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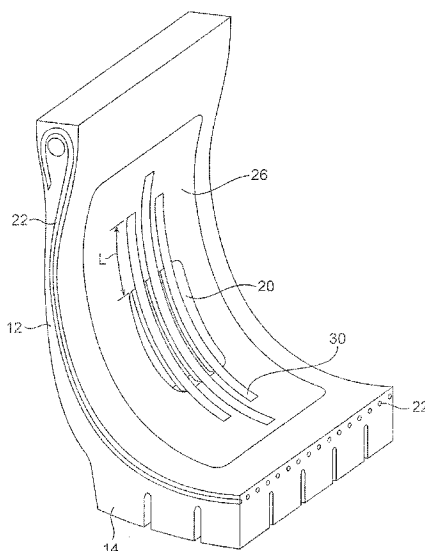


FIG. 6

(57) Abstract: Methods of repairing tire portions have steps that include removing at least part of the damaged portion of the tire to form an aperture or opening through the tire; forming one or more grooves in the tire adjacent to and extending from the aperture; placing at least one repair reinforcement within each of the one or more grooves; placing a patch on the tire to cover the aperture and each repair reinforcement; and, applying material to fill the remainder of the opening.



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## INTEGRATED TIRE SECTION REPAIR

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0001] The invention relates to a method and apparatus for repairing damaged portions of tires.

#### Description of the Related Art

[0002] It is generally known that a tire may become damaged. Damage may result from encountering road hazards and debris, or may be the result of tire mounting or dismounting, or an accident. In some instances, the damage may include abrasions, lacerations, or punctures.

[0003] One prior art method of repairing injuries to the body plies of a tire involves removing the damaged material, overlaying the section along an inside surface of the tire with a patch containing wires or cords, and filling the damaged area with rubber. With this technique, the repair reinforcements are offset relative to the tire's original reinforcements by a distance extending between the tire reinforcement and the reinforcement location within the patch. Therefore, the patch reinforcements are located beyond the interior surface of the tire, which may result in a distance at least 5-6 mm or more from the patch reinforcements to the tire reinforcements. When greater distances between the patch reinforcements and the tire reinforcements exist, shear amplitudes operating between the patch reinforcements and the tire reinforcements increase, which may lead to patch separation and failure. This limits the size and durability of the repairs.

[0004] Another repair technique involves removing a large trapezoidal section of the tire sidewall to a predetermined size and shape of a replacement patch section, where the patch reinforcements are substantially aligned within the same plane as the tire reinforcements. This technique is difficult and time consuming to practice, as it requires precise preparation of the trapezoidal tire aperture to match the patch dimensions, which is primarily done from the inside of the tire. It is also inflexible, as the tire is prepared to the predetermined patch size and shape.

### SUMMARY OF THE INVENTION

[0005] Particular embodiments of the present invention include methods for repairing portions of tires. Such repair of tire portions is performed after injury to the tire that results from, for example, interaction with a road hazard. Particular embodiments of methods of the present invention, that are methods of repairing tire portions have steps that include removing at least part of the damaged portion of the tire to form an opening through the tire; forming one or more grooves in the tire adjacent to and extending from the opening; placing at least one repair reinforcement within each of the one or more grooves; placing a patch on the tire to cover the opening and each repair reinforcement; and, applying material to fill the remainder of the opening.

[0006] Other embodiments for repairing damaged tire portions have steps that include identifying a tire having a plurality of reinforcements extending through the tire, the tire having a damaged portion in at least one of the sidewall, tread, or shoulder; removing at least part of the damaged portion of the tire to form a cavity; forming one or more grooves in the tire adjacent to and extending from the cavity; placing at least one repair reinforcement within each of the one or more grooves; and placing a patch on the tire to cover and the cavity and each repair reinforcement.

[0007] Other embodiments for repairing damaged tire portions have steps that include removing at least part of the damaged portion of the tire to form an aperture or opening through the tire or cavity in the tire; forming one or more grooves in an inner surface of the tire adjacent to and extending from the opening or cavity; applying an adhesive to the one or more grooves; placing at least one repair ply within each of the one or more grooves, the repair ply comprising rubber having one or more reinforcements embedded therein; placing a patch on the inner surface of the tire to cover the opening and each repair ply; and, applying material to fill the remainder of the opening or cavity.

[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 tire with a damaged section in need of repair.

[0010] FIG. 2a is a side view of an outer portion of the tire shown in FIG. 1, shown with damaged portion removed.

[0011] FIG. 2b is a side view of an outer portion of a tire having multiple layers of reinforcements, also shown with damaged portion removed.

[0012] FIG. 3 is a side view of the inner portion of the tire shown in FIG. 2a, illustrated with grooves formed in the tire and a buffed or cleaned area surrounding the aperture.

[0013] FIG. 4a is an inverted perspective view of FIG. 3.

[0014] FIG. 4b is a perspective view of an inner portion of a tire shown with damage occurring in the tread area of the tire, and a cavity formed in the tire after removal of damaged portion.

[0015] FIG. 5a is a section view through line A-A illustrated in FIGS. 3 and 4.

[0016] FIG. 5b is a section view similar to FIG. 5a, shown with an adhesive and repair ply placed in a groove.

[0017] FIG. 6 is a perspective view of the portion of the tire shown in FIGS. 3 and 4, illustrated with reinforcements placed within the grooves.

[0018] FIG. 7a is a perspective view of the portion of the tire shown in FIG. 6, illustrated with a patch applied to cover the aperture.

[0019] FIG. 7b is a perspective view of the portion of the tire shown in FIG. 6, illustrated with a reinforced patch applied to cover the aperture.

[0020] FIG. 8 is a side view of the outer portion of the tire illustrated in FIG. 7.

[0021] FIG. 9 is a side view of the portion of the tire illustrated in FIG. 8, shown with filler material placed within the aperture.

[0022] FIG. 10a illustrates a cross section of a repair ply having a single reinforcement therethrough.

[0023] FIG. 10b illustrates a cross section of a repair ply having a multiple reinforcements therethrough.

[0024] FIG. 10c illustrates a cross section of a repair ply having multiple reinforcements therethrough that are offset from the center of the reinforcement.

[0025] FIG. 10d illustrates a cross section of a repair ply having five reinforcements coated with a thin layer of rubber.

[0026] FIG. 11 is a schematic view illustrating an opening, with grooves extending in a radial direction.

[0027] FIG. 12 is a schematic view illustrating an opening, with reinforcements contained in a repair ply having multiple reinforcements therein.

[0028] FIG. 13 is a schematic view illustrating an opening, with grooves extending parallel to each other.

[0029] FIG. 14 illustrates a spool with repair reinforcement wound about the spool.

#### DETAILED DESCRIPTION OF THE DRAWINGS

[0030] Particular embodiments of the present invention provide methods for repairing damaged tire portions.

[0031] Particular embodiments of the present invention include one or more steps for repairing a tire **10** having a damaged sidewall **12**, tread **14**, or shoulder **16**. The steps may include identifying a tire **10** having a plurality of reinforcements **22** extending through the tire **10**, the tire **10** having a damaged portion **18** in at least one of the sidewall **12**, tread **14**, or shoulder **16**. The tire reinforcements **22** may comprise one or more layers of metallic cables, including steel cables; textile cords, including nylon cords, aramid cords, or any other textile cords known in the art; or any other reinforcement known in the art, and any combination thereof. If the tire **10** comprises two or more layers of reinforcements **22**, the layers may be arranged in either a biased or radial orientation. Furthermore, the layers can be aligned in a stacked relationship, as illustrated in FIG. 2b, or could be arranged in an alternating or offset pattern.

[0032] The steps may further include the step of removing or excising at least part of the damaged section or portion **18** of the tire **10**. Generally, the amount of damaged material removed is not more, or not significantly more, than an amount required to repair the damage. In one particular embodiment, the step may include removing or excising at least part of the damaged section or portion **18** of the tire **10** to form an aperture or opening **20** through the tire **10**. In another embodiment, the step may

include removing or excising at least part of the damaged section or portion **18** of the tire **10** to form a cavity **21** in the tire **10** rather than an opening **20**.

[0033] In one particular embodiment, enough material is excised from the tire **10** about the damaged portion **18** such that the remaining material on the tire **10** about the opening **20** is undamaged. In other words, the damaged portion is removed at least to a point where the reinforcements **22** are firmly encased in undamaged rubber. In another particular embodiment, at least two millimeters of cord or cable **22** is removed beyond the visibly damaged cord or cable. If, however, as illustrated in FIG. 4b, the damaged section is located on an inner portion **14** of the tire **10** such as, for example, under the tread **14**, the method may comprise removing at least part of the damaged portion of the tire to form a cavity **21** in the tire rather than forming an aperture **20** through the tire **10**.

