG. **4B** by direction arrows “**C**,” from the initial arrangement to the expanded arrangement.

[0036] In the expanded tread ring arrangement, the plurality of expansion members are displaced radially outward from the initial tread ring arrangement, and therefore are spaced further apart in a spaced annular arrangement. As the expansion members expand the tread ring by pulling locations about the side edges, the side edges of the tread ring are expanded more than the center portion of the tread width between the side edges. As such, the circumference of each tread ring side edge in the expanded arrangement is greater than the circumference of the tread ring in the center of the tread width as shown in FIG. **4B**.

[0037] To apply the tread ring to the tire carcass, the tread ring is expanded to a circumference greater than the circumference of the outer side of the tire carcass, such that when the expanded tread ring is arranged about the tire carcass, a gap “**D**” is provided between the outer side **32** of the tire carcass and the inner side **24** of the tread ring as shown in FIG. **4B**. At least one of the tire carcass and the tread ring is moveable in the axial direction relative to the other, shown in FIG. **4B** by direction arrows “**E**,” such that the expanded tread ring is arranged about the tire carcass. After the expanded tread ring is positioned about the tire carcass as desired, the expansion members **44a**, **44b** translate radially inward relative to the tread ring shown in FIG. **4C** by direction arrows “**F**,” allowing

the inner side **24** of the tread ring to contract into an installed arrangement about the outer side **32** of the tire carcass.

[0038] As discussed above with reference to FIGS. **4A-4C**, the expansion members **44a, 44b** may engage the tread ring adjacent the side edge by grasping or clamping a portion of the tread. To facilitate tread ring expansion and application to tire carcass, the expansion members **44a, 44b** translate radially between initial, extended, and installed tread ring arrangements using any known means for moving the expansion members, for example, hydraulic or pneumatic cylinders, cams, linear drives, rotary drives, or motors in communication with belts, gears, or chain drives, or other actuators known in the art. For example, with reference to FIG. **5**, radial movement of the expansion members **44a, 44b** may include cooperatively controlling the position of each inner engaging member **46** and outer engaging member **48** with an actuator configured for radial movement. The inner engaging members **46** may be operably connected to inner radial actuators **50** adapted to translate the inner engaging members radially between initial, extended, and installed tread ring arrangements. The outer engaging members **48** may be operably connected to outer radial actuators **52** adapted to translate the outer engaging members radially between initial, extended, and installed tread ring arrangements cooperatively with the inner engaging members **46**. Additionally, at least one of the inner engaging members **46** and the outer engaging members **48** may translate relative to the other to an unclamped position enabling engagement and disengagement of the tread ring, such as shown in FIG. **4A**. The radial actuators **50, 52** may be configured to actuate independently for engaging and releasing the tread ring. Once a tread ring is engaged by the expansion members, the radial actuators **50, 52** may be configured to actuate in unison for movement of the engaged expansion members between the initial, extended, and installed tread ring arrangements. In addition to, or in lieu of, linear movement, the expansion members **44a, 44b** may be arranged to move in a pivotal movement between the initial arrangement and expanded arrangement, and between the expanded arrangement and installed arrangement. Further, in addition to, or in lieu of, linear movement, the expansion members **44a, 44b** may be arranged to engage the tread ring moving in a pivotal arrangement.

[0039] Referring to FIG. **5**, the tread ring expansion assembly **42** may include actuators to facilitate axial movement of the expansion members **44a, 44b**. The tread ring expansion assembly **42** may include a first block **54** operatively connected to the expansion member **44a** and a second block **56** operatively connected to the expansion member **44b**, the

first and second blocks translatably positioned on an assembly support structure **58** to facilitate axial movement of the expansion members **44a**, **44b** toward and away from the tread ring. Axially directed actuators **60** may be attached to the assembly support structure **58** operably attached to the first and second blocks **54**, **56** configured to move the first block **54**, with expansion member **44a**, axially toward and away from the first lateral side edge **26** of the tread ring **20**, and to move the second block **56**, with expansion member **44b**, axially toward and away from the second lateral side edge **28**. In particular embodiments, one of the first and second blocks **54**, **56** may be fixed in place and the other axially translatable. The actuators **60** may be configured to actuate independently for engaging and releasing the tread ring. Additionally, as the tread ring expands, the width of the tread ring may narrow. As such, as the expansion members translate between the initial and expanded arrangements and between expanded and installed arrangements, the actuators **60** may be configured to provide axial movement of the expansion members to maintain the center of the tread over the center of the tire carcass.

[0040] In particular embodiments, in addition to, or in lieu of, the expansion members moving linearly in an axial direction, the expansion members may be configured to engage and disengage the tread ring in a rotational motion. For example, the expansion members may be pivotally connected to the assembly support structure such that each expansion member pivots toward and away from the tread ring side edge.

