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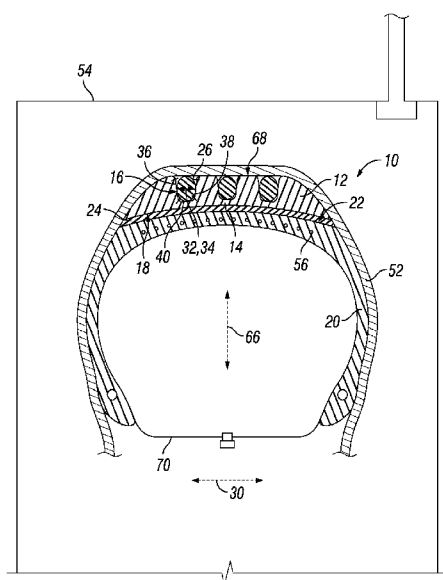


FIG. 6

(57) Abstract: A method of forming a retreaded tire is provided that includes providing a tread (12) with a bottom surface, an under-tread (14), and a groove (16). A tire carcass with an upper surface is provided and bonding material is applied and is located between the bottom surface and upper surface. A support member (26) is inserted into the groove (16). Heat and pressure are applied to the bonding material in order to cure the bonding material to create attachment between the tread and the tire carcass. The method also includes the removal of the support member (26) from the groove (16) of the tread.

TITLE

METHOD OF RETREADING A TIRE USING A GROOVE SUPPORT

FIELD OF THE INVENTION

[0001] The present invention relates generally to a method of retreading a tire by way of supporting a groove of the applied tread in order to prevent peaking during curing. More particularly, the present application involves a method of retreading a tire in which supports that can be O-rings are placed into the bottoms of the grooves of the tread to support thin under-tread during the curing process to in turn prevent peaking.

BACKGROUND

[0002] The retreading process of formation of a tire involves the placement of new pre-cured tire tread onto an existing/used tire carcass once the old tread on the tire carcass wears down to the point of replacement. The retreading process thus allows a tire carcass to be used multiple times in order to achieve both cost and environmental savings. The used tire carcass is first prepared through the removal of material on its outer surface. This material may be removed through buffing or abrading operations, for example by brushing, to achieve a surface that can be attached to the new tread. Next, adhesion material, such as cushion rubber, can be placed on the outer surface of the carcass, or onto the bottom surface of the new tread that is to be placed onto the carcass.

[0003] In order to create the bond between the used tire carcass and the new tread, the adhesion material must be cured. This curing process involves the application of heat and pressure to the adhesion material in order to create a permanent bond of the new tread to the used tire carcass to complete the process. The assembly can be placed inside of a flexible curing membrane, sometimes called an envelope, and vacuum can be applied in order to urge the new tread against the surface of the tire carcass with the adhesion material therebetween. An inflatable bladder may be inflated inside the tire carcass and can be urged against the interior of the tire carcass in a direction towards the forces applied by the vacuum to further press the adhesion material so that it is pressed

from both sides. The combination of a retread tire with a curing membrane may be referred to as a tire-membrane assembly.

[0004] Multiple tire-membrane assemblies can be placed inside of a tire curing chamber, such as an autoclave. The vacuum and inflation can be applied when the tire-membrane assembly is in the tire curing chamber, and the tire curing chamber is heated and also positively pressurized. The various pressure forces on the tread and carcass cause the adhesion material to be firmly pressed between these two members, and the heat in the tire curing chamber along with the pressure causes curing of the adhesion material to effect a permanent attachment.

[0005] In order to save material and improve tire performance, the new tread may be supplied with a very thin under-tread. With reference to Fig. 1, a very thin under-tread 14 is present on the tread 12. Unfortunately, forces F applied on the new tread 12 during the process may be in a lateral or axial direction 30, and tread 12 with a thin under-tread 14 will cause the lateral rigidity of the tread 12 to be weakened. Fig. 2 shows the tread 12 with the forces F applied. This weakened area may cause the tread 12 to be narrowed, and for the bottom of the tread grooves to form a bulge 62. This phenomenon is sometimes referred to as “peaking.” In some instances, peaking could cause the width of the tread 12 to be 10-15 millimeters narrower than the original tread 12, and the bulge 62 will cause the bottom of the tread grooves to bulge outwards in the radial direction 66 a distance of up to 2 millimeters. The narrowing of the tread width and the bulging of the bottom of the tread grooves are not acceptable in the retreading tire process. As such, there remains room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification, which makes reference to the appended Figs. in which:

[0007] Fig. 1 is a cross-sectional view of a tread of a retread tire formed without a support member.

[0008] Fig. 2 is a cross-sectional view of the tread of Fig. 1 with forces applied during the formation process that produce bulging.

[0009] Fig. 3 is a perspective view of a retread tire.

[0010] Fig. 4 is a top plan view of tread of a retread tire.

[0011] Fig. 5 is an exploded cross-sectional view of a tire carcass, bonding material, tread, and support member.

[0012] Fig. 6 is an assembled, cross-sectional view of the tire carcass, bonding material, tread, and support member of Fig. 5 placed into flexible curing membrane and an autoclave.

[0013] Fig. 7 is a partial perspective view of a tread with support members inserted into grooves of the tread.

[0014] Fig. 8 is a top plan view of a support member that is an O-ring.

[0015] Fig. 9 is a cross-sectional view taken along line 9-9 of Fig. 8.

[0016] Fig. 10 is a front elevation view of the O-ring of Fig. 8.

[0017] Fig. 11 is a front cross-sectional view of tread with O-rings in grooves of the tread that do not extend to an upper surface of the tread.

[0018] Fig. 12 is a front cross-sectional view of tread with support members in grooves of the tread that have a square cross-section.

[0019] Fig. 13 is a cross-sectional view of the support member of Fig. 12 before insertion into the grooves.

[0020] Fig. 14 is a front cross-sectional view of tread with grooves having a particular cross-sectional shape with support members inserted therein that have complimentary shapes.

[0021] Fig. 15 is a cross-sectional view of the support member of Fig. 14 before insertion into the grooves.

[0022] Fig. 16 is a front cross-sectional view of tread with support members that are coiled springs.

[0023] Fig. 17 is a perspective view of the support member of Fig. 16 that is a coiled spring.

[0024] Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the invention.

DETAILED DESCRIPTION OF REPRESENTATIVE EMBODIMENTS

[0025] Reference will now be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, and not meant as a limitation of the invention. For example, features illustrated or described as part of one embodiment can be used with another embodiment to yield still a third embodiment. It is intended that the present invention include these and other modifications and variations.

[0026] It is to be understood that the ranges mentioned herein include all ranges located within the prescribed range. As such, all ranges mentioned herein include all sub-ranges included in the mentioned ranges. For instance, a range from 100-200 also includes ranges from 110-150, 170-190, and 153-162. Further, all limits mentioned herein include all other limits included in the mentioned limits. For instance, a limit of up to 7 also includes a limit of up to 5, up to 3, and up to 4.5.

[0027] The present invention provides for a method of forming a retreaded tire 10 that involves the use of a support member 26 placed into the grooves 16 of the tread 12 to reinforce the tread 12 during the retreading process. The support member 26 can be made in a variety of manners, and in one exemplary embodiment is an O-ring that is placed into the groove 16 and is sized so as to be bigger than the groove 16. The presence of the O-ring 26 prevents the formation of a bulge 62 in the groove 16 and prevents the tread 12 from otherwise shrinking an amount in the axial direction 30

that could occur if the O-ring 26 were absent. Once bonding material 24 connecting the tread 12 and the tire carcass 20 is cured, the O-ring 26 can be removed from the groove 16 and may be reused in the retreading of another retreaded tire 10 if desired.