[0034] The damaged section **18** may be cut, ground, burned, or otherwise removed from the outer surface of the tire **10**, or if desired, may be removed from the inner surface of the tire **10**. In one particular embodiment, removal of the damaged portion comprises not only removing the rubber portion of the tire, but also cutting and removing a portion of one or more damaged reinforcements **22** in the tire as well. In the removal process, standard tools and established techniques can be used, such as grinders, burnishers, or rasps.

[0035] In a particular embodiment, after removal of any damaged portion **18**, the tire **10** comprises an aperture or opening **20** that extends through the tire **10**. In the embodiment of FIG. 2a, the aperture **20** extends through the sidewall **12** of the tire. As mentioned previously, it is contemplated that during removal of the damaged portion **18**, portions of damaged reinforcements **22** may be removed, and therefore the ends of the remaining reinforcements **22** may be visible about the perimeter of the opening **20**. In one particular embodiment, the aperture **20** is not sized to accommodate a particular size of patch. Rather, the size of the aperture **20** is based mainly on the size of the damaged portion **18**, in that the larger the size of the damaged portion **18**, the larger the size of the aperture **20**. Similarly, it is contemplated that any shape of opening **20** can be formed, as the shape of the opening **20** is also not necessarily based on accommodating a particular shape of patch.

[0036] In one embodiment, as illustrated in the FIGS. 2-4b, the opening **20** comprises a substantially consistent width from top to bottom, such that the same number of cords or cables **22** are exposed in the top portion of the aperture **20** as are exposed in the bottom portion of the aperture **20**. If the tire **10** is a radial tire **10**, and the damage is in the sidewall **12** or shoulder **16** of the tire, the opening **20** may be generally a trapezoidal shape, with the smaller end of the trapezoid closer to the bead of the tire, because the radially-extending reinforcements **22** are spaced farther apart as the reinforcements **22** extend radially outwardly.

[0037] The methods may further include the step of forming one or more grooves or skivings **24** in the tire **10** adjacent to and extending from the aperture **20** or cavity **21**. In a particular embodiment, the grooves **24** are formed by removing material from the tire adjacent to the opening **20** or cavity **21**. Typically, the grooves **24** are formed along the interior or inner surface of the tire **10**, as illustrated in FIGS. 3 and 4. However, the grooves **24** can also be formed in the outer surface of the tire **10**.

[0038] The grooves **24** may extend in any direction relative to the tire **10** and opening **20**. For example, in FIGS. 3 and 13, the grooves extend parallel to each other. FIG. 11 illustrates another embodiment wherein the grooves **24** extend in a radial direction relative to the tire **10** and therefore have an angle  $\alpha$  formed between them. In one particular embodiment, at least some of the grooves **24** extend in a direction substantially parallel to the adjacent tire reinforcements **22**. The grooves **24** also may be formed from any of a plurality of known techniques. In one particular embodiment, a hot regrooving tool is used to form the grooves **24**, although use of other tools such as ultrasonic cutters and grinders is also contemplated.

[0039] The width of the grooves **24** can be adapted to the user's preferences and as necessary for the particular circumstances. For example, in one embodiment, the grooves **24** are sized to accommodate a single repair reinforcement **32** or repair ply **30a** having a single reinforcement **32**. In other embodiments, the grooves **24** are sized to accommodate multiple reinforcements **32** or one or more repair plies such as **30b** and **30d** having multiple reinforcements **32**. Furthermore, rather than a plurality of grooves **24** and reinforcements **32** or repair plies **30**, in one particular embodiment a single groove **24**

is formed that accommodates a single repair ply **30e** having multiple reinforcements **32** extending therethrough.

[0040] With regard to the depth of the grooves **24**, no particular depth is required. However, in one embodiment, the depth of the groove is substantially equal to or slightly shallower than the thickness of the repair reinforcement **30** or **32**, as described in more detail below. Generally, the bottom of the groove **24** is as close to the reinforcements **22** as is reasonably practicable under the circumstances. FIG. **5a** illustrates a cross-sectional view of the aperture **20** along line **A-A** of FIG. **4a**. The cross-section of the tire **10** portion has a thickness whereby the reinforcements **22** are located at a depth  $D_R$  measured in this instance from the inside surface of the tire **10**. The grooves **24** also have a depth,  $D_G$ , also measured from the inside surface of the tire **10** to the bottom of the groove **24**. In one particular embodiment, the difference  $\Delta$ , measured as  $D_R$  minus  $D_G$ , is less than five millimeters. In another embodiment, the difference  $\Delta$ , measured as  $D_R$  minus  $D_G$ , is about one-half millimeter to two millimeters. In this manner, it can be appreciated that the plane of the repair reinforcements **32** and the plane of the tire's reinforcements **22** will be in close proximity, which minimizes the effects of shear amplitude, including the resultant sidewall bulging upon inflation of the tire **10**.

[0041] It is contemplated that the grooves **24** may be of any length. In one particular embodiment, each groove **24** extends outward from the opening **20** by a length  $L$  of at least fifty millimeters. In another embodiment as illustrated in FIGS. **3-4**, at least two of the grooves comprise different lengths. In yet another embodiment, the grooves **24** have the same length but at least two of the grooves **24** are offset or staggered from one another. Finally, it is contemplated that the grooves **24** may have the same length with ends that are not offset or staggered from each other.

[0042] The method may further include the step of placing at least one repair reinforcement within each of the one or more grooves **24**. The repair reinforcements **32** may comprise any reinforcement discussed and contemplated above, with reference to the tire reinforcements **22**. Alternatively, one or more repair reinforcements **32** can be coated with or embedded within a polymer **34** such as rubber to form a repair ply **30**. In one particular embodiment, the repair ply comprises a sheet of rubber having a plurality of reinforcements embedded therein. FIGS. **10a-10d** illustrate exemplary embodiments

of repair plies **30a-30d**. The term “repair reinforcement” is therefore meant to encompass both reinforcements **32** and repair plies **30**.

[0043] The repair reinforcements **30** or **32** extend across or span the aperture **20** when placed in a groove **24**. FIG. 6 illustrates such placement of repair plies **30** into the grooves **24**. In one particular embodiment as illustrated in FIG. 5b, an adhesive **38** such as rubber cement is first placed in the groove **24** as needed to at least partially secure the repair reinforcement **30** or **32** relative to the groove **24**.

[0044] As mentioned above, in one particular embodiment, the depth  $D_G$  of the groove **24** is substantially equal to or slightly shallower than the thickness of the repair reinforcements **30**, **32**. For example, in FIG. 5b, repair ply **30c** is shown in a groove **24**. As illustrated, repair ply **30c** extends slightly outward of the groove **24**. However, it is also contemplated that the depth  $D_G$  of the groove **24** is deeper than the thickness of the repair reinforcement. In such an embodiment, filler material such as rubber or rubber cement can be placed under or over the repair reinforcement **30** or **32** such that the thickness of the installed repair reinforcement **30** or **32** is substantially equal to or higher than the surrounding material.

[0045] Particular embodiments of the disclosed methods comprise any of a plurality of different types of repair reinforcements **30** or **32**. In one particular embodiment, the repair reinforcement is a repair ply **30** such as repair plies **30a**, **30b**, **30c**, and **30d** having one or more reinforcements **32** contained therein. However, it is also contemplated that the repair reinforcement may be one or more reinforcements **32**. Additionally, the repair reinforcements **30**, **32** are not required to be the same as the reinforcements **22** in the tire, either in number or composition. For example, if portions of five damaged metallic cables are removed to from aperture **20**, any number of repair reinforcements **30** or **32** can be used in the repair, and the repair reinforcements **30** or **32** may comprise either cables or cords. Furthermore, the size, such as the circumference, of the repair reinforcements **30** or **32** may be different from tire reinforcements **22**.

[0046] Repair ply **30a** comprises a single reinforcement **32** contained within a polymer such as skim rubber **34**. Repair plies **30b**, **30c**, and **30d** comprise a plurality of reinforcements **32** contained within rubber **34**, the reinforcements **32** generally being spaced equally across the width of the respective reinforcement **30b**, **30c**, or **30d**.

Additionally, the reinforcements **32** can be spaced substantially equidistant between the top and bottom of the reinforcement, as in reinforcements **30** and **30b**. However, as illustrated in FIG. **10c**, the reinforcements **32** may be located nearer the top or bottom of the reinforcement **30c**. In one particular embodiment as illustrated in FIG. **10c**, the repair ply **30c** comprises two layers **34**, **36** of rubber that are joined together with, for example, uncured rubber or rubber cement. Alternatively, the repair ply may comprise a single piece of rubber **34** with cables or cords **32** embedded therein nearer the top or bottom of the rubber **34**.