[0041] In another example shown in FIG. 6, the expansion members may engage the tread ring by engaging an aperture on or through the tread ring, or a tread recess on the inner side of the tread ring. The expansion members **64** may include an inner engaging member **66** having a protrusion **68** or hook adapted to engage an aperture **70** or a tread recess as desired. The aperture **70** may extend through a full thickness of the tread ring, or may extend partially through the tread ring thickness. When extending through the full thickness, the aperture may or may not be filled with tread material or other suitable material after the tread ring is applied to the tire carcass. After the expansion members engage the aperture or tread recess, the expansion members **64** translate radially outward from the initial arrangement to an expanded arrangement. The expansion members **64** are configured to translate between initial, expanded, and installed tread ring arrangements using any known means for moving the expansion members, for example, hydraulic or pneumatic cylinders, cams, linear drives, rotary drives, or motors in communication with belts, gears, or chain drives, or other

actuators known in the art. Additionally, the expansion members **64** may be configured for axial motion as discussed above with reference to FIG. **5**.

[0042] In addition to, or in lieu of, engaging the annular tread ring about each opposing side edge, the expansion members may engage one or more grasping tabs extending outwardly adjacent each side edge of the tread ring at the engaging locations about the side edges of the tread ring as shown in FIGS. **7A** and **7B**. As shown in FIG. **7A**, the expansion members **74** may be adapted to grasping or clamping onto a grasping tab **76** molded onto the tread ring. Optionally, the tread ring may include wings extending from each side edge, such as shown in FIG. **2A**, and the expansion members may be adapted to grasp or clamp onto the wings. The wings, for example, may be configured to extend downwardly along the tire shoulder and potentially down at least a portion of the sidewall. For engaging the tread ring, the expansion members **74** may be adapted to grasp or clamp onto a grasping tab, wings, or other tread ring features, using any known means for grasping or clamping, for example, hydraulic or pneumatic actuators, cams, grips, or other grasping mechanisms. For example, a pair of grasping actuators may clamp onto the tabs, each grasping actuator moving toward the tab in a clamping arrangement. In particular embodiments, one grasping actuator may press the tab against a fixed member in a clamping arrangement. The grasping tabs **76** may extend radially outward from the outer side **22** of the tread ring as shown in FIGS. **7A** and **7B**. For further example, the grasping tabs may extend outwardly from the lateral side edges at a desired angle. In particular embodiments, the grasping tabs may extend outwardly from the lateral side edges between 0 and 90 degrees from the axial direction of the tread ring. The expansion members **74** are configured to translate between initial, expanded, and installed tread ring arrangements using any known means for moving the expansion members, for example, hydraulic or pneumatic cylinders, cams, linear drives, rotary drives, or motors in communication with belts, gears, or chain drives, or other actuators known in the art. For example, with reference to FIGS. **7A** and **7B**, radial movement of the expansion members **74** may include controlling the position of the expansion members **74** with an actuator configured for radial movement. The expansion members **74** may be operably connected to radial actuators **78** adapted to translate the expansion members radially between initial, extended, and installed tread ring arrangements. Additionally, the expansion members may be configured for axial motion as discussed above with reference to FIG. **5**.

[0043] In another example, apertures may be provided through the grasping tabs, and in addition to, or in lieu of grasping or clamping the tabs, the expansion members may be

adapted to engage the tab apertures with a hook, protrusion, fastener, or other engagement member.

[0044] In particular embodiments, the installation device or system may include a tire carcass-retaining structure **80**, partially shown in FIG. **3** positioning the tire carcass **30** in a desired arrangement within the expanded tread ring **20** for mounting the tread ring to the tire carcass. The carcass-retaining structure **80** is configured to retain and inflate the tire carcass comprising any means for retaining a tire carcass known to one of ordinary skill in the art. For example, the carcass-retaining structure may include one or more annular bead-engaging surfaces **84** upon which one or more of the tire carcass beads, shown as tire carcass beads **34** in FIG. **1**, engage in a mounted arrangement for inflating the tire carcass. The tire carcass-retaining structure **80** may be movable relative to the tread ring expansion assembly **42** such that the tire carcass-retaining structure translates the tire carcass to position the inflated tire carcass within the expanded tread ring. It is contemplated that at least one of the tread ring expansion assembly and tire carcass-retaining structure are movable relative to the other to arrange the expanded tread ring and tire carcass for mounting. The tread ring expansion assembly and/or the tire carcass-retaining structure may be movable along guides or tracks. Movement of the tread ring expansion assembly and/or tire carcass-retaining structure may be achieved using any known means for moving, such as by a hydraulic or pneumatic cylinder, linear drive, or motor in communication with a belt, gear, or chain drive, for example.

