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(54) **SIPE GEOMETRY FOR IMPROVED BUFFING OF TREAD BAND**

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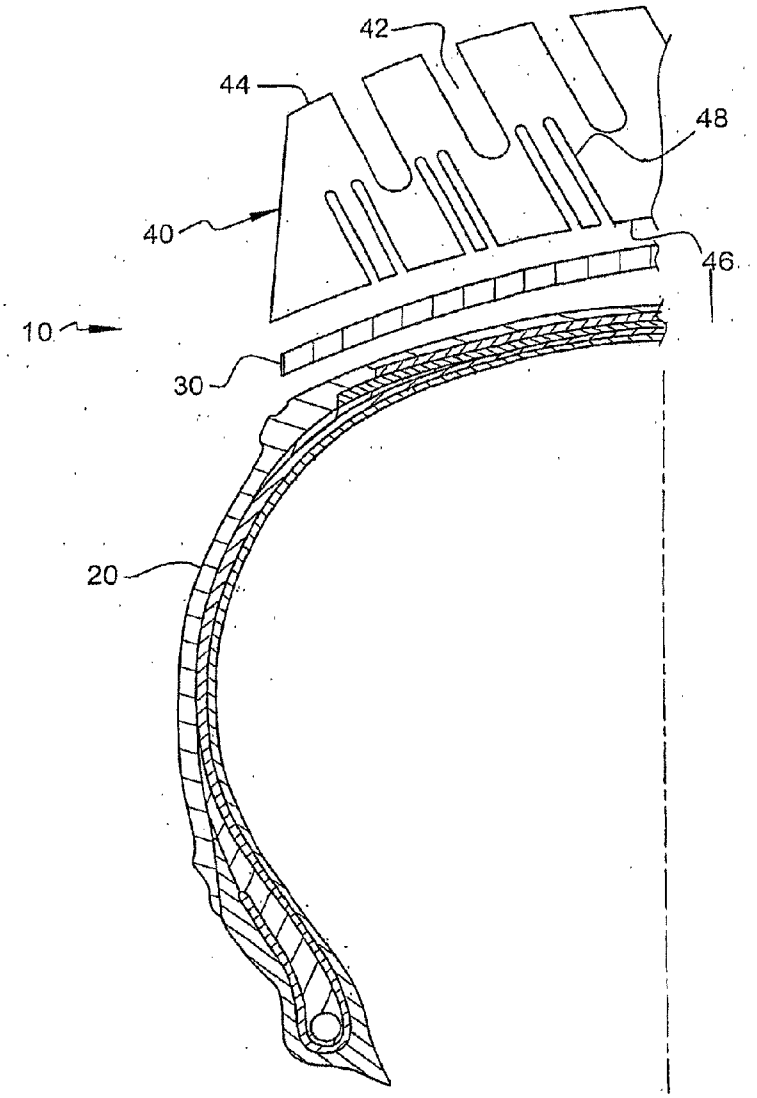
(52) **U.S. Cl.** **152/209.18**; 152/209.1; 156/123

(57) **ABSTRACT**

A mold for a tread layer having tread-forming side and sole-forming side, the sole-forming side having a plurality of mold elements extending there from toward the tread-forming side. Either the mold elements or the sole-forming side of the mold is configured to create a tread layer having a recessed tread element such as an incision, lateral groove, longitudinal groove or other void on the sole side of the tread layer that enables the edges of the recessed tread element to obtain full coverage when subjected to an abrasion process.