[0047] The method may further include the step of placing a patch **28** on the tire to cover each repair reinforcement **30** or **32**. Typically, if an aperture **20** is formed during the repair process, the patch **28** is applied to cover the aperture **20** as well each repair reinforcement **30** or **32**. Adhesives can be applied to the patch and/or the tire as needed to form a secure attachment.

[0048] In one particular embodiment, as illustrated in FIG. **7a**, the patch **28** is a non-reinforced patch that comprises a first layer of rubber that is compatible with the repair reinforcements **30** or **32** and the surface **26** of the tire **10** to which it contacts, along with a second layer of rubber that has low air permeability. Such a patch **28** is designed purely for adhesion and air retention, and is not compromised by an additional requirement of providing structural support. In another embodiment, the patch **128** comprises a plurality of reinforcements **29** embedded within the patch **128**.

[0049] Prior to application of the patch **28**, an area **26** about the opening **20** may be buffed and/or cleaned with solvent and vacuumed to remove any debris or demolding lubricant on the surface to which the patch **28** adheres. FIGS. **6-8** illustrate an embodiment wherein the grooves **24** are formed on the inner surface of tire **10**. Specifically, FIG. **6** illustrates the inner surface of tire **10** with area **26** buffed and/or cleaned, and FIGS. **7a-7b** illustrate perspective views of the inner surface of the tire **10** after application of the patch **28** or **128**. Finally, FIG. **8** illustrates an outer view of the tire **10** after the patch **28** is applied.

[0050] The method may further include the step of applying material **40** to fill the remainder of the opening **20** or cavity **21**. Generally, the material is applied to fill the remainder of the opening **20** on a side of the tire opposite the repair reinforcements **30** or

**32** and patch **28**. As mentioned previously, the grooves **24**, repair reinforcements **30** or **32**, and patch **28** are typically located on an inner surface of the tire **10**, and therefore the step of applying material **40** will typically be performed from the outer surface of the tire **10**. FIG. 9 illustrates a side view of an outer portion of tire **10** after application of the filler material **40**. The filler material may comprise uncured rubber or any other suitable rubber.

[0051] If a cavity **21** is formed by the removal of the damaged portion rather than the formation of an aperture **20**, as mentioned previously, the method may comprise applying material **40** to fill the remainder of the cavity **21**. It is contemplated that this step could be performed before placing the patch **28** or **128** over the repair reinforcements **30** or **32** and the remainder of the cavity **21**, so that air is not trapped under the patch **28**.

[0052] In one particular embodiment, the filler material **40** is a rubber material **40**, and the rubber material **40** is applied to the level of the surrounding tire area. After the filler material is applied, it is shaped to blend with the exterior features of the tire. In yet another particular embodiment, one or more of the materials used in the disclosed section repair is uncured rubber. In such an embodiment, at least the portion of the tire that comprises uncured rubber is then cured in the standard manner in an envelope in an autoclave, or with a spotter.

[0053] The method may further include the step of cutting a repair reinforcement from a spool to a length (**L**) to fit within a groove, prior to positioning the repair reinforcement into the groove. By cutting one or more of the repair reinforcements from a spool, there is no requirement to form the grooves to a particular length. Furthermore, the ability to cut the repair reinforcements **30** to a given length enables the user the ability to repair damaged areas of different sizes without an increased cost or a requirement to stock multiple lengths of repair reinforcements **30**.

[0054] While this invention has been described with reference to particular embodiments thereof, it shall be understood that such description is by way of illustration and not be way of limitation. Accordingly, the scope and content of the invention are to be defined only by the terms of the appended claims.

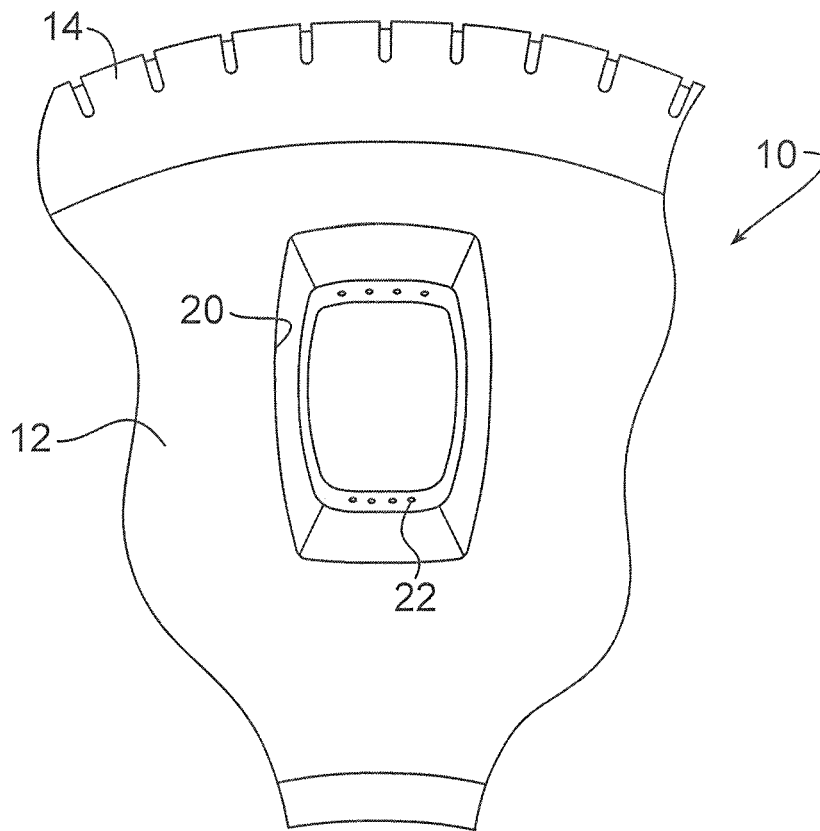
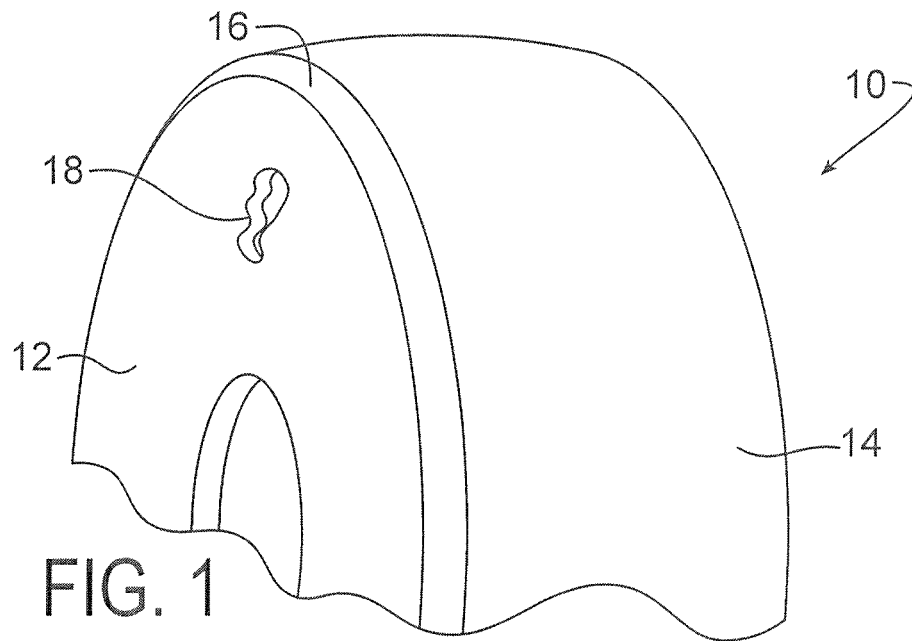
CLAIMS