[0028] With reference to Fig. 3, a retreaded tire 10 is shown through which a central axis 28 extends. The central axis 28 is identified with other components of the retreaded tire 10 and relates to the position of these components once assembled into the retreaded tire 10. The other directions identified herein, such as the radial direction 66, axial direction 30, and the circumferential direction 64, likewise relate to the position of the retreaded tire 10 and its components when assembled. An axial direction 30 is defined as the direction along the central axis 28 or the direction parallel to the central axis 28. The radial direction 66 extends at a 90 degree angle to the axial direction 30, and the circumferential direction 64 extends around the arc length of the retreaded tire 10, or its components, so as to circle 360 degrees the central axis 28. The axial direction 30, the radial direction 66 and the circumferential direction 64 are identified with other components in the drawings that are then subsequently assembled into the retreaded tire 10 as their orientations would be upon assembly.

[0029] With reference now to Fig. 4, a top plan view of the tread 12 is shown. The tread 12 is cured and may be produced in a straight manner and subsequently turned upon itself about the central axis 28 to form a ring or circular shape. The shape of the tread 12 shown in Fig. 4 is that which it will assume when placed onto the tire carcass 20 and assembled into the retreaded tire 10. The tread 12 has a groove 16 that may be a circumferential groove that extends 360 degrees about the central axis 28 in the circumferential direction 64. The groove 16 extends from a top surface 68 of the tread 12 to the under-tread 14. The groove 16 has a diameter 42 that is measured from the bottom of the groove 16 through the central axis 28 to the opposite bottom of the groove 16 on the other side of the central axis 28. The diameter 42 may be consistent all the way around the groove 16, or the groove 16 may have varying depths in the radial direction 66 so that some portions of the bottom of the groove 16 are closer to the central axis 28 than other portions of the bottom of the groove 16 in the radial direction 66.

[0030] With reference to Fig. 5, various components of the retreaded tire 10 assembly is shown in an exploded view. A tire carcass 20 that includes a series of belts 56 can be an already cured, used component that is now being fitted with new tread 12 for subsequent reuse. The upper

surface 22 of the tire carcass 20 may be brushed in order to prepare it for attachment with the tread 12. Bonding material 24 may be placed onto either the upper surface 22, the bottom surface 18 of the tread 12, or onto both the upper surface 22 and the bottom surface 18. The bonding material 24 may be cushion rubber, or any other type of adhesive that can be used to effect attachment between the tread 12 and the tire carcass 20. The bonding material 24 can be any material that needs to be cured through thermal vulcanization. Alternatively, the bonding material 24 can be a material that can be cured through chemical vulcanization in order to effect attachment of the tread 12 to the tire carcass 20.

[0031] The retread tire 10 also includes a series of support members 26 that are placed into the grooves 16 of the tread 12. The grooves 16 may be circumferential grooves that extend all the way around the central axis 28 in the circumferential direction 64. The grooves 16 may be straight so that they have the same cross-sectional shape and position with respect to the axial direction 30 all the way around the central axis 28. Alternatively, the grooves 16 may zigzag or have different positions in the axial direction 30 around the central axis 28. Grooves 16 that zigzag or have different positions in the axial direction 30 around the central axis 28 can be seen with reference to the grooves 16 of Fig. 3.

[0032] The support members 26 can be placed into the grooves 16 in a variety of manners. In some instances, retread machines already have existing rollers that can be used to urge the support members 26 into the grooves 16. With the support members 26 located within the grooves 16, the assembled tire carcass 20 and tread 12 are placed within a flexible curing membrane 52 as shown in Fig. 6. The bonding material 24 is located between the bottom surface 18 and the upper surface 22 and vacuum can be applied to draw the flexible curing membrane 52 against the top surface 68 and against the outside surface of the tire carcass 20. An inflatable bladder 70 may be optionally positioned inside of the tire carcass 20 and can be inflated in order to provide pressure against the inner surface of the tire carcass 20. The bonding material 24 can thus be pressed between the bottom surface 18 and the upper surface 22 by the flexible curing membrane 52 or through a combination of forces by both the flexible curing membrane 52 and the inflatable bladder 70.

[0033] The flexible curing membrane 52 may engage the top surface 68 and also the various support members 26 that protrude from the grooves 16 in the radial direction 66 away from the

central axis 28. The forces imparted onto the tread 12 during the curing process by the flexible curing membrane 52 do not compress the tread 12 in the axial direction 30 and prevent the formation of bulges 62 in the grooves 16 of the tread 12 due to the presence of the support members 26 in the grooves 16. The support members 26 function to prevent the grooves 16 from collapsing inward onto themselves in the axial direction 30 so that a thin under-tread 14 can still be employed on the tread 12 during the retreading process.

[0034] The assembled flexible curing membrane 52 and retreaded tire 10 components may be placed within an autoclave 54 that supplies heat to the retreaded tire 10 components that functions to thermally cure the bonding material 24 so that the tread 12 is attached to the tire carcass 20. The autoclave 54 may also provide positive pressure onto the outside of the flexible curing membrane 52 and these forces may be transferred through the tread 12 and into the bonding material 24 in order to further cause the bonding material 24 to be pressed onto the upper surface 22 by the bottom surface 18. It is to be understood that when chemical vulcanization is used, the autoclave 54 need not be employed as heat is not needed. Further, other mechanisms of heating the bonding material 24 may be implemented in other exemplary embodiments besides through the use of an autoclave 54.

[0035] Once the bonding material 24 is cured and a permanent attachment between the tread 12 and the tire carcass 20 is achieved, the retreaded tire 10 may be removed from the autoclave 54, and then subsequently may be removed from the flexible curing membrane 52. The support member 26 may then be removed from the groove 16. A screw driver or other tool may be used if needed to assist in the removal of the support member 26 from the groove 16. The support member 26 may be subsequently reused in the formation of another retreaded tire 10.

[0036] With reference both to Figs. 5 and 6, the grooves 16 of the tread 12 are defined by interior walls of the tread 12. The tread 12 has a first wall 36 that extends from the top surface 68 in the radial direction 66. Disposed in the axial direction 30 from the first wall 36 is a second wall 38 of the tread 12 that likewise extends from the top surface 68 in the radial direction 66. A third wall 40 extends between the first wall 36 and the second wall 38 and is located in the tread 12 so as to define a bottom portion of the groove 16. The third wall 40 is closer to the central axis 28 in the radial direction 66 than the first and second walls 36, 38. All of the walls 36, 38 and 40 may be planar, curved, or may have a combination of both planar and curved portions in cross-sectional

shape. As shown in Fig. 6, the support member 26 when inserted into the groove 16 engages all three walls 36, 38 and 40 and extends out of the groove 16 so that it is higher than the three walls 36, 38 and 40 in the radial direction 66 and is above the top surface 68. Pressure from the flexible curing membrane 52 when vacuum is applied may force the inserted support member 26 downward so that it is level with the top surface 68.

[0037] Fig. 7 shows a tread 12 with four grooves 16 positioned along the width of the tread 12 in the axial direction 30. Each one of the grooves 16 has the same cross-sectional shape, and a support member 26 is located into each one of the grooves 16 and engages all of the walls of the tread 12 that define the grooves 16. In some versions of the retreading process, some of the grooves 16 do not include a support member 26 located therein while other grooves 16 do in fact include a support member 26 located therein.