[0045] With reference to FIGS. **2-4C**, operation of the installation device **10** includes initially arranging a tread ring **20** within the tread ring expansion assembly **42**, with the tread ring expansion members **44** in an unclamped initial arrangement, such as shown in FIG. **4A**, to engage the lateral side edges **26**, **28** of the tread ring **20**. Subsequently, the expansion members **44** engage the annular tread ring **20** about each opposing side edge **26**, **28** at locations distal from a lateral centerline **CL** of the tread width. The engaged expansion members translate radially outward expanding the tread ring from an initial arrangement to an expanded arrangement by pulling the engaged locations about the side edges of the tread ring. In the expanded arrangement, the circumference of the inner side **24** of the tread ring is larger than the circumference of the outer side **32** of the tire carcass.

[0046] After tread ring expansion, a joining material may be arranged along either or both the inner side of the tread ring and the outer side of the tire carcass at any instance before the tire carcass is inserted into the expanded tread ring. With reference to FIG. **3**, the

tire carcass **30** is then inserted into the expanded arrangement of the tread ring. Subsequently, the expanded tread ring is contracted toward the tire carcass by radially inward translation of the expansion members, whereby the lateral centerline of the tread width on the inner side of the tread ring engages the tire carcass before the tread ring side edges engage the tire carcass. The tread expansion members may then be disengaged and retracted from the tread ring and the assembled treaded tire carcass removed from the installation device.

[0047] The methods and apparatus disclosed herein are useful for installing a tread band on a tire carcass to form a retreaded tire such as a retreaded heavy duty truck tire or a trailer tire. Heavy duty truck tires include steer and drive tires. Nevertheless, such methods and apparatus may be applied and used in conjunction with any type of tire to form any new or retreaded tire and as such, any type of tire may provide an embodiment of the present invention. Exemplary tire types for use with the subject invention further include light truck tires, off the road tires, bus tires, aircraft tires, bicycle tires, motorcycle tires, and passenger vehicle tires.

[0048] The terms “comprising,” “including,” and “having,” as used in the claims and specification herein, shall be considered as indicating an open group that may include other elements not specified. The terms “a,” “an,” and the singular forms of words shall be taken to include the plural form of the same words, such that the terms mean that one or more of something is provided. The terms “at least one” and “one or more” are used interchangeably. The term “single” shall be used to indicate that one and only one of something is intended. Similarly, other specific integer values, such as “two,” are used when a specific number of things is intended. The terms “preferably,” “preferred,” “prefer,” “optionally,” “may,” and similar terms are used to indicate that an item, condition or step being referred to is an optional (not required) feature of the invention. Ranges that are described as being “between a and b” are inclusive of the values for “a” and “b” unless otherwise specified.

[0049] While this invention has been described with reference to particular embodiments thereof, it shall be understood that such description is by way of illustration only and should not be construed as limiting the scope of the claimed invention. Accordingly, the scope and content of the invention are to be defined only by the terms of the following claims. Furthermore, it is understood that the features of any specific embodiment discussed herein may be combined with one or more features of any one or more embodiments otherwise discussed or contemplated herein unless otherwise stated.

CLAIMS

What is claimed is:

1. A method of applying a tread ring to a tire carcass comprising the steps of:
providing an annular tread ring having a tread width extending laterally between opposing side edges;
engaging the annular tread ring about each opposing side edge at locations distal from a lateral centerline of the tread width;
expanding the tread ring radially outward from an initial arrangement to an expanded arrangement at the engaged locations about the side edges of the tread ring;
arranging the expanded tread ring about an outer side of the tire carcass; and
contracting the tread ring into an installed arrangement about the outer side of the tire carcass, whereby the lateral centerline of the tread width on an inner side of the tread ring engages the tire carcass before the tread ring side edges engage the tire carcass.
2. The method of claim 1, wherein a circumference of each tread ring side edge in the expanded arrangement is greater than a circumference at the lateral centerline of the tread width in the expanded arrangement, where each circumference is taken along the inner side of the tread ring.
3. The method of claim 1, wherein the step of engaging the annular tread ring comprises engaging the inner side of the tread ring at each of the engaged locations.
4. The method of claim 1, wherein the step of engaging the annular tread ring comprises grasping a thickness of the tread ring from each side edge of the tread ring at each of the engaged locations.
5. The method of claim 1, wherein the step of engaging the annular tread ring comprises engaging the annular tread ring at locations axially opposite a corresponding location on the opposing side edge.