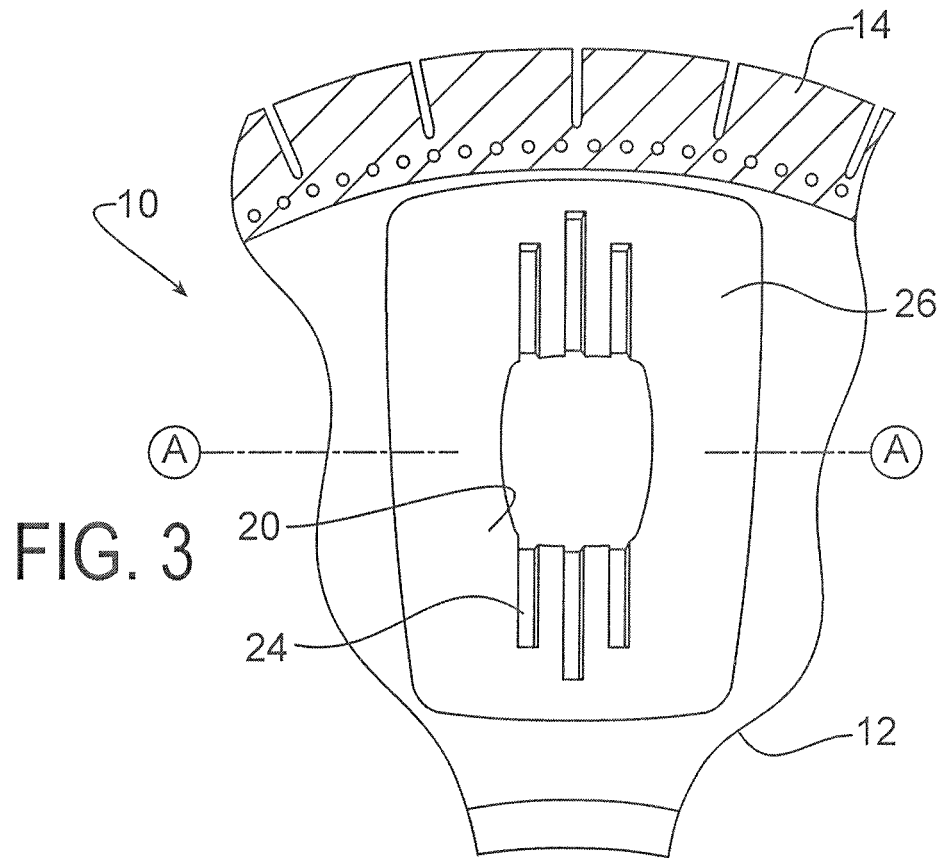
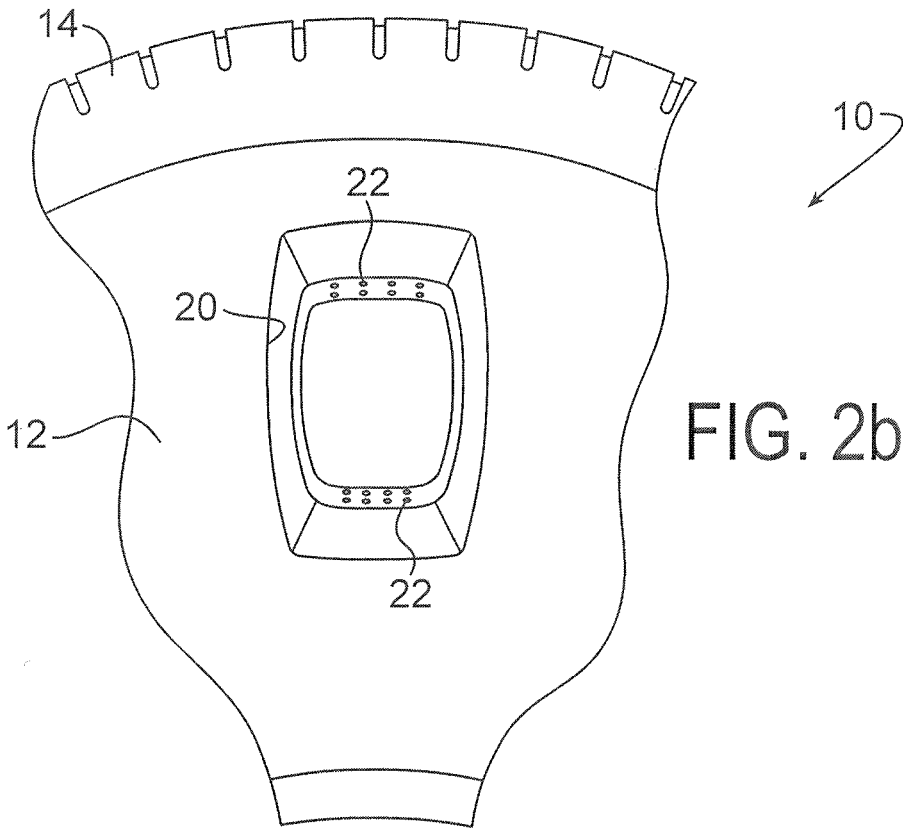
What is claimed is:

1. A method of repairing a damaged portion of a tire, the method comprising the steps of:
  - removing at least part of the damaged portion of the tire to form an opening through the tire;
  - forming one or more grooves in the tire adjacent to and extending from the opening;
  - placing at least one repair reinforcement within each of the one or more grooves;
  - placing a patch on the tire to cover the opening and each repair reinforcement;and,
  - applying material to fill the remainder of the opening.
2. The method of claim 1, wherein the one or more grooves are formed in an inner surface of the tire, and the patch is placed on the inner surface of the tire.
3. The method of claim 2, wherein the material is applied to fill the remainder of the opening on an outer surface of the tire.
4. The method of claim 1, wherein the step of removing the damaged portion of the tire is performed through an outer surface of the tire.
5. The method of claim 1, wherein the material is applied to fill the remainder of the opening on a side of the tire opposite the repair reinforcements and the patch.
6. The method of claim 1, wherein the damaged portion is in the sidewall or shoulder area of the tire.
7. The method of claim 1, wherein the step of forming one or more grooves comprises removing material to form the one or more grooves.
8. The method of claim 1, wherein each of the one or more grooves extend substantially parallel to at least one adjacent tire reinforcement.
9. The method of claim 1, wherein each of the one or more grooves extend in a radial direction relative to the tire.
10. The method of claim 1, wherein the one or more grooves is a plurality of grooves, and the grooves extend parallel to one another.

11. The method of claim 1, further comprising the step of curing at least the repaired portion of the tire.
12. The method of claim 1, wherein the at least one repair reinforcement comprises a cord.
13. The method of claim 1, wherein the at least one repair reinforcement comprises a cable.
14. The method of claim 1, wherein the at least one repair reinforcement comprises at least one repair ply.
15. The method of claim 14, wherein the at least one repair ply comprises a sheet of rubber having a plurality of reinforcements embedded therein.
16. The method of claim 1, wherein the at least one repair reinforcement is at least partially wound about a spool.
17. The method of claim 1, wherein prior to positioning the at least one repair reinforcement into the at least one groove, the repair reinforcement is cut from a spool to a length to fit within the groove.
18. The method of claim 1, wherein prior to the step of applying the patch, an area on the inside of the tire about the aperture is buffed or cleaned with solvent.
19. The method of claim 1, wherein the one or more grooves is a plurality of grooves and at least two of the grooves have offset ends.
20. The method of claim 1, wherein the step of removing the damaged section also includes the step of removing at least a small portion of undamaged section.
21. The method of claim 1, wherein after placing the at least one repair reinforcement within each of the one or more grooves, a portion of the at least one repair reinforcement is located less than five millimeters from an adjacent tire reinforcement.
22. The method of claim 1, wherein after placing the at least one repair reinforcement within each of the one or more grooves, a portion of the at least one repair reinforcement is located from about one-half millimeter to about two millimeters from an adjacent tire reinforcement.
23. The method of claim 1, wherein before the step of placing the at least one repair reinforcement within each of the one or more grooves, rubber cement is first placed into the one or more grooves.

24. The method of claim 1, wherein the patch comprises a plurality of reinforcements embedded therein.
25. A tire that has been repaired by the method of claim 1.
26. A method of repairing a damaged portion of a tire, the method comprising the steps of:
- identifying a tire having a plurality of reinforcements extending through the tire, the tire having a damaged portion in at least one of the sidewall, tread, or shoulder;
  - removing at least part of the damaged portion of the tire to form a cavity;
  - forming one or more grooves in the tire adjacent to and extending from the cavity;
  - placing at least one repair reinforcement within each of the one or more grooves; and
  - placing a patch on the tire to cover the cavity and each repair reinforcement.
27. The method of claim 26, further comprising the step of:
- applying material to fill the remainder of the cavity.
28. A method of repairing a damaged portion of a tire, the method comprising the steps of:
- removing at least part of the damaged portion of the tire to form an aperture or opening through the tire or cavity in the tire;
  - forming one or more grooves in an inner surface of the tire adjacent to and extending from the opening or cavity;
  - applying an adhesive to the one or more grooves;
  - placing at least one repair ply within each of the one or more grooves, the repair ply comprising rubber having one or more reinforcements embedded therein;
  - placing a patch on the inner surface of the tire to cover the opening or cavity and each repair ply; and,
  - applying material to fill the remainder of the opening or cavity.
29. The method of claim 28, wherein the step of removing at least part of the damaged portion of the tire includes forming an aperture through the tire; and,
- the step of applying material is performed on an outer surface of the tire.