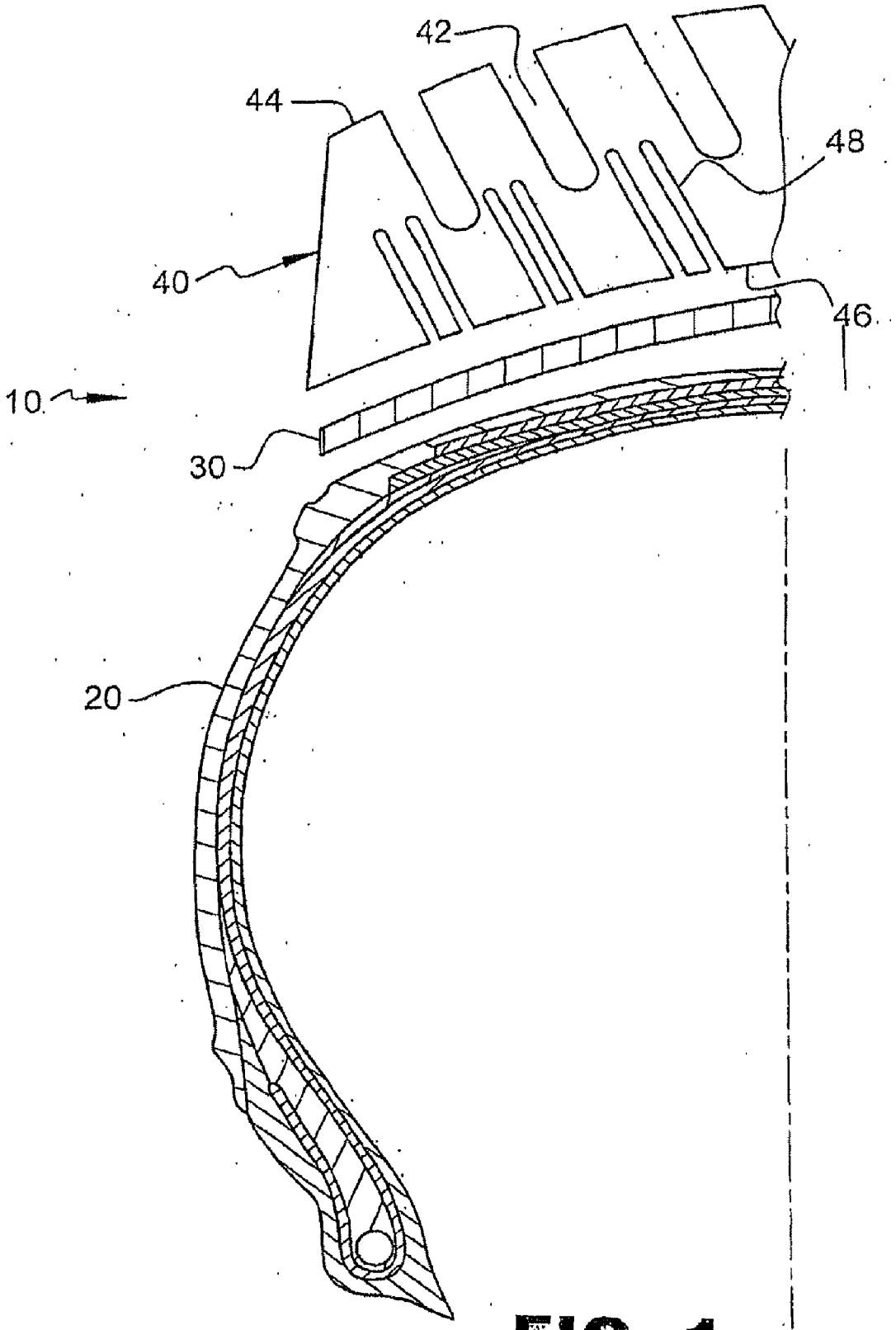


FIG. 1

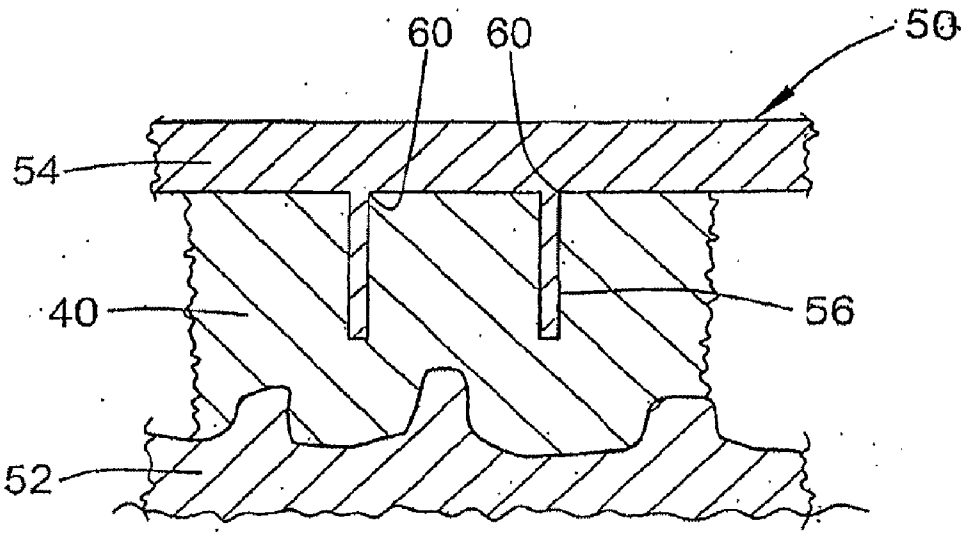


FIG. 2

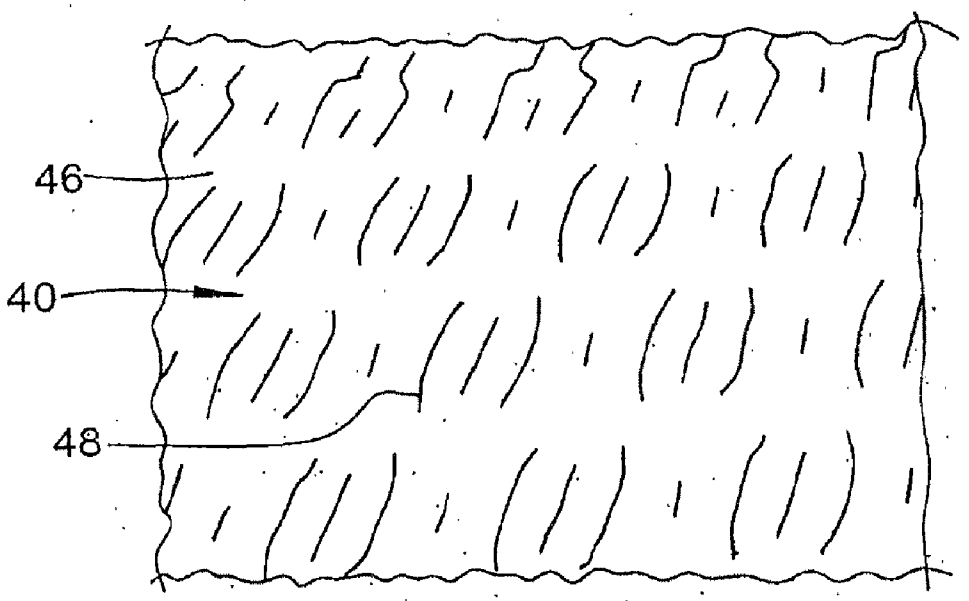


FIG. 3

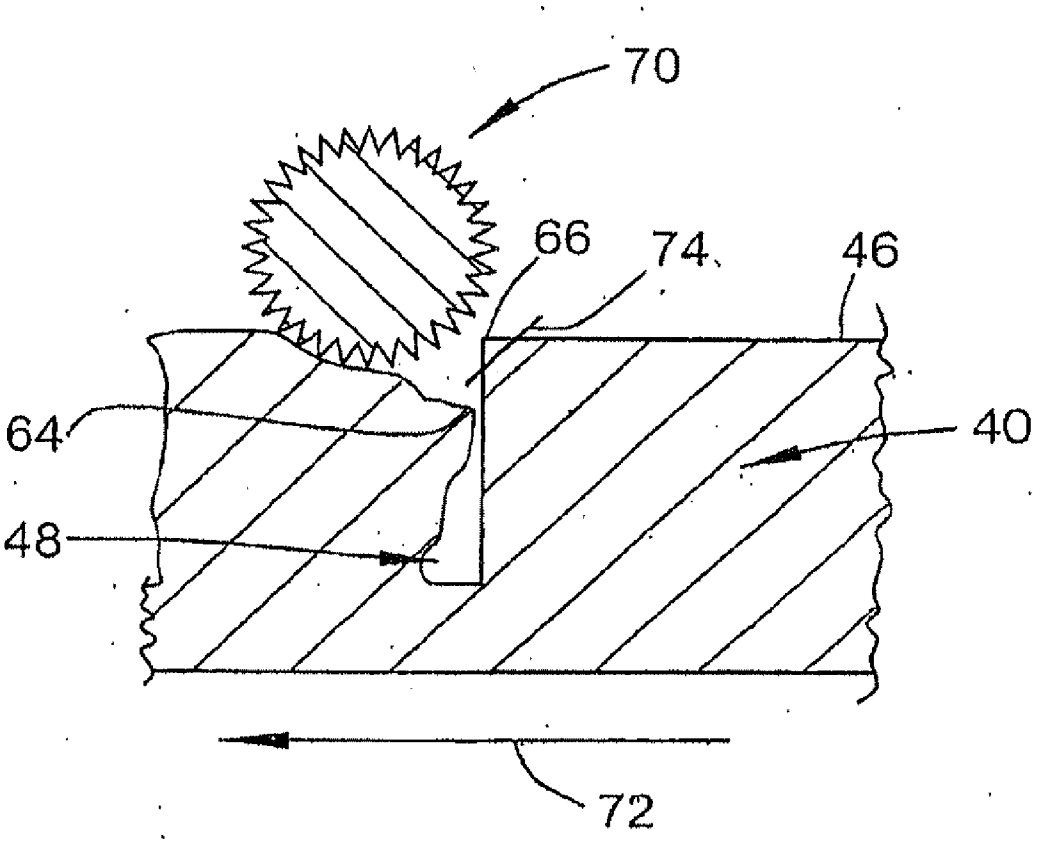


FIG. 4

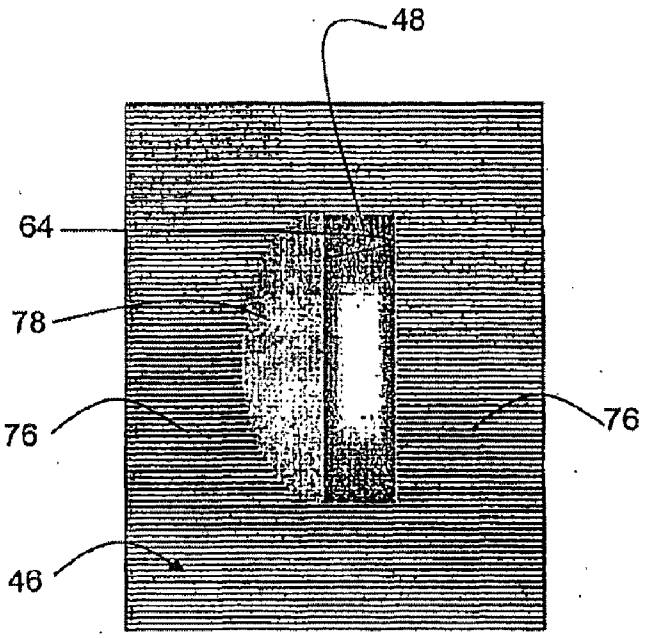


FIG. 5

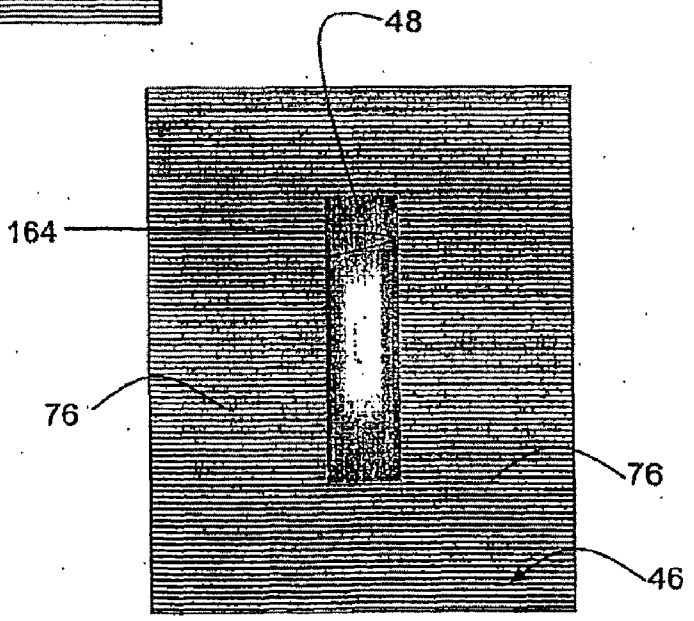


FIG. 7

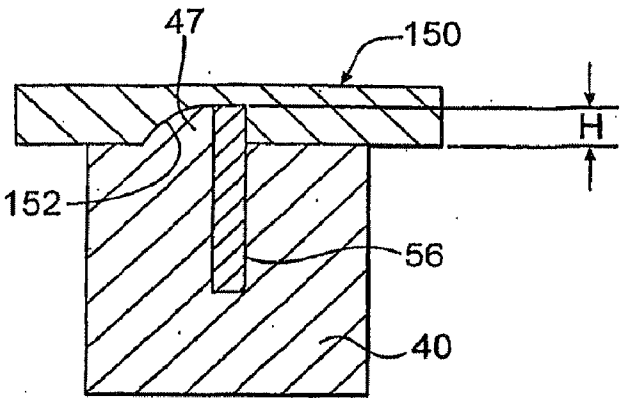


FIG. 6

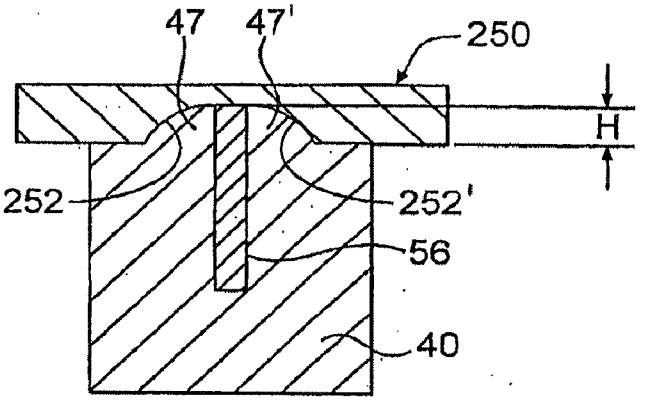


FIG. 8

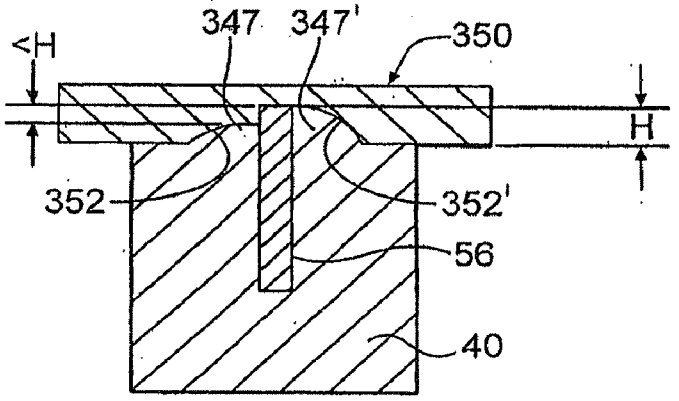


FIG. 9

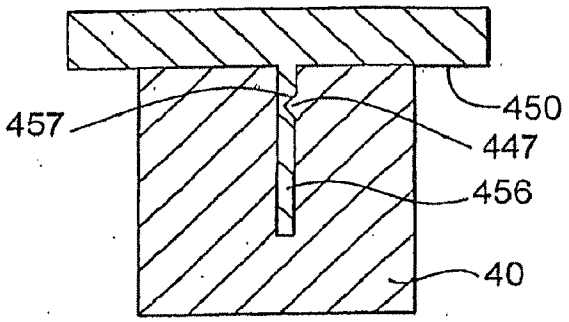


FIG. 10

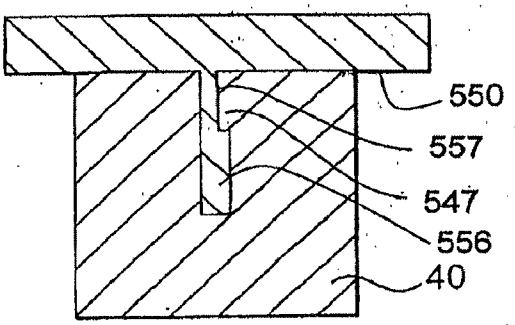


FIG. 11

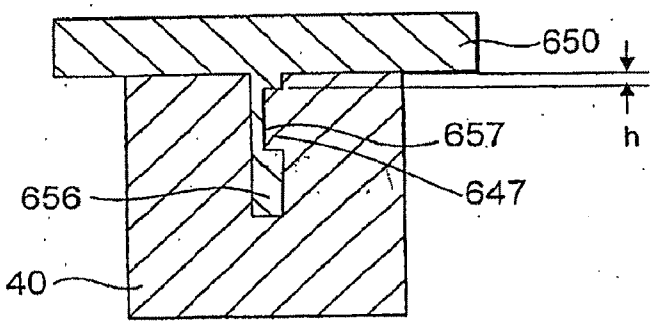


FIG. 12

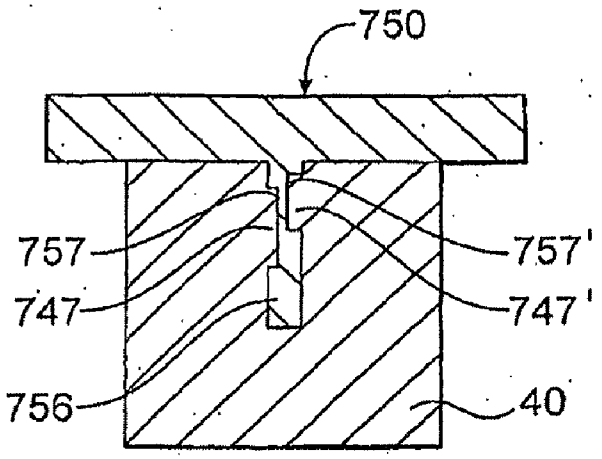


FIG. 13

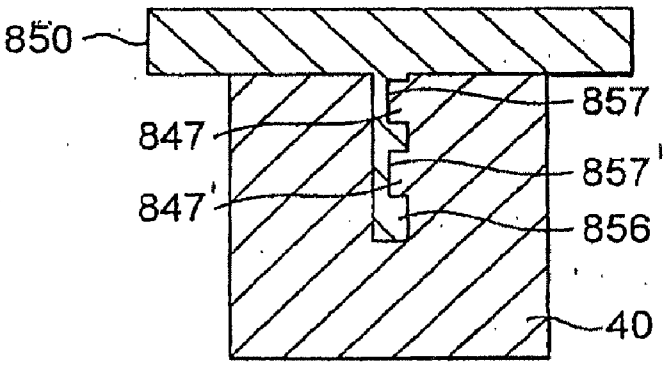


FIG. 14

SIPE GEOMETRY FOR IMPROVED BUFFING OF TREAD BAND

BACKGROUND OF THE INVENTION

[0001] This application claims priority to, and the benefit of, U.S. patent application Ser. No. 12/446,479 filed on Apr. 21, 2009 with the United States Patent and Trademark Office and International Application No. PCT/US06/45726 filed on Nov. 29, 2006 with the United States Receiving Office, each of which are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention is in the field of re-treaded tires.

DESCRIPTION OF THE RELATED ART