6. The method of claim 1, comprising from 8 to 12 engaged locations spaced circumferentially about each side edge.
7. The method of claim 1, the tread ring comprising a grasping tab extending outwardly adjacent each side edge at each engaging location about the tread ring, wherein the step of engaging the annular tread ring provides engaging the tabs.
8. The method of claim 1, wherein the tread ring includes one or more apertures arranged along the inner side of the tread ring near each side edge at each engaging location, whereby the step of engaging the annular tread ring provides engaging the one or more apertures arranged near each side edge.
9. The method of claim 1, wherein the tread ring includes one or more recessed tread portions arranged along the inner side of the tread ring near each side edge at each engaging location, whereby the step of engaging the annular tread ring provides engaging the one or more recessed tread portions arranged near each side edge.
10. The method of claim 1, the step of engaging the annular tread ring comprising:
engaging a plurality of expansion members to each side edge at a plurality of locations about the tread ring, the locations distal from the lateral centerline of the tread width, and
where the step of expanding the tread ring includes pulling each engaged location of the tread ring radially outward with the expansion members.
11. The method of claim 10, where each expansion member includes a first engaging member and a second engaging member, the step of engaging comprising:
grasping a thickness of the tread ring from each side edge of the tread ring between the first engaging member and the second engaging member at each of the engaged locations.

12. A device for installing a tread ring onto a tire carcass, the device comprising:
 - a tread ring expansion assembly having
 - a first plurality of expansion members on one side of the tread ring expansion assembly arranged radially about an axis central to a tread ring receiving cavity, the first plurality of expansion members adapted to engage a first lateral side edge of the tread ring,
 - a second plurality of expansion members arranged radially about the axis on an opposite side of the tread ring expansion assembly adapted to engage a second lateral side edge of the tread ring,
 - the first and second plurality of expansion members operably positioned to engage each tread ring side edge at locations distal from a lateral centerline of a tread ring width,
 - each of the expansion members movable between a first radial position and a second radial position, wherein the first radial position corresponds to an initial tread ring arrangement and the second radial position corresponds to an expanded tread ring arrangement.
13. The device of claim 12, wherein each of the expansion members are movable between the second radial position and a third radial position, wherein the third radial position corresponds to an installed tread ring arrangement.
14. The device of claim 12, wherein the first plurality of expansion members are movable transverse to the radial movement between first and second radial positions.
15. The device of claim 12, wherein the second plurality of expansion members are movable transverse to the radial movement between first and second radial positions.
16. The device of claim 12, wherein the first plurality of expansion members are axially aligned with the second plurality of expansion members.
17. The device of claim 12, comprising from 8 to 12 expansion members arranged radially about each side of the tread ring receiving cavity.

18. The device of claim 12, wherein each expansion member includes a first engaging member and a second engaging member, the expansion member adapted to grasping a thickness of the tread ring between the first engaging member and the second engaging member.
19. The device of claim 12, wherein the tread ring includes one or more apertures arranged along an inner side of the tread ring near each side edge at each engaging location, and the expansion members are adapted to engage the one or more apertures arranged near each side edge.
20. The device of claim 12, wherein the tread ring includes one or more recessed tread portions arranged along an inner side of the tread ring near each side edge at each engaging location, and the expansion members are adapted to engage the one or more recessed tread portions arranged near each side edge.

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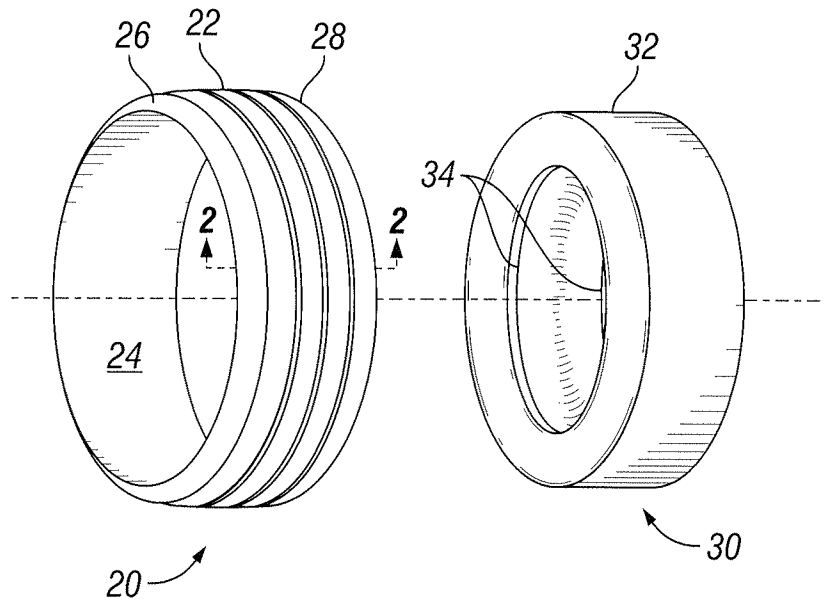