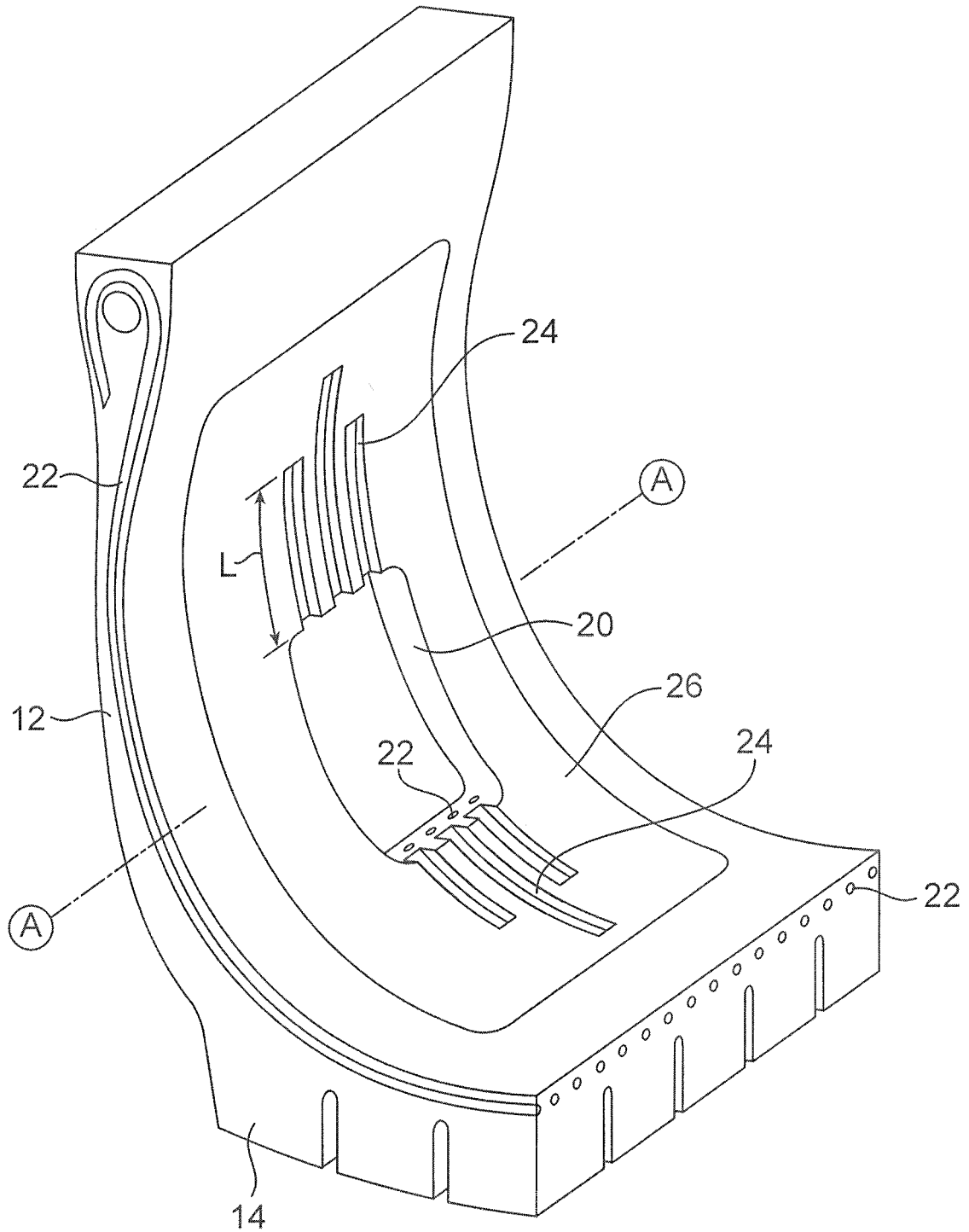


FIG. 4a

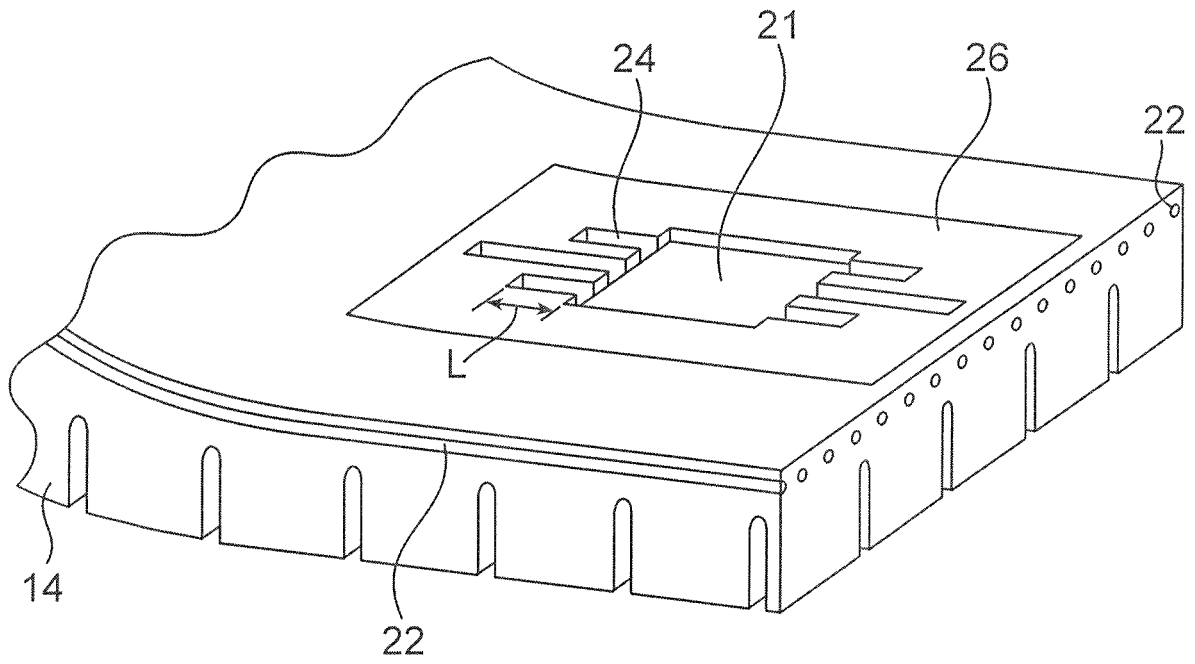


FIG. 4b

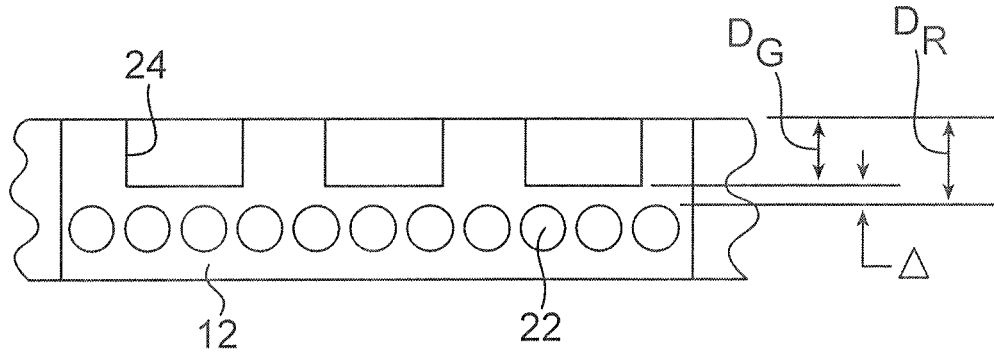


FIG. 5a

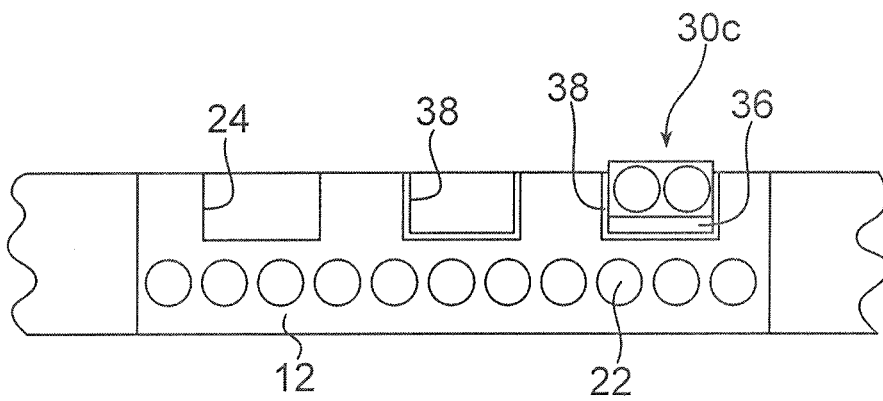


FIG. 5b

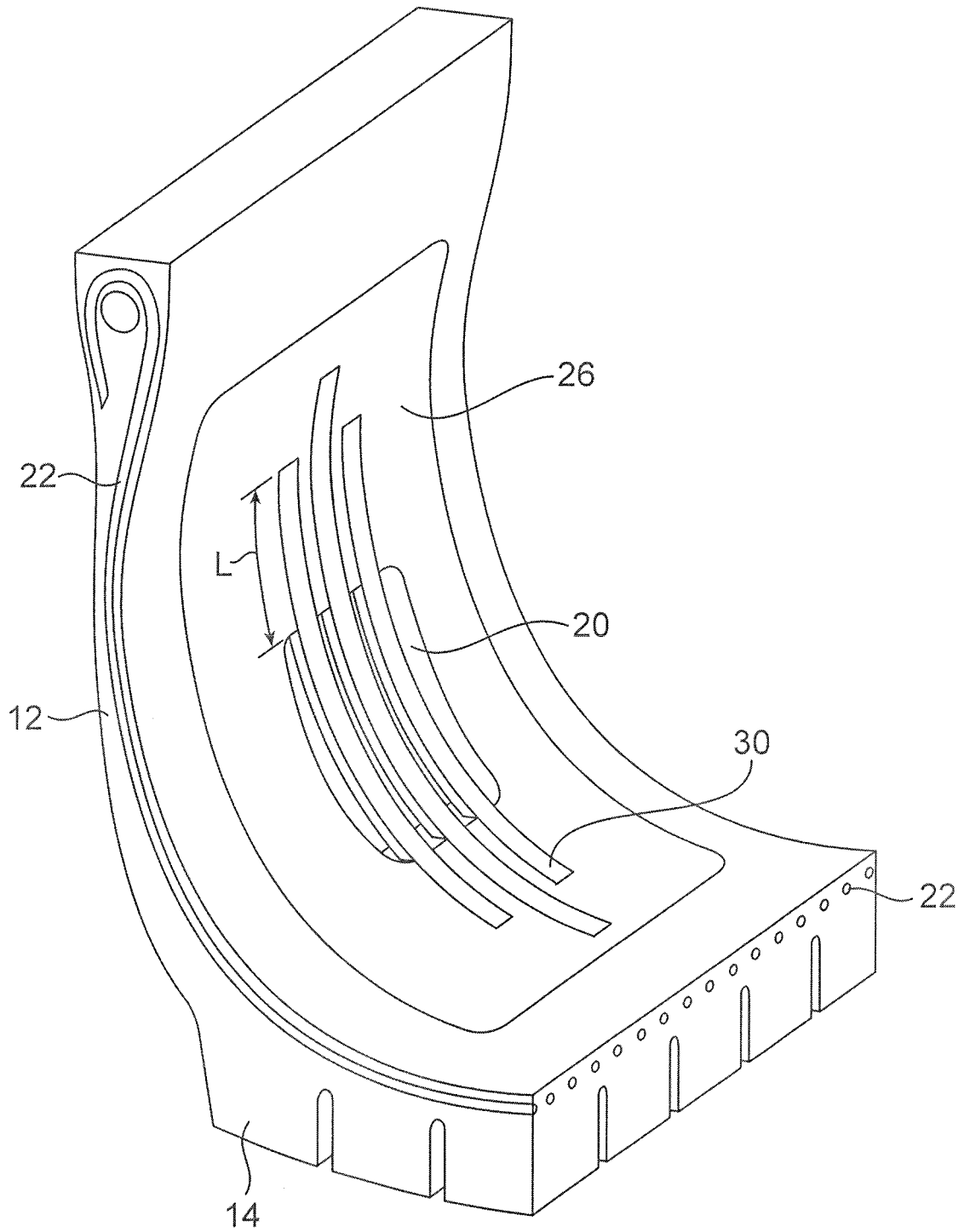


FIG. 6

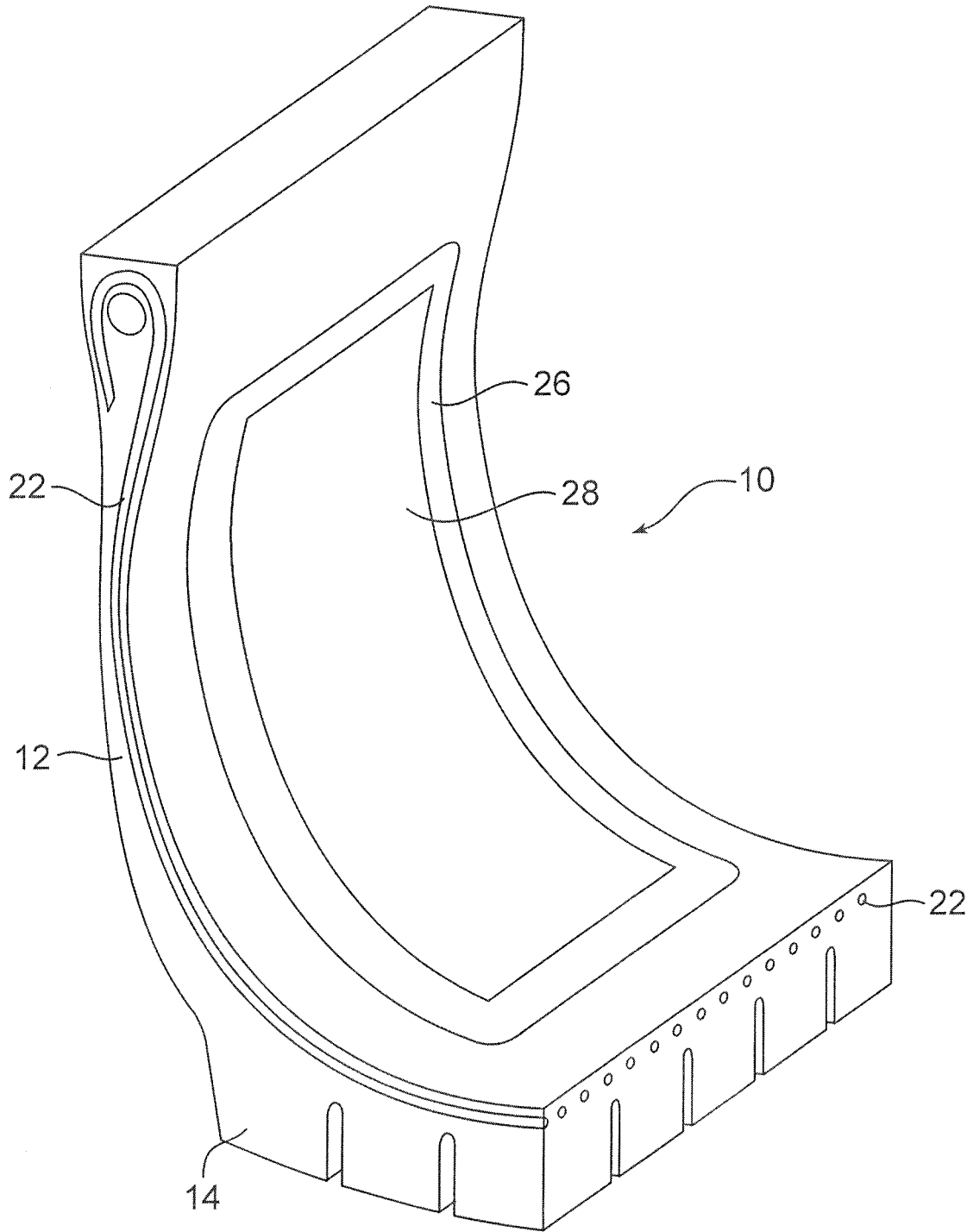


FIG. 7a

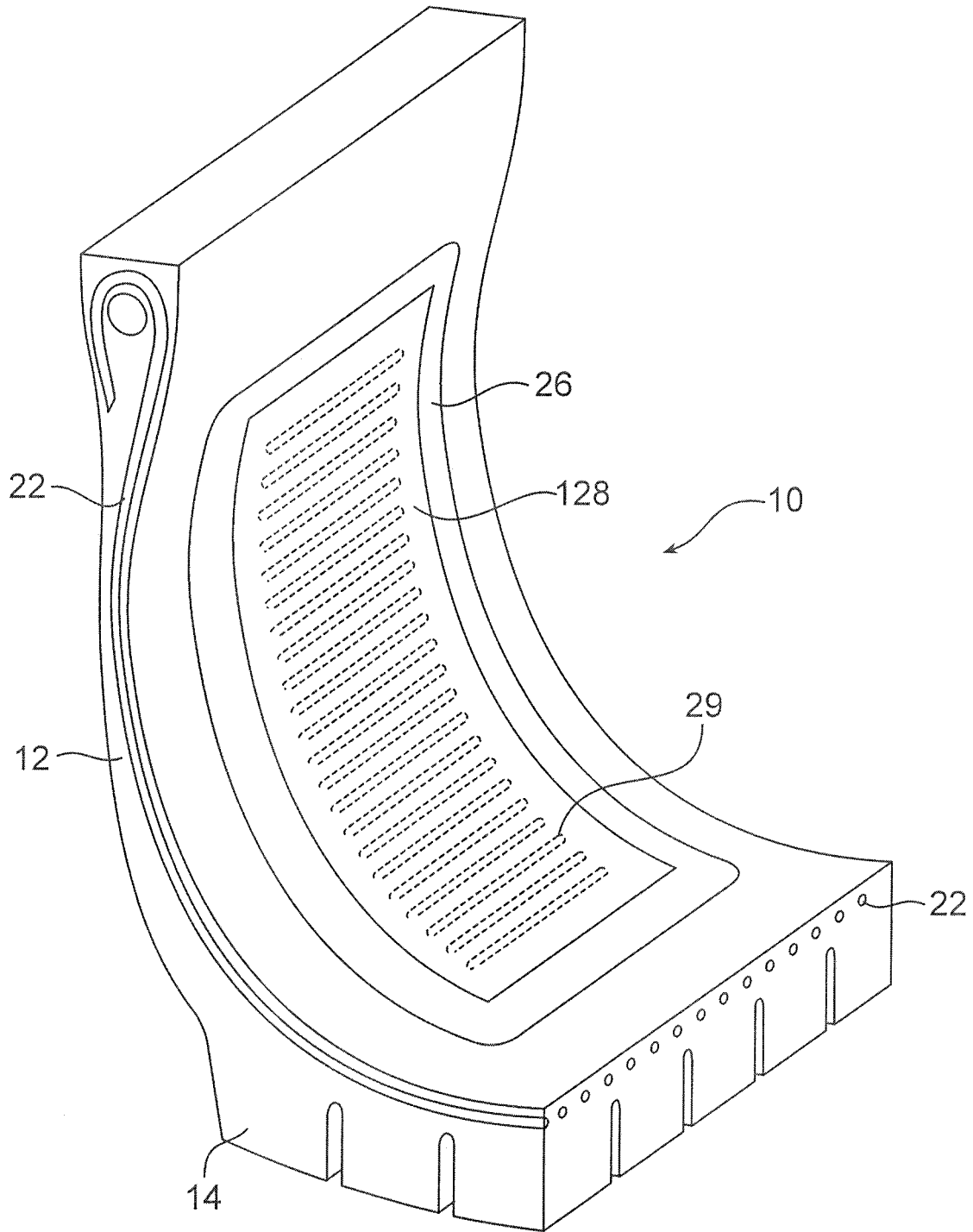


FIG. 7b

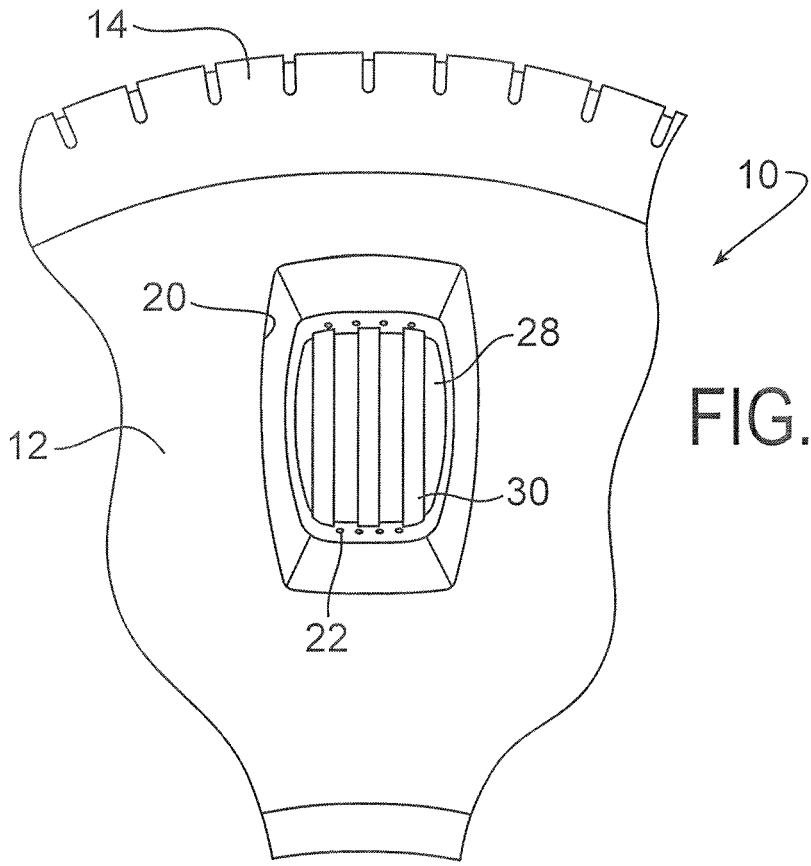


FIG. 8

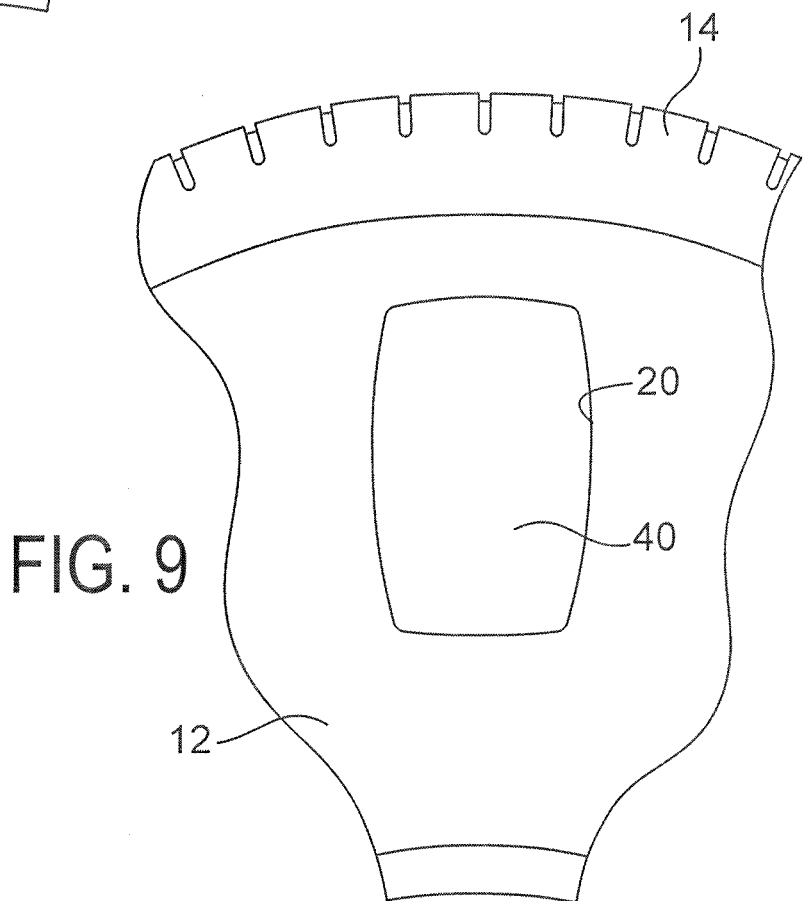


FIG. 9

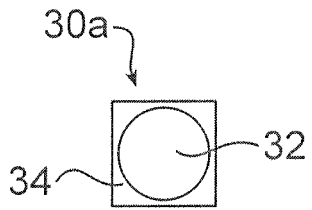


FIG. 10a

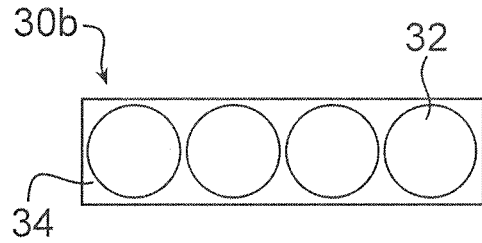


FIG. 10b

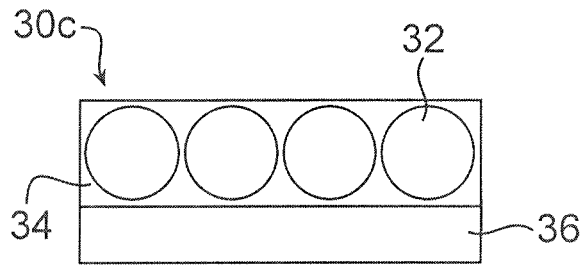


FIG. 10c

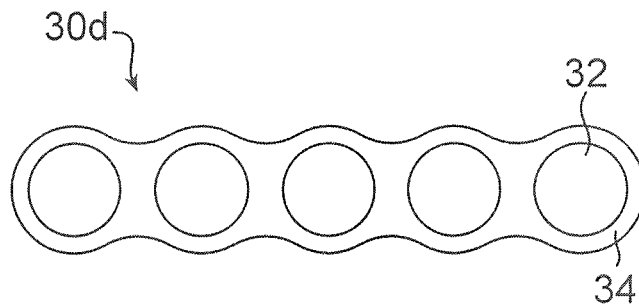


FIG. 10d

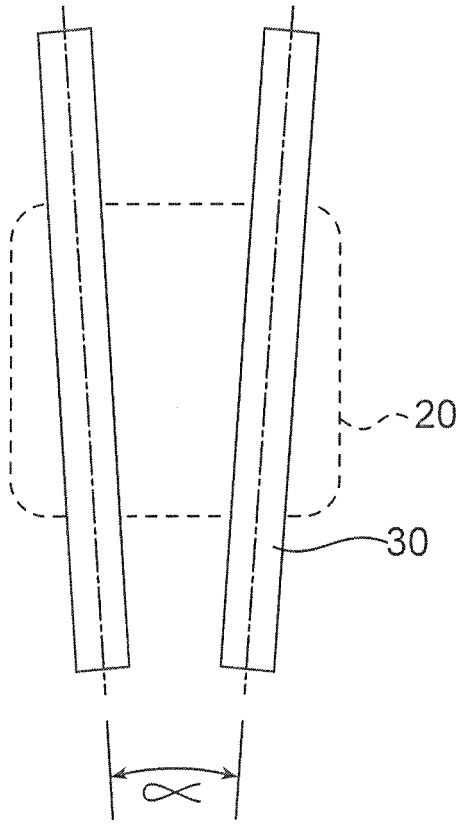