[0003] When tires become worn, they can be restored with new tread band or tread layer. Large truck tires are typically retreaded as part of a routine tire-management program. The carcass of a truck tire is expected to last several hundred thousand miles and be amenable to having a new tread layer adhered to it several times. New truck tires are quite expensive and are therefore bought with the expectation that their high initial costs are offset by the long service life of the carcass and the low comparative cost of retreading.

[0004] A variety of procedures and different types of equipment are available for use in recapping or retreading pneumatic tires. One of the first steps in retreading a worn tire is to remove existing tread layer material from the tire carcass by a sanding procedure known as buffmg. Next a layer of what is known as "cushion gum" is applied to the carcass. This layer of extruded, uncured rubber may be stitched or adhesively bonded to the carcass. Next, a tread layer is applied atop the layer of cushion gum. In the cold recapping process, the tread layer is cured rubber, and has a tread pattern already impressed in its outer surface. The tire is then placed in an autoclave, and heated under pressure for an appropriate time to induce curing of the gum layer, and binding of the gum layer to the inner or sole side of the tread layer and the carcass. The term "cure" refers to the formation of cross-links between the elastomer molecules in the rubber compound. It is further noted that there are various methods of bonding the tread layer to the carcass such as the use of adhesives, bonding agents, cushion gums, etc., and that all of the methods known in the art are included when referring to the term "bonding interface".

[0005] A common problem with tires including retreads, is that as the tire wears, the traction-providing elements also wear, until eventually the elements are substantially worn away. The result can be a significant reduction in traction for the worn tire. Efforts have been made to develop a tread layer that has tread elements cut into the sole side (the side facing the cushion gum layer) of the tread layer. The term "tread elements" refers to incisions, lateral grooves, and/or longitudinal grooves or any other void formed in the tread layer. The term "mold elements" are the parts of the mold that create the tread elements in the tread layer, such as for example a fin. Tread elements molded into the sole side of the tread layer appear as the tire wears, giving improved worn traction over the life of the retread and allowing the tire to be removed from service later in life.

SUMMARY OF THE INVENTION

[0006] A particular embodiment of the present invention includes a tread layer for a tire, the tread layer comprising: a tread layer body having a tread side and a sole side; a plurality of recessed tread elements molded from the sole side of the tread body; wherein the plurality of recessed tread elements each has a protrusion extending from a first inner surface of the recessed tread element toward an opposing surface of the tread element.

[0007] Another particular embodiment of the present invention includes a tread layer for a tire, the tread layer comprising: a tread layer body having a tread side and a sole side; a plurality of protrusions extending from the sole side of the tread layer, wherein the recessed tread elements each abut at least one of the protrusions.

[0008] Another particular embodiment of the present invention includes a method of molding a tread layer comprising the steps of: molding a tread surface on a tread side of the tread layer; molding a plurality of recessed tread elements from a sole side of the tread layer; molding a plurality of protrusions extending from the sole side of the tread layer, wherein the recessed tread elements each abut at least one of the protrusions.