[0038] The support member 26 may be made out of a flexible material so that it is adaptive to different tread 12 patterns. In this regard, if the groove 16 is not straight all the way around the tread 12 in the circumferential direction 64, the flexible support member 26 may extend left or right in the axial direction 30 to accommodate this change in shape of the groove 16. Likewise, if the depth of the groove 16 changes upon its extension in the circumferential direction 64 the flexible support member 26 may also adjust to accommodate this change so that it is closer to and further from the central axis 28 in the radial direction 66 at various portions along the length of the support member 26 in the circumferential direction 64. The flexible feature of the support member 26 allows it to fit into grooves 16 that are not uniform in cross-sectional shape, width, or shape.

[0039] The support member 26 may be provided in a variety of manners. With reference to Figs. 8-10, the support member 26 is an O-ring that has a circular cross-sectional shape. The O-ring can be made of rubber or other material and is already cured. The O-ring may be of any hardness, and may be made of a flexible material. The O-ring can be made in any variety of manners, such as by extruding a rod of material and then attaching it front to end. The O-ring is a ring of material spaced a uniform distance from the central axis 28. In this regard, the O-ring has an inner diameter 44 that represents the empty space available inside of the material that makes up the O-ring and that extends in the circumferential direction 64 around the central axis 28. The O-ring is uniform in shape about its entire extension in the circumferential direction 64. The O-ring has a width 34 that

extends in the axial direction 30 and in effect is the diameter of the material making up the O-ring. The support member 26 also has an outer diameter 46 that is the portion of the support member 26 farthest from the central axis 28 in the radial direction as measured through the central axis 28. When the support member 26 is provided as an O-ring, the outer diameter 46 is constant along the entire length of the O-ring in the circumferential direction 64.

[0040] The width 34 of the support member 26 may be greater than the width of the groove 16 which could be the distance from the first wall 36 to the second wall 38 in the axial direction 30, or which could be the size of the groove 16 in the axial direction 30. The width 34 may be from 5%-10%, from 10%-15%, from 15%-20%, from 20%-25%, from 15%-25%, or about 20% greater than the width of the groove 16. This size may be measured when the support member 26 is in a stretched state around the tread 12, as opposed to an at rest state, because the width 34 is smaller when the support member 26 is stretched and thus there is a difference in size between the stretched state and the at rest state. The size of the support member 26 may be selected so that the overall lateral rigidity of the tread 12, which is the rigidity of the tread 12 in the axial direction 30, is equivalent to tread 12 with a normal sized under-tread 14. If there is overcompensation, such as if the support members 26 are too large and stretch the tread 12 in the axial direction 30, then this overcompensation may cause the width of the tread 12 to be larger than its original design.

[0041] The size of the inner diameter 44 of the support member 26 may be selected so that it is less than the diameter 42 of the groove 16, which may be the diameter 42 of the third wall 40. The support member 26 may be stretched and pushed over the tread 12 and when moved into place in the groove 16 may be in a stretched state as it rests within the groove 16. The support member 26 may remain on the tread 12 through its own forces which tend to restrict it and cause it to be biased towards the central axis 28 due to it being stretched when in place in the groove 16. The inner diameter 44 of the support member 26 may be from 1%-5%, from 5%-10%, from 10%-15%, or up to 20% smaller than the diameter 42.

[0042] When inserted into the grooves 16, the support member 26 when fashioned as an O-ring may compress therein so that the sides of the O-ring are flat. This is because the O-ring may take the shape of the first and second walls 36, 38 which could be parallel to one another in cross-section. Regardless of the shrinkage of the width 34 when stretched, the width 34 even when the O-

ring is stretched may be greater than the distance between the first and second walls 36, 38 so that the O-ring can properly fit within the groove 16 during insertion to be deformed and provide support to the tread 12.

[0043] Fig. 11 shows an alternate embodiment of the process in which the support members 26 are again O-rings, but are smaller in size with respect to the grooves 16 than previously disclosed. The O-rings are located within the grooves 16 and engage the third wall 40. The O-rings engage portions of the first and second walls 32, 34 but do not engage all of the first and second walls 32, 34. Further, the O-rings are sized so that they do not extend above the top of the top surface 68 in the radial direction 66 when positioned within the grooves 16. The O-rings thus do not engage the flexible curing membrane 52 when it is applied over the assembled components and vacuum is applied.

[0044] Although described as being provided as an O-ring, it is to be understood that the support member 26 can be variously configured and need not be an O-ring in other embodiments. Figs. 12 and 13 show an alternate design of the support member 26 in which instead of having a circular cross-sectional shape has a square cross-sectional shape. This support member 26 likewise forms a ring around the central axis 28 so that a void is present and defined by an inner diameter 44 of the support member 26. The support member 26 is uniform in this regard so that it has an inner diameter 44 that is consistent about its entire length in the circumferential direction 64. The outer diameter 46 is likewise uniform in length in the circumferential direction 64 along all points as measured through the central axis 28. Upon insertion into the grooves 16, the square support member 26 engages the first and second walls 36, 38 of the tread 12 that define the groove 16, but does not engage the third wall 40. A space is left between the third wall 40 and the support member 26 so that the support member 26 is spaced from the bottom of the groove 16 in the radial direction 66. However, in other embodiments, the support member 26 could in fact engage the third wall 40 and thus be located at the bottom of the groove 16 in the radial direction 66. The support member 26 can have any cross-sectional shape and is not limited to one having a circular, square, or rectangular cross-sectional shape.

[0045] In some embodiments, the support member 26 can be provided so as to match the shape of the groove 16 so that it is of a complimentary shape. With reference to Figs. 14 and 15, a

support member 26 that has an hourglass type shape is shown that is again constructed as a ring of material having a consistent inner diameter 44 and outer diameter 46 about their lengths in the circumferential direction 64 through the central axis 28. The grooves 16 have an hourglass type cross-sectional shape that is the same cross-sectional shape as the support member 26. When inserted, the support member 26 is complimentary in shape with the groove 16 and engages all surfaces of the tread 12 that define the groove 16. Although described as hourglass in shape, it is to be understood that the support member 26 and complimentary groove 16 can be of any cross-sectional shape in accordance with various exemplary embodiments.

[0046] The support member 26 can be configured in a variety of other manners. With reference to Figs. 16 and 17, the support member 26 is provided as a spiral tension spring. The support member 26 may be made out of metal and can have a cross-sectional shape that is circular. The spiral tension spring support member 26 has a head 48 and a tail 50 located at opposite ends that may be connected to one another to thus arrange the support member 26 into a ring configuration. The spiral tension spring support member 26 can be located into the groove 16 and can function in the aforementioned manners to prevent bulging of the tread 12 and to prevent narrowing of the width of the tread 12. The coiled tension spring support member 26 may engage all of the walls 36, 38 and 40 that define the groove 16 and can be of a material different than that of the tread 12.

[0047] The method of retreading the tire 10 thus involves preparing, if necessary, the upper surface 22 of the tire carcass 20 and then applying bonding material 24 to one of or both of the prepared upper surface 22 and the bottom surface 18 of the tread 12. Next, the tread 12 can be wrapped around the tire carcass 20 so that the bonding material is located between the upper surface 22 and the bottom surface 18. Next, the support members 26 may be placed within the grooves 16. Rollers present on retreading machines may be used to help effect this placement. Next, the aforementioned components may be placed within a flexible curing membrane 52, and then can be placed within an autoclave 54. Pressure and heat are then used to cure the bonding material 24. Once bonded, the assembled retreaded tire 10 is removed from the flexible curing membrane 52 and the autoclave 54. Finally, the support members 26 are removed from the grooves 16.