FIG. 1

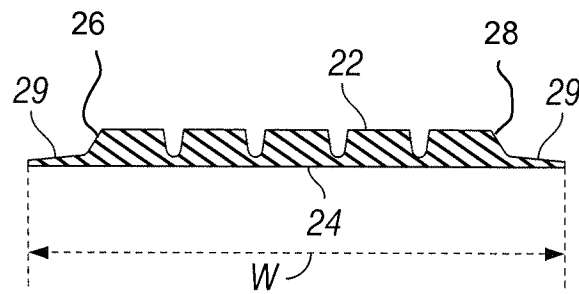


FIG. 2A

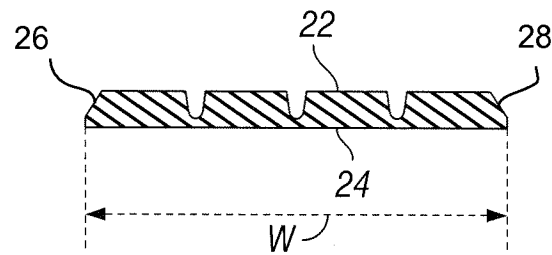


FIG. 2B

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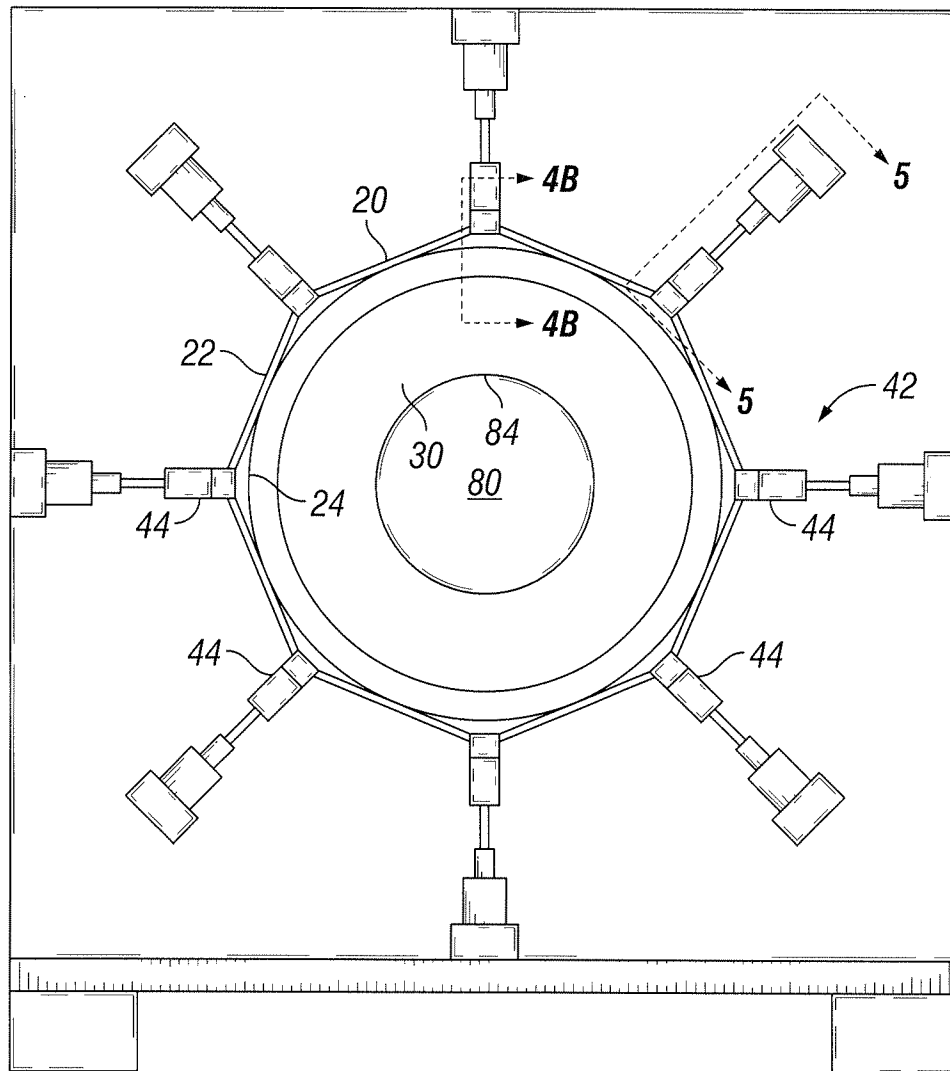