[0009] Another particular embodiment of the present invention includes a mold for curing a tread layer comprising: a first side of the mold having a tread-forming surface; a second side of the mold having a sole-forming surface; wherein the second side of the mold comprises a plurality of mold elements extending from the sole-forming surface toward the first side of the mold; wherein the second side of the mold has at least one recess in the sole-forming surface abutting the at least one mold element.

[0010] Another particular embodiment of the present invention includes a mold for curing a tread layer comprising: a first side of the mold having a tread-forming surface; a second side of the mold having a sole-forming surface; wherein the second side of the mold comprises a plurality of mold elements extending therefrom toward the first side of the mold; at least a portion of at least one mold element having a variable cross-sectional thickness.

[0011] Another particular embodiment of the present invention includes a mold for curing a tread layer comprising: a first side of the mold having a tread-forming surface; a second side of the mold having a sole-forming surface; wherein the second side of the mold comprises a plurality of mold elements extending therefrom toward the first side of the mold and wherein the second side of the mold has at least one recess in the sole-forming surface abutting the at least one mold element.

[0012] These and other advantages will be apparent upon a review of the detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** shows a partial cross-sectional view of a retread tire having recessed tread elements formed from the sole side of the tread layer in accordance with one embodiment of the invention;

[0014] FIG. **2** shows a partial cross-sectional view of a tread layer mold for forming recessed tread elements in the sole side of the tread layer;

[0015] FIG. **3** shows a top view of a the sole side of the tread layer of FIG. **2** having a plurality of recessed tread elements formed therein;

[0016] FIG. **4** shows a cross-sectional view of an abrasion system operation providing a surface texture to the sole side of the tread layer of FIG. **2**;

[0017] FIG. **5** shows a schematic plan view of the results of the texture formed on the recessed tread elements of the sole side of the tread layer by the abrasion system operation of FIG. **4**;

[0018] FIG. **6** shows a partial cross-sectional view of a tread layer mold in accordance with another embodiment of the present invention for forming a raised area on one side of the recessed tread elements in the sole side of the tread layer;

[0019] FIG. **7** shows a schematic plan view of the results of the texture formed on the recessed tread elements of the sole side of the tread layer formed in accordance with FIG. **6** by the abrasion system operation of FIG. **4**;

[0020] FIG. **8** shows a partial cross-sectional view of a tread layer mold in accordance with an embodiment of the present invention for forming a raised area on two sides of the recessed tread elements in the sole side of the tread layer;

[0021] FIG. **9** shows a partial cross-sectional view of a tread layer mold in accordance with still another embodiment of the present invention for forming a raised area on two sides of the recessed tread elements in the sole side of the tread layer, with each raised area having different heights;

[0022] FIG. **10** shows a partial cross-sectional view of a tread layer mold in accordance with still another embodiment of the present invention wherein the mold forms a variable thickness in the recessed tread element;

[0023] FIG. **11** shows a partial cross-sectional view of a tread layer mold in accordance with still another embodiment of the present invention wherein the mold forms a variable thickness in the recessed tread element;

[0024] FIG. **12** shows a partial cross-sectional view of a tread layer mold in accordance with still another embodiment of the present invention wherein the mold forms a variable thickness in the recessed tread element;

[0025] FIG. **13** shows a partial cross-sectional view of a tread layer mold in accordance with still another embodiment of the present invention wherein the mold forms another configuration of a variable thickness in the recessed tread element; and

[0026] FIG. **14** shows a partial cross-sectional view of a tread layer mold in accordance with an embodiment of the present invention wherein the mold forms still another configuration of a variable thickness in the recessed tread element.

DETAILED DESCRIPTION OF THE DRAWINGS

[0027] Referring now to FIG. **1**, a partially exploded axial section of a retread tire **10** is shown comprising a tire carcass **20**, a cushion layer **30**, and a tread layer **40** in accordance with a first embodiment of the invention. The tread layer **40** comprises a band of cured rubber having a tread pattern **42** formed in its outer surface **44**. A plurality of recessed tread elements **48** are also shown formed in the inner surface **46**, or sole side surface, of the tread layer **40**. These recessed tread elements **48** formed in the sole side surface of the tread layer **40** are molded into the tread layer from the sole side. The cushion layer **30** is positioned between the ready-to-retread the carcass **20** and the tread layer **40**. Once these elements are assembled under normal retread procedures, the tire **10** is then placed in an autoclave, and heated under pressure for an appropriate time to induce curing of the cushion layer **30**, and binding of the cushion layer **30** to the sole side surface **46** of the tread layer **40** and the tire carcass **20**. In the embodiment shown, the width of the tread side **44** is narrower than the width of the sole side **46**. It is noted that, in the examples described herein, a cushion layer **30** is used between the carcass **20** and the tread layer **40**. This is for example only and is not intended to be limiting on the invention. It is contemplated that the any type of bonding interface can be used between the tread layer **40** and the tire carcass **20**; e.g., adhesives.

[0028] The production of the tread layer **40** is shown in FIG. **2**. Mold **50** has a first side or tread impression side **52** for forming the tread pattern **42** in the outer surface **44** of the tread layer **40** and a second side or interior side **54** for forming the sole side **46** of the tread layer **40**. The interior side **54** comprises mold elements **56**, shown herein as fins, for forming recessed tread elements **48** in the sole side **46** of the tread layer **40**. In forming a tread where the width of the tread side is narrower than the width of the sole side, such as in FIG. **1**, with regards to the mold for forming such a tread, the mold includes a tread forming surface for forming the tread side of the tread and a sole-forming surface for forming the sole side of the tread such that the width of the tread-forming surface is narrower than the width of the sole-forming surface.