FIG. 11

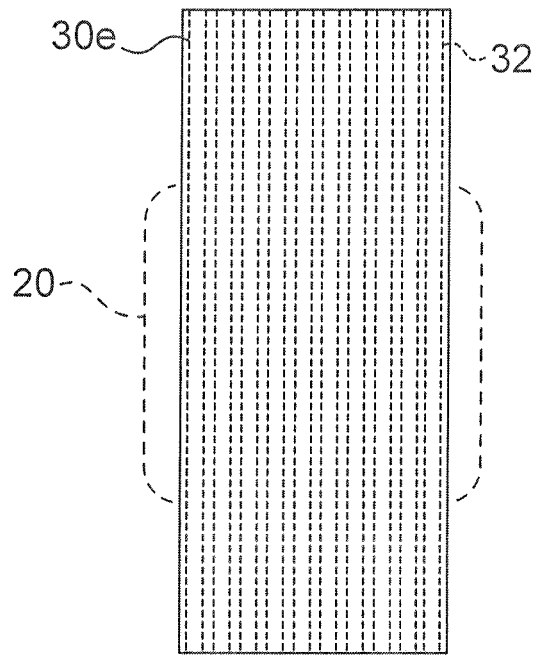


FIG. 12

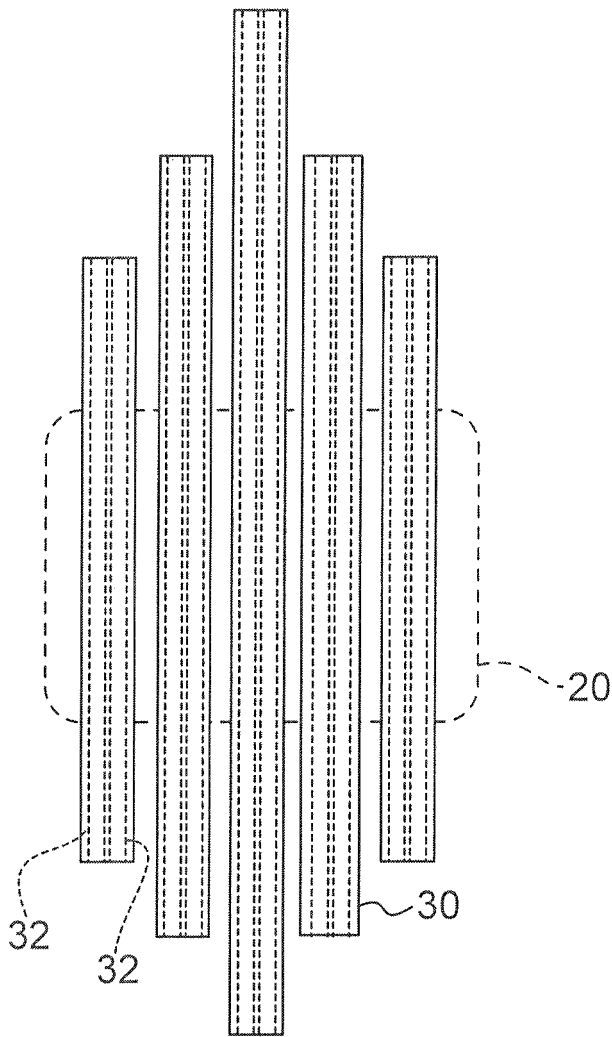


FIG. 13

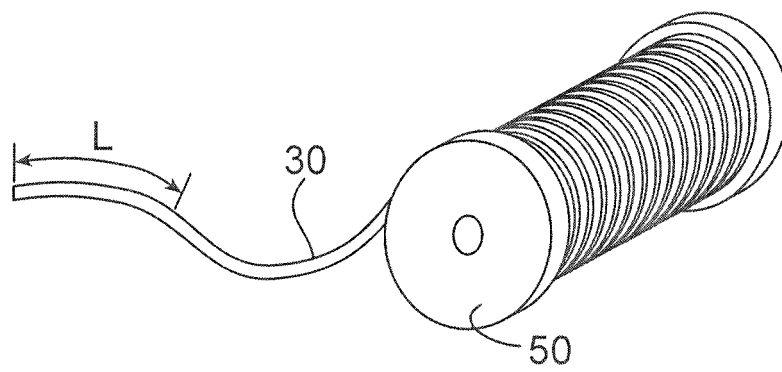


FIG. 14

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/68498

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(8) - B29C 73/00 (2008.04)

USPC - 152/367

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)  
USPC - 152/367

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
USPC - 29/402.01-402.04,402.06,402.08,428; 152/367,368,371,372

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
PubWest (PGPB,USPT,EPAB,JPAB); Google; Search terms used: Radial tire, cord, cable, groove, recess, repair, patch, fix, sidewall, shoulder, cement, adhesive, hole, opening, aperture, window