FIG. 3

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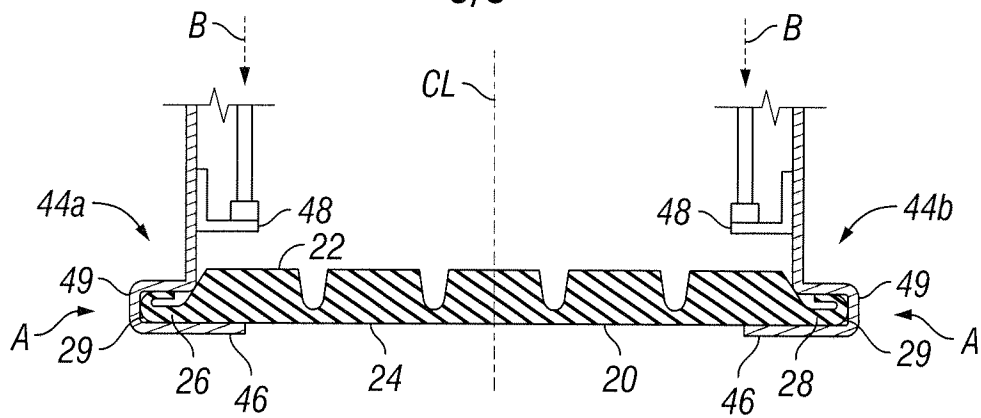