[0048] While the present invention has been described in connection with certain preferred embodiments, it is to be understood that the subject matter encompassed by way of the present

invention is not to be limited to those specific embodiments. On the contrary, it is intended for the subject matter of the invention to include all alternatives, modifications and equivalents as can be included within the spirit and scope of the following claims.

CLAIMS

What is claimed is:

1. A method of forming a retreaded tire, comprising the steps of:

providing a tread that has an under-tread and a groove, wherein the tread has a bottom surface;

providing a tire carcass that has an upper surface;

applying bonding material such that the bonding material is located between the bottom surface of the tread and the upper surface of the tire carcass;

inserting a support member into the groove of the tread;

applying heat and pressure to the bonding material in order to cure the bonding material to create attachment between the tread and the tire carcass; and

removing the support member from the groove of the tread.
2. The method as set forth in claim 1, wherein the support member is an O-ring, wherein the O-ring has a circular cross-sectional shape before the step of insertion into the groove.
3. The method as set forth in claims 1 or 2, wherein the groove has a width that extends in an axial direction of the retreaded tire, wherein the support member has a width that is larger than the width of the groove.
4. The method as set forth in claim 3, wherein the width of the support member as measured when stretched is from 15%-25% larger than the width of the groove.

5. The method as set forth in any one of claims 1-4, wherein the groove is defined by a first wall and a second wall of the tread, wherein the first wall and the second wall are spaced apart in an axial direction of the retreaded tire, wherein the groove is further defined by a third wall of the tread that is located closer to a central axis of the retreaded tire in a radial direction of the retreaded tire than the first wall and the second wall, wherein the third wall has a diameter about the central axis;

wherein the support member has an inner diameter that is less than the diameter of the third wall.

6. The method as set forth in claim 5, wherein the inner diameter of the support member is from 5%-10% smaller than the diameter of the third wall.

7. The method as set forth in claim 5 or 6, wherein the support member engages the first wall and the second wall when the support member is inserted into the groove.

8. The method as set forth in any one of claims 5-7, wherein the support member engages the third wall when the support member is inserted into the groove.

9. The method as set forth in any one of the preceding claims, wherein the step of inserting the support member takes place before the step of applying heat and pressure to the bonding material, and wherein the step of removing the support member takes place after the step of applying heat and pressure to the bonding material.

10. The method as set forth in claim 1, wherein the support member has a rectangular cross-sectional shape before the step of insertion into the groove.

11. The method as set forth in claim 1, wherein the support member has a cross-sectional shape before the step of insertion into the groove that is the same as a cross-sectional shape of the groove.

12. The method as set forth in claim 1, wherein the support member is a spiral tension spring.

13. The method as set forth in any one of the preceding claims, wherein when the support member is inserted into the groove of the tread the support member extends 360 degrees about a central axis of the retreaded tire.

14. The method as set forth in any one of the preceding claims, wherein the groove is a circumferential groove that extends 360 degrees about a central axis of the retreaded tire.

15. The method as set forth in any one of the preceding claims, wherein the bonding material is cushion rubber, wherein the step of applying heat and pressure to the bonding material is performed by a flexible curing membrane that engages the tread and by an autoclave into which the tread, the bonding material, and the tire carcass are located.

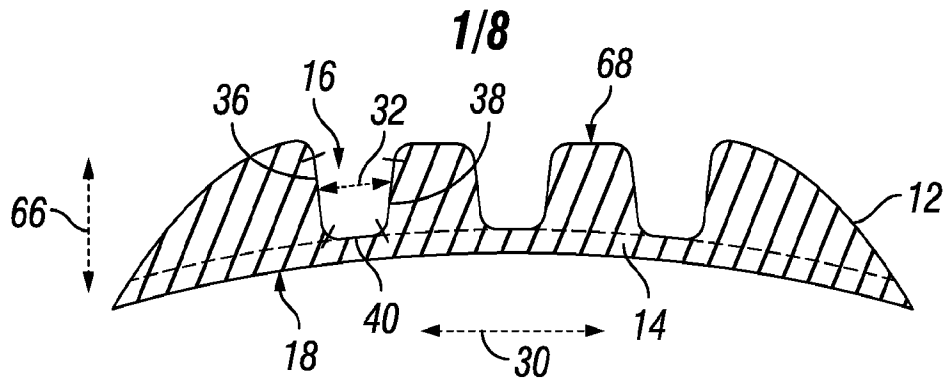


FIG. 1
(Prior Art)

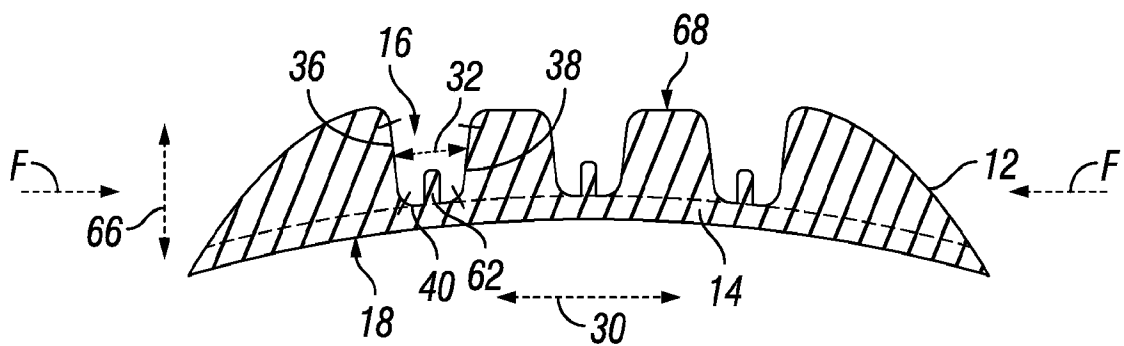


FIG. 2
(Prior Art)