[0029] When the tread layer **40** is removed from the mold **50** as shown in FIG. **3**, the recessed tread elements **48** are visible in the sole side surface **46**. Referring back to FIG. **2**, it is noted that the mold elements **56** may be perpendicular to the sole side surface **46** and that corners **60** are formed at the interface of the sole side surface **46** and the recessed tread elements **48**. The mold elements **56** may also be transverse to the sole side surface **46**; however, angled corners will still be formed.

[0030] Although not shown, the sole side surface **46** is typically covered with mold release agents upon removal of the tread layer **40** from the mold **50**. Accordingly, the sole side surface **46** must be treated to remove the release agents from the surface. One such treatment method involves adding a texture to the sole side surface **46**.

[0031] Referring now to FIG. **4**, a rotating abrasion system **70** is shown providing a surface texture to the sole side **46** of the tread layer **40**. The abrasion system **70** may include, for example, a grinding wheel or wire brush. The tread layer **40** moves in a single direction **72** past the fixed abrasion system **70**. However, the recessed tread elements **48** (shown herein as a sipe or incision) create a problem with abrasion system **70** in that the first edge **64** or leading edge of the recessed tread element **48** pushes away from the abrasion system **70**. The second edge **66** or trailing edge of the recessed tread element **48** is textured as marked at element **74**.

[0032] The result is best shown in FIG. **5** which shows a plan view of the texture **76** formed abutting the recessed tread elements **48** of the sole side **46** of the tread layer **40** by the abrasion system operation of FIG. **4**. As shown in FIG. **5**, a portion of the sole side surface **78** generally abutting the first edge **64** of the recessed tread element **48** may not be roughened by the abrasion system **70** and may still be covered with mold release agent. Either of these factors may result in poor bonding of the tread layer **40** and limit the endurance of the retreaded tire **10**.

[0033] In order to improve the endurance of the retreaded tire **10** the sole side of the tread layer should be completely roughened. Referring now to FIG. **6**, a mold **150** is used to form the recessed tread elements **48** in a manner allowing full surface treatment. Mold **150** comprises a recess **152** on a first

side or leading side of each mold element **56** for forming recessed tread elements in the sole side **46** of the tread layer **40**. This creates an elevated bump or protrusion **47** on one side of the tread element. When the tread layer **40** is removed from the mold **150** and subjected to the abrasion system **70**, the tread layer **40** is positioned such that the elevated bump **47** is the first edge or leading edge with relation to the abrasion system **70**. While the elevated bump **47** will still push away slightly from the abrasion system **70**, the elevated height, H, ensures that the surface adjacent the leading edge **164** is fully treated as best shown in FIG. **7**.

[0034] Other embodiments of the mold **250**, **350** and corresponding tread layer **40** are shown in FIGS. **8** and **9**. In these embodiments, the mold comprises a recess on either side of each mold element **56**. In FIG. **8**, the recesses **252**, **252'** are symmetrical to the mold element **56** whereas in FIG. **9**, one recess **352'** is larger than the other recess **352** to create bumps **347'**, **347** of different heights and shapes, respectively. The depth of the recess/height H of the bump **47**, **47'**, **347**, **347'** is generally less than 1 mm to provide full coverage of the treatment, however the invention is not limited to a specific height. The optimum height of the bumps is generally a function of the softness of the tread rubber. Particular embodiments of the invention include non-limiting ranges for the height H of at least 0.2 or at least 0.4 mm to about 2.5 mm or to about 5 mm or alternatively of between at least 0.4 mm and 2 mm or between 0.5 mm and 1.5 mm.

[0035] While the exemplary embodiments described and shown herein include bumps or protrusions having a rounded shape, the invention is not meant to be limited to such shapes as the shape may include any suitable shape including, for example, triangular, rectangular, oval or parts of these shapes.

[0036] In the previous embodiments, recesses were formed in the mold surface to ensure complete roughening treatment of the sole side surface having recessed tread elements. In the next embodiments of FIGS. **10-14**, complete treatment is achieved by modifications made to the mold elements rather than the mold surface. FIG. **10** shows a mold **450** with a mold element **456** having a generally triangular or pointed recess **457** in one side of the mold element **456**. FIG. **11** shows a mold **550** with a mold element **656** having a recess **657** formed in one side thereof wherein one side of the recess **657** is tangent to the mold surface. In FIG. **12**, a mold **650** is shown with a mold element **656** also having a recess **657** formed in one side thereof. However, recess **657** is spaced a distance, h, from the mold surface. It is noted that the distance, h, is typically less than 1 mm and more particularly less than 0.5 mm as will be discussed in more detail below. In FIG. **13**, a mold **750** is shown with a mold element **756** having a recess **757**, **757'** formed in both sides thereof wherein one recess **757** is larger and offset from recess **757'**. It is also contemplated that the recesses **757**, **757'** can be the same size and symmetrical to each other. In FIG. **14**, a mold **850** is shown with a mold element **856** having a recess **857**, **857'** formed in one side thereof. It is also contemplated that the recesses **857**, **857'** can be the same or different sizes or symmetrical with respect to their positioning along the length of the mold element **856**.