FIG. 4A

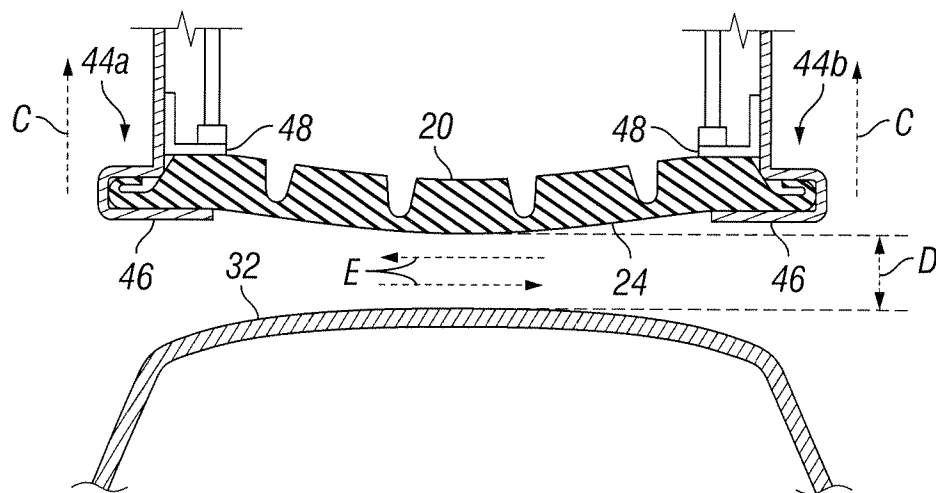


FIG. 4B

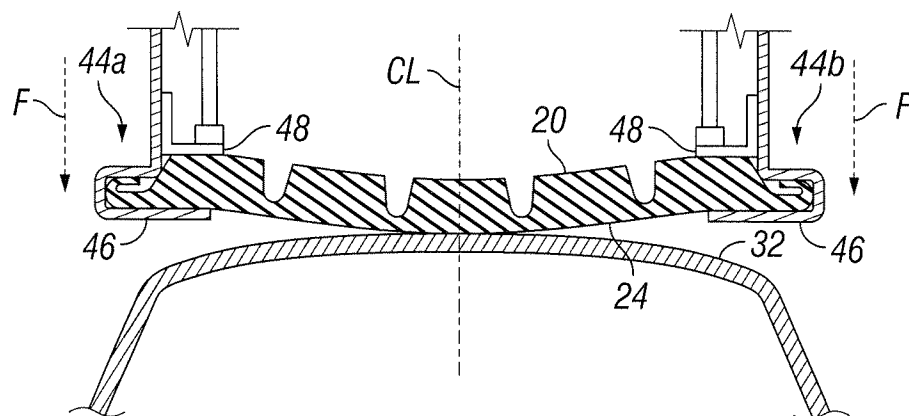


FIG. 4C

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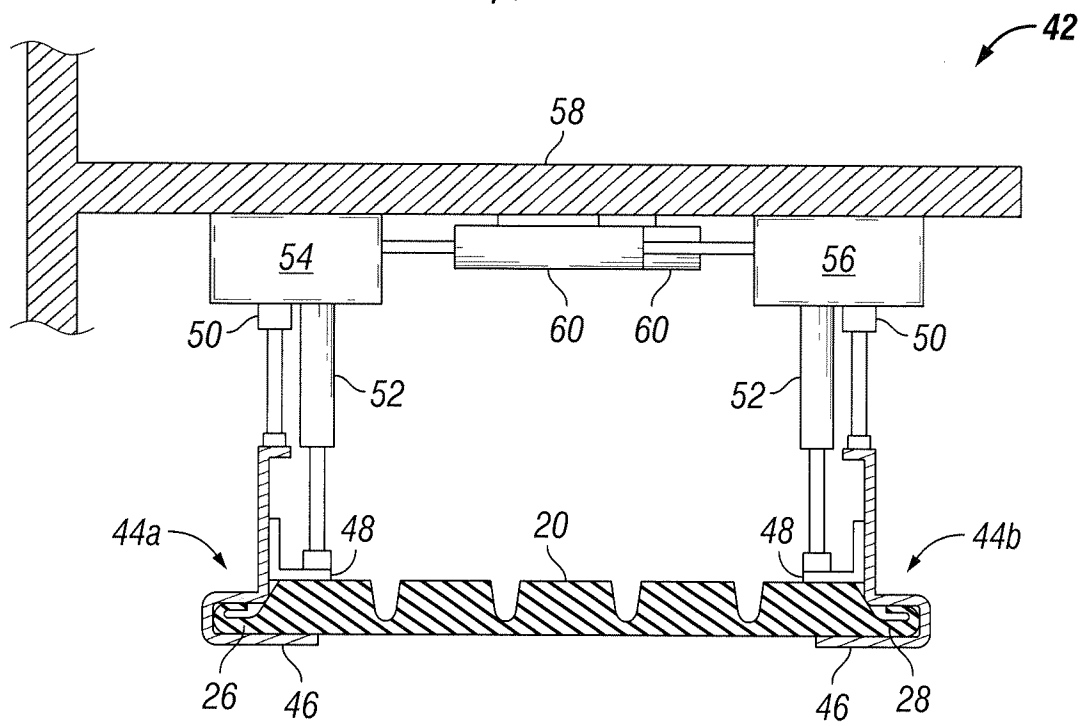