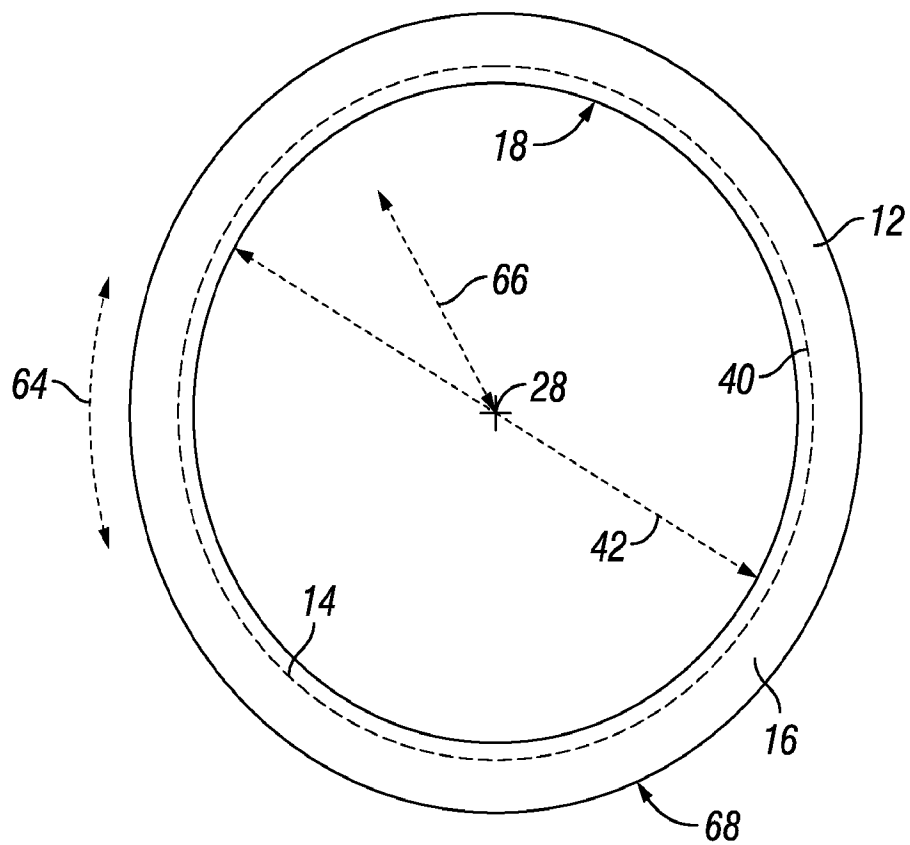


FIG. 4

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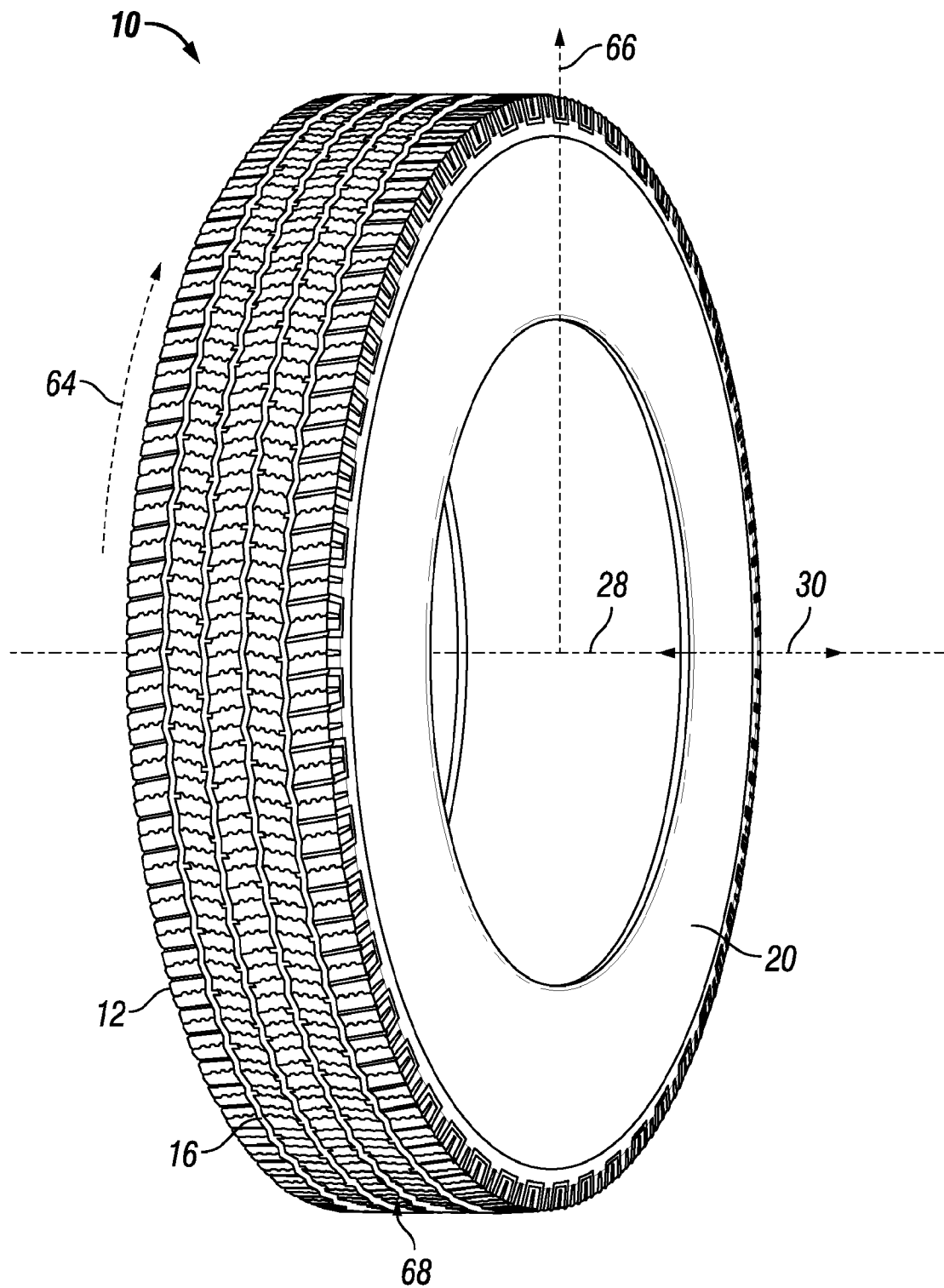