[0037] These configurations of mold elements **456**, **556**, **656**, **756**, **856** result in blocking material as protrusions **447**, **547**, **647**, **747**, **747'**, **847** in the recessed tread element inner wall that prevent an edge from deflecting (e.g., as best seen in FIG. **4**, edge **64**) during the abrasion process. Accordingly, the protrusions are typically formed at or near the sole surface at a distance, h, of 0 mm to 1 mm from the sole surface, although the invention is not intended to be limited to such a range. The purpose of the blocking material is not to reinforce the tread blocks but instead prevents an edge of the recessed tread element from deflecting during the abrasion process. The blocking protrusions can be of a single continuous geometry or of a plurality of smaller geometries and of any suitable shape. The blocking protrusions can also extend downward into the recessed tread element and also across the recessed tread element in the width direction.

[0038] All shapes and geometries of the protrusions are acceptable as long as the protrusions can be pushed against an opposing wall during the abrasion process to prevent the recessed tread element edge from deflecting. As illustrated above, the opposing wall may be an opposing wall of the recessed tread element or an opposing wall of another protrusion from the recessed tread element wall, as best seen in FIG. **13**. Furthermore, the protrusions **747** and **747'** may illustrate an embodiment wherein the longer protrusion **747**, which extends well into the depth of the recessed tread element, may be provided for rigidity while the shorter protrusion **747'** is provided to prevent the edge of the recessed tread element from deflecting during the abrasion process, such deflection occurring when the shorter protrusion **747'** is pushed against the longer protrusion **747**.

[0039] While this invention has been described with reference to preferred embodiments, thereof, it shall be understood that such description is by way of illustration and not by way of limitation. Accordingly, the scope and content of the present invention are to be defined only by the terms of the appended claims.

1. A tread layer for a retreaded tire, the tread layer comprising:

a tread layer body having a thickness defined by an outer surface and an inner surface of the tread layer body, the outer surface arranged on a tread side of the tread layer and the inner surface arranged along a sole side of the tread layer and forming an outer bonding surface of the tread layer body for bonding the tread layer body to a tire carcass, the tread side having a width that is narrower than a width of the sole side;

a recessed tread element comprising a void formed into the sole side of the tread layer;

a protrusion extending outwardly from the inner surface of the tread layer body and away from the tread side, wherein the protrusion is arranged along the sole side to abut the recessed tread element.

2. The tread layer of claim **1**, wherein the inner surface of the tread layer is a texturized inner surface, the protrusion extending outwardly from the texturized inner surface.

3. The tread layer of claim **2**, wherein the first protrusion extends outwardly from the inner surface by a distance forming a height, the height of first protrusion being at least 0.2 mm to about 5 mm.

4. The tread layer of claim **1**, wherein the protrusion has a rounded cross-sectional form.

5. The tread layer of claim **1**, wherein the protrusion is a first protrusion and wherein a second protrusion is arranged on the sold side of the tread layer body and in abutment with the recessed tread element, the second protrusion extending outwardly from the inner surface of the tread layer body and away from the tread side, the first protrusion and the second protrusion being arranged on opposing sides of the recessed tread element.

6. The tread layer of claim **5**, wherein each of the first and second protrusions extend outwardly from the inner surface by a distance forming a height, the height of first protrusion being different than the height of the second protrusion.

7. The tread layer of claim **5**, wherein the first protrusion extends outwardly from the inner surface by a distance forming a height, the height of first protrusion being at least 0.2 mm to about 5 mm.

8. The tread layer of claim **5**, wherein each of the first and second protrusions has a rounded cross-sectional form.

9. The tread layer of claim **1**, wherein the protrusions are formed having a height greater than 0.5 mm above the sole side of the tread body.

10. The tread layer of claim **1**, wherein the recessed tread element is a sipe or incision.

11. The tread layer of claim **1** further comprising: a tire carcass, wherein the sole side of the tread layer is bonded to the tire carcass.

12. The tread layer of claim **1**, wherein the recessed tread element is a sipe or an incision.

13. A method of providing a tread layer for retreading a tire comprising the steps of:

providing a tread layer for a tire, the tread layer including:

a tread layer body having a thickness defined by an outer surface and an inner surface of the tread layer body, the outer surface arranged on a tread side of the tread layer and the inner surface arranged along a sole side of the tread layer and forming an outer bonding surface of the tread layer body for bonding the tread layer body to a tire carcass, the tread side having a width that is narrower than a width of the sole side;

a recessed tread element comprising a void formed into the sole side of the tread layer; and,

a protrusion extending outwardly from the inner surface of the tread layer body and away from the tread side, wherein the protrusion is arranged along the sole side to abut the recessed tread element.

14. The method of claim **13**, wherein the inner surface of the tread layer is a texturized inner surface, the protrusion extending outwardly from the texturized inner surface.

15. The method of claim **13**, wherein the protrusion has a rounded cross-sectional form.

16. The method of claim **13**, wherein the protrusion is a first protrusion and wherein a second protrusion is arranged on the sold side of the tread layer body and in abutment with the recessed tread element, the second protrusion extending outwardly from the inner surface of the tread layer body and away from the tread side, the first protrusion and the second protrusion being arranged on opposing sides of the recessed tread element.

17. The method of claim **16**, wherein each of the first and second protrusions extend outwardly from the inner surface by a distance forming a height, the height of first protrusion being different than the height of the second protrusion.

18. The method of claim **16**, wherein each of the first and second protrusions has a rounded cross-sectional form.

19. The method of claim **13** further comprising the step of:

bonding the tread layer to a tire carcass to form a retreaded tire.

20. The method of claim **13**, where the tread layer provided in the step of providing a tread layer is formed by a molding process.

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