FIG. 5

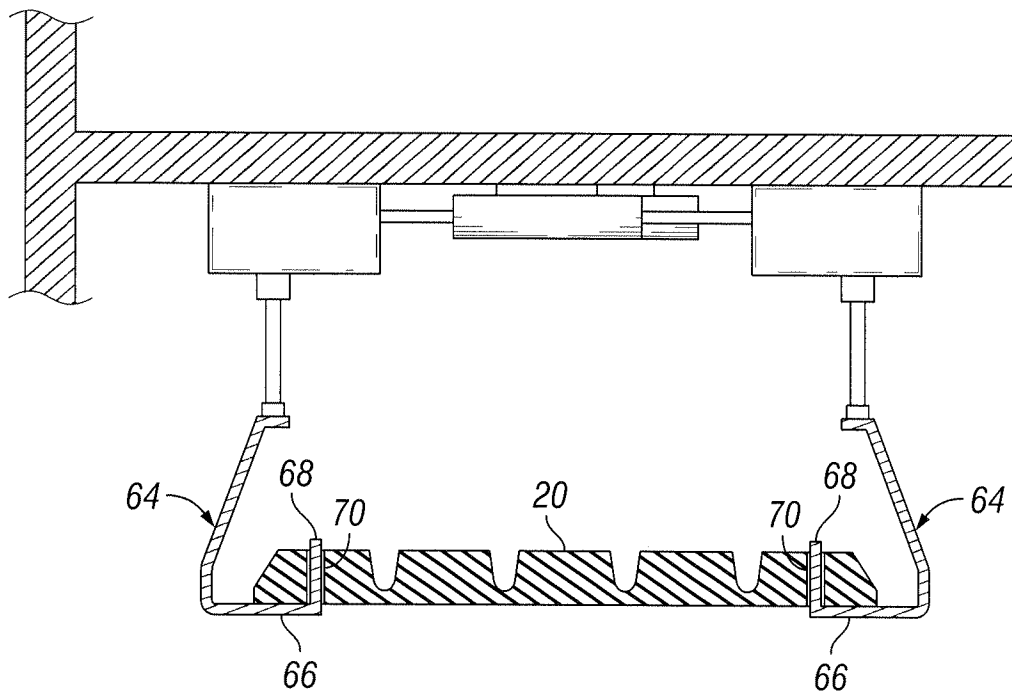


FIG. 6

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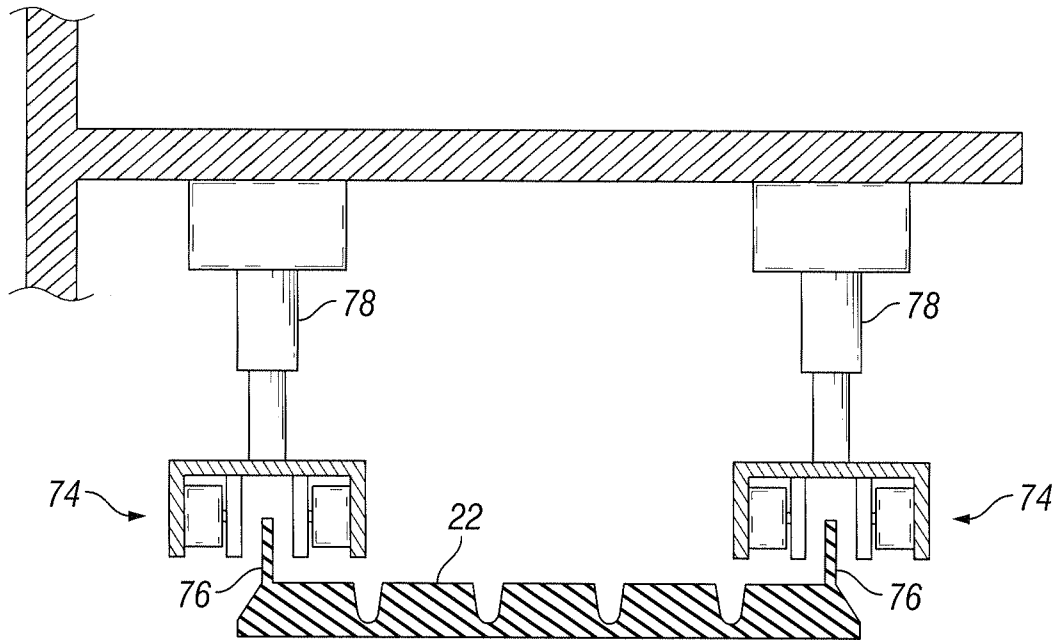


FIG. 7A

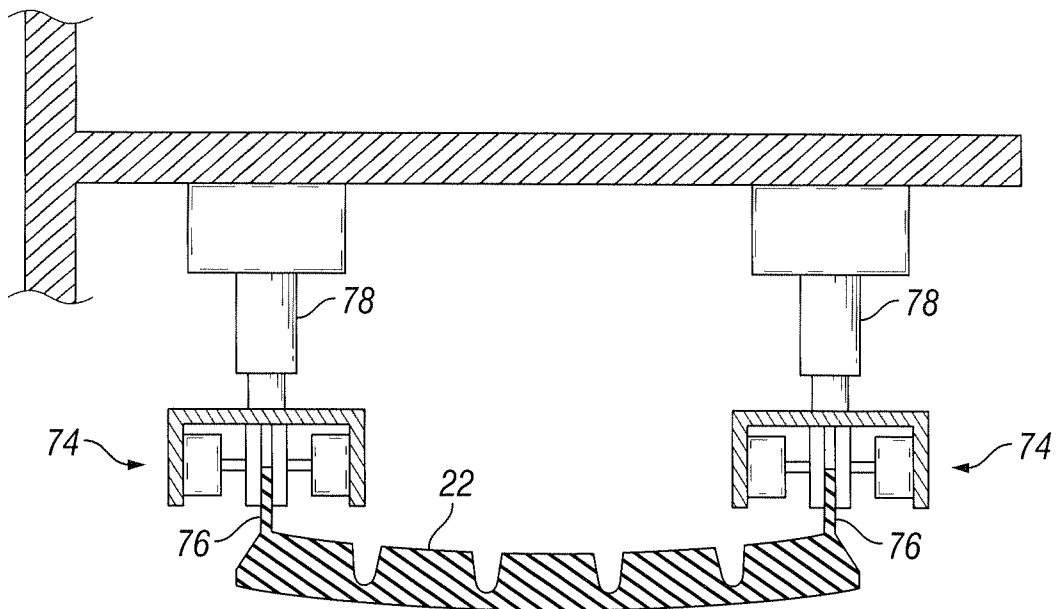


FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/23336

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B29C 33/10; B29C 33/46 (2012.01)

USPC - 425/17; 425/28.1

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8): B29C 33/10; B29C 33/46 (2012.01)

USPC: 425/17; 425/28.1

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

USPC: 425/17; 425/28.1

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

Google Scholar, Google Patents, PubWEST (PGPB,USPT,EPAB,JPAB)

Search terms used: Tire, carcass, tread, ring, annular, edges, centerline, expand, assemble, contract, finger, mount, install, entrap, air, steel, aluminum, thermoset, thermoplastic, aperture

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,154,794 A (OLSON) 13 October 1992 (13.10.1992), Claim 7, Fig 1, 3, 6; col 2, ln 67-68; col 3, ln 1-2, ln 52-59; col 4, ln 12-22; col 5, ln 56-60; col 6, ln 1-5, ln 19-23	1-20
Y	US 4,957,574 A (CLAYTON, et al.) 18 September 1990 (18.09.1990), Claim 3, Fig 1, 2; col 4, ln 5-14, ln 28-32	1-20

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

07 May 2012 (07.05.2012)

Date of mailing of the international search report

15 MAY 2012

Name and mailing address of the ISA/US

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