FIG. 3

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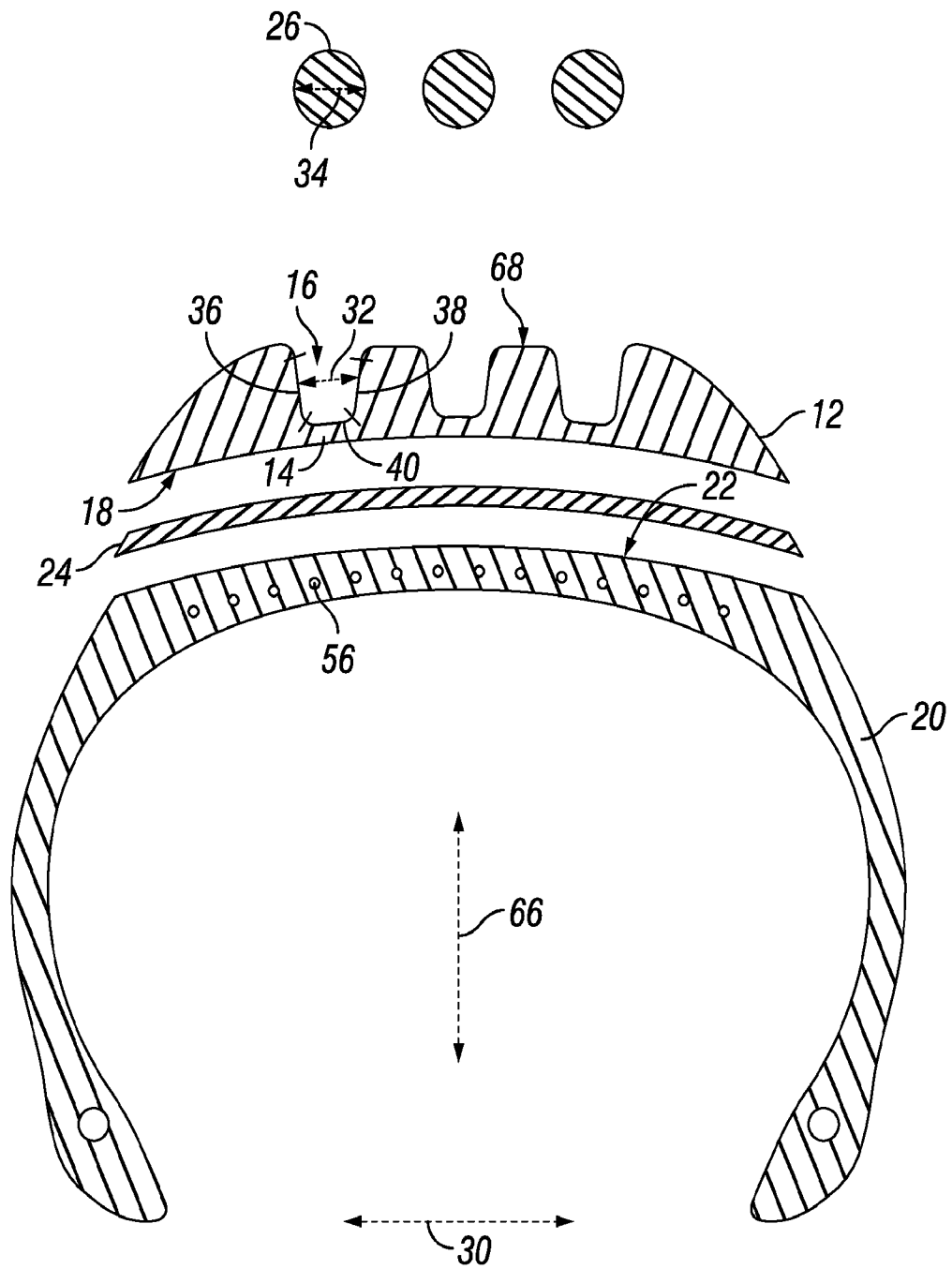
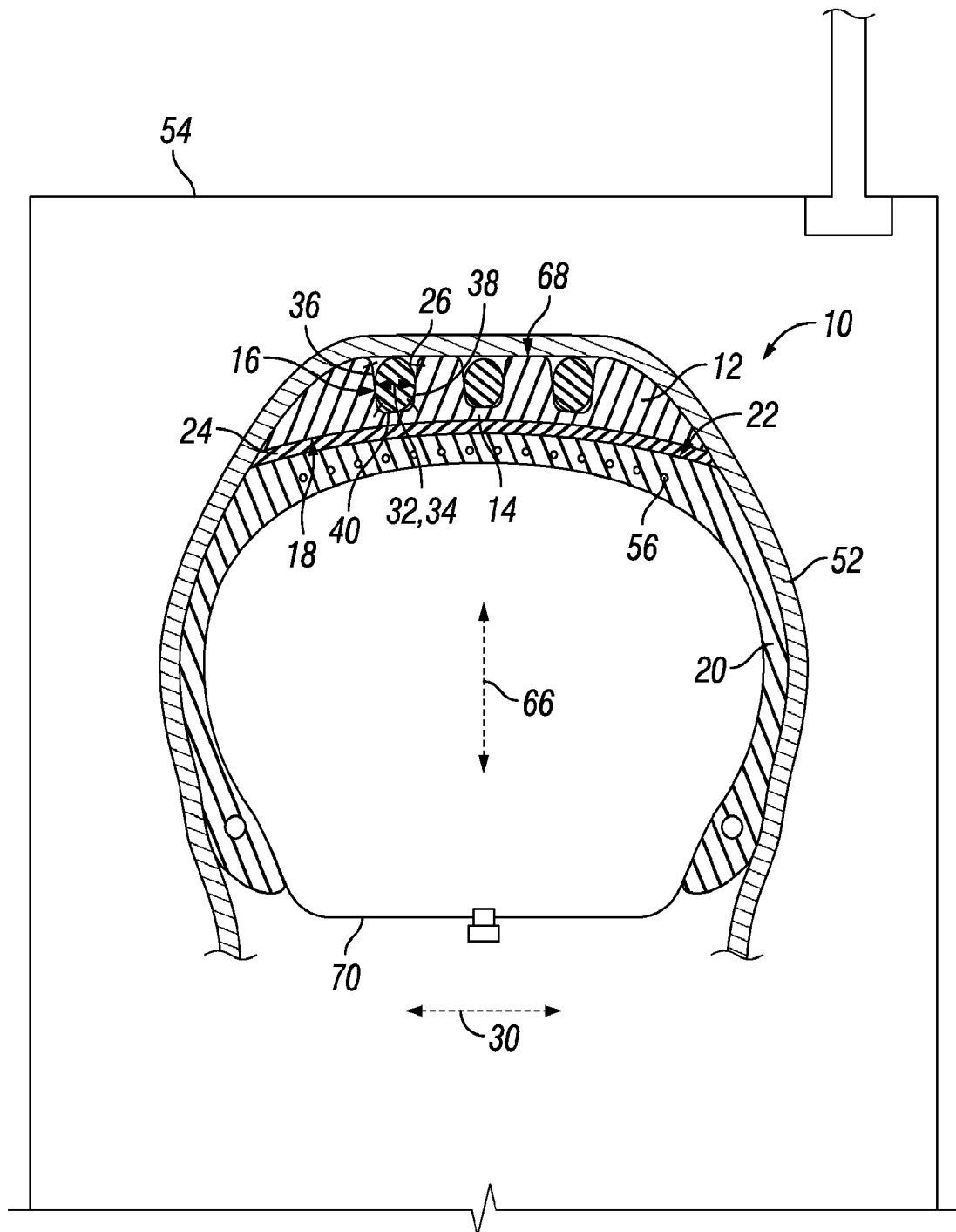