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 5,139,840 (Ferrara) 18 August 1992 (18.08.1992); Figs. 2 and 3; col 1, lns 46-49; col 2, lns 42-47; col 3, lns 10-24; col 4, lns 41-47.	1, 2, 4, 6-17, 19-22 and 24-27 ----- 3, 5, 18, 23, 28 and 29
Y	US 4,434,832 (Koch et al.) 06 March 1984 (06.03.1984); Figs. 1 and 2; col 1, lns 15-28; col 4, lns 22-24; col 5, lns 3-5.	3, 5, 18 and 29
Y	EP 0 279 901 A2 (Ferrara) 31 August 1988 (31.08.1988); Fig. 1a, 2 and 3; col 9, lns 6-10.	23, 28 and 29
A	US 5,695,577 (Ferrara) 9 December 1997 (09.12.1997); Entire document	1-29

Further documents are listed in the continuation of Box C.

<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p>
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<p>Date of the actual completion of the international search</p> <p>26 September 2008 (26.09.2008)</p>	<p>Date of mailing of the international search report</p> <p style="font-size: 1.5em; font-weight: bold;">02 OCT 2008</p>
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<p>Name and mailing address of the ISA/US</p> <p>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201</p>	<p>Authorized officer:</p> <p style="text-align: right;">Lee W. Young</p> <p>PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774</p>
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