FIG. 5

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**FIG. 6**

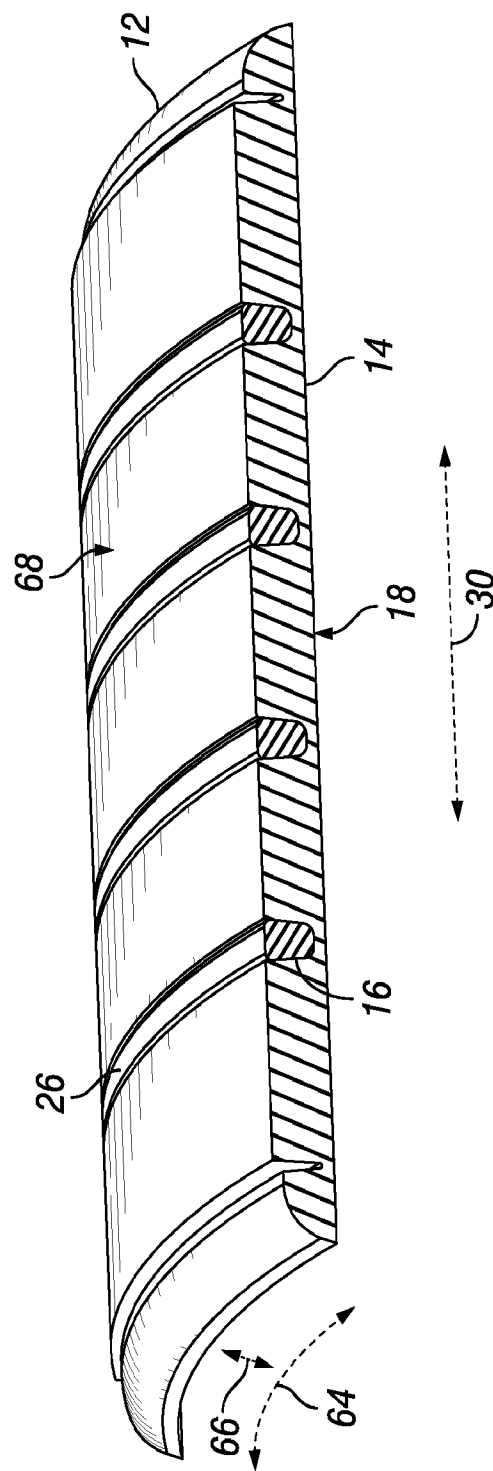


FIG. 7

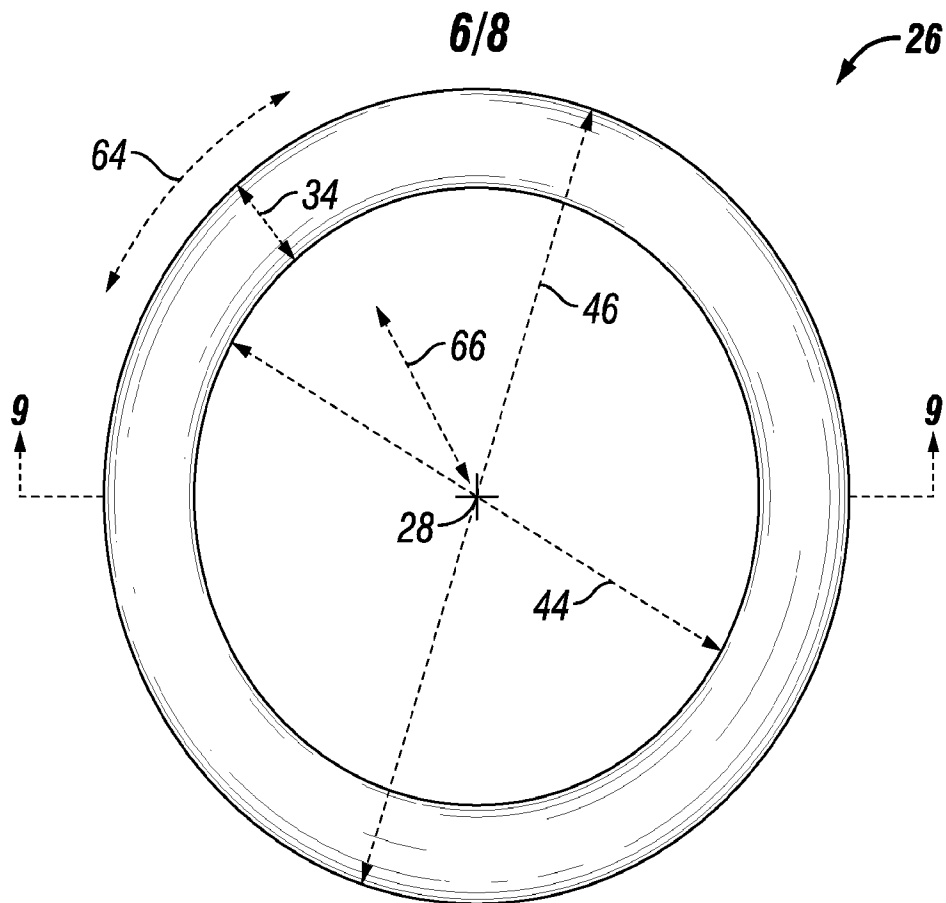


FIG. 8

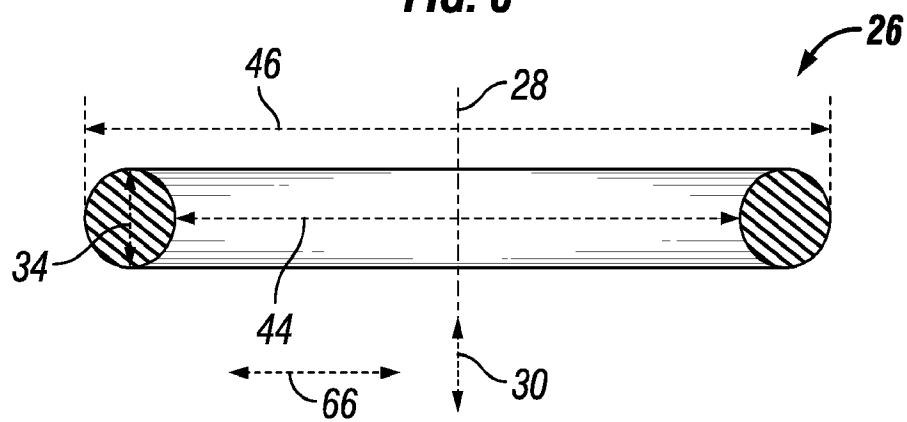


FIG. 9

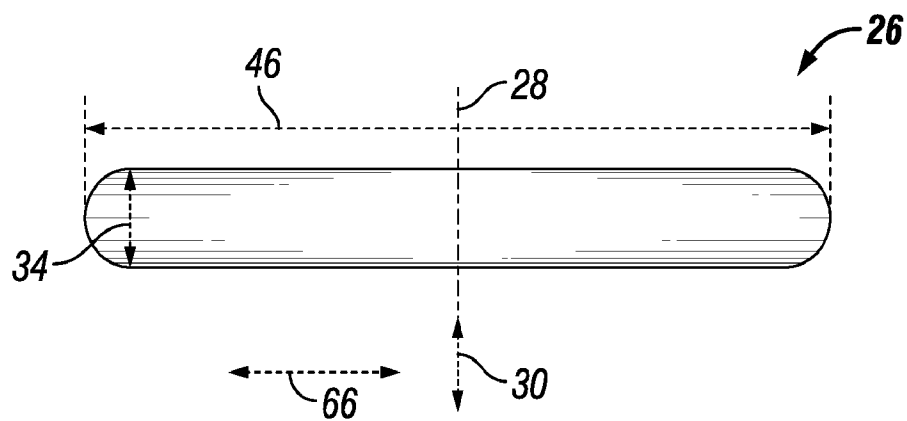


FIG. 10

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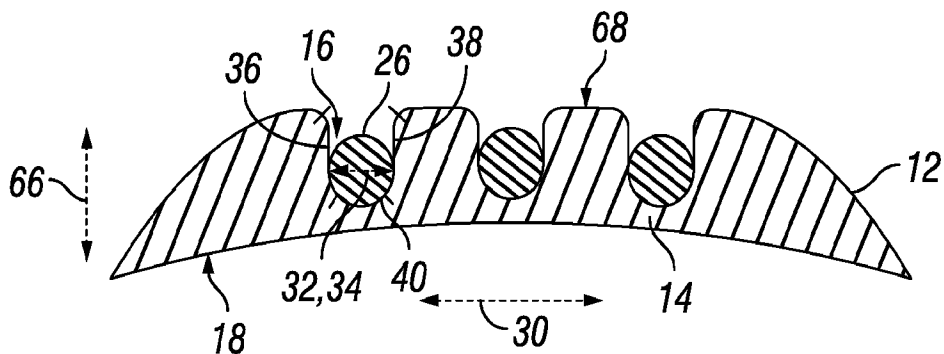


FIG. 11

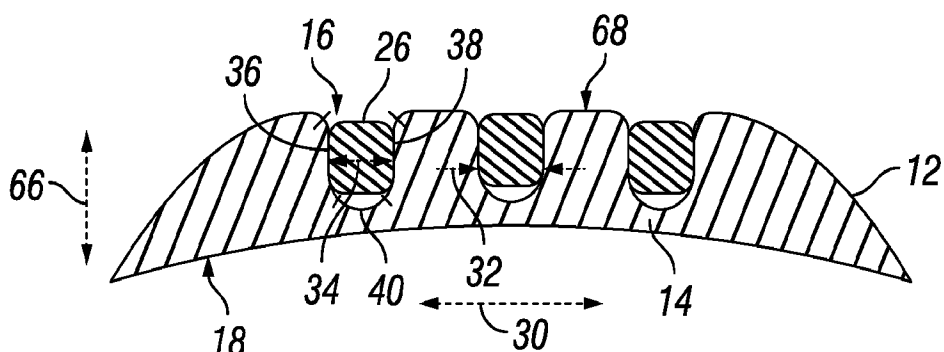


FIG. 12

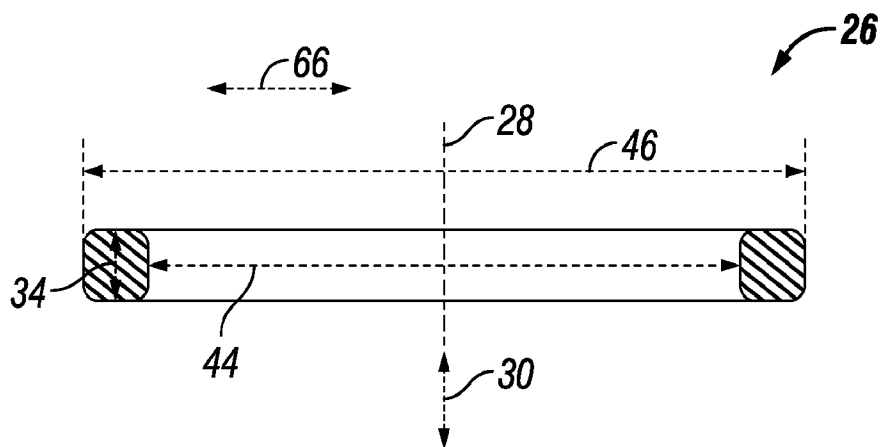


FIG. 13

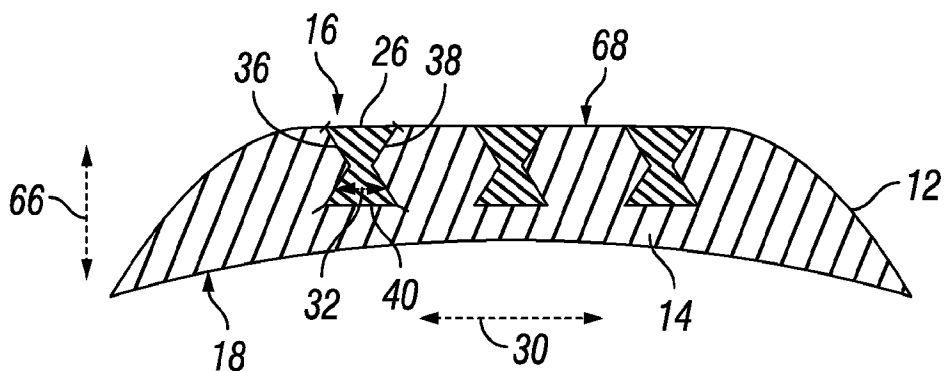


FIG. 14

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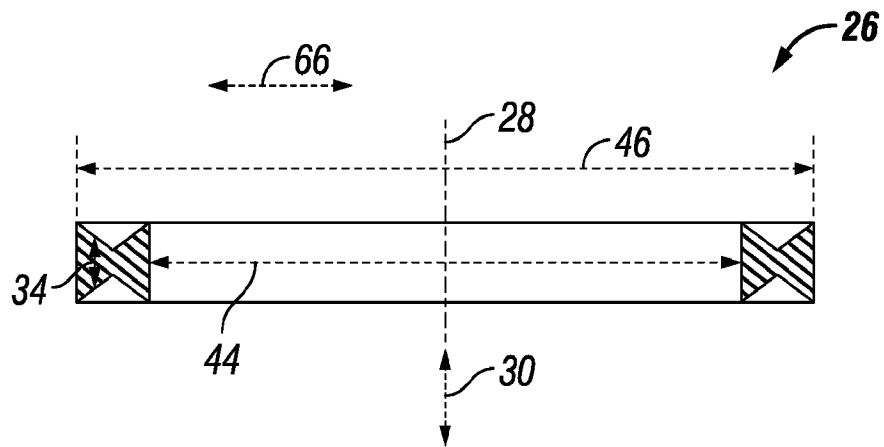


FIG. 15

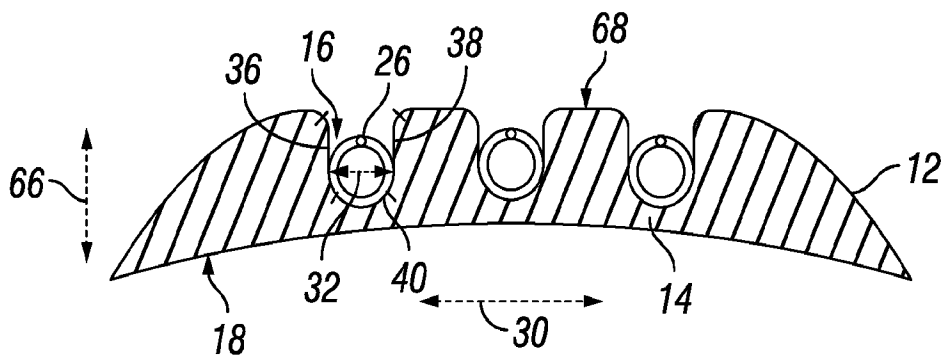


FIG. 16

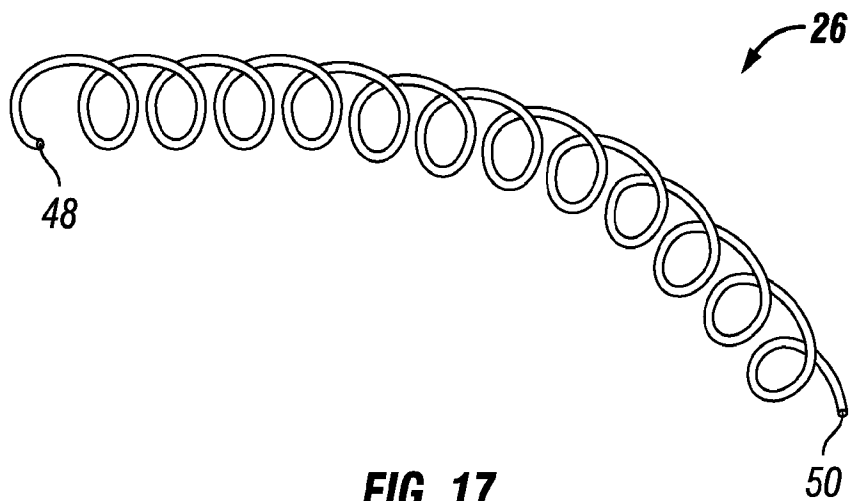


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2015/067658

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B29D30/56
 ADD.

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)
 B29D

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 520 289 A (BANDAG INC) 2 August 1978 (1978-08-02) page 6, line 88 - line 122; figure 3 page 6, line 123 - page 7, line 40; figures 1,2,4	1-15
X	----- WO 2014/120212 A1 (MICHELIN & CIE [FR]; MICHELIN RECH TECH [CH]; COLBY E BRUCE [US]; IKON) 7 August 2014 (2014-08-07) paragraph [0020] - paragraph [0043]; figures 1-6	1,12
X	----- JP S62 48536 A (YOKOHAMA RUBBER CO LTD) 3 March 1987 (1987-03-03) abstract; figures 2A-2D ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

13 September 2016

Date of mailing of the international search report

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Fregosi, Alberto

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/067658

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No

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