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(54) **SOLE STRUCTURE FOR ARTICLE OF FOOTWEAR**

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(73) Assignee: **NIKE, Inc.**, Beaverton, OR (US)

(21) Appl. No.: **18/650,750**

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(51) **Int. Cl.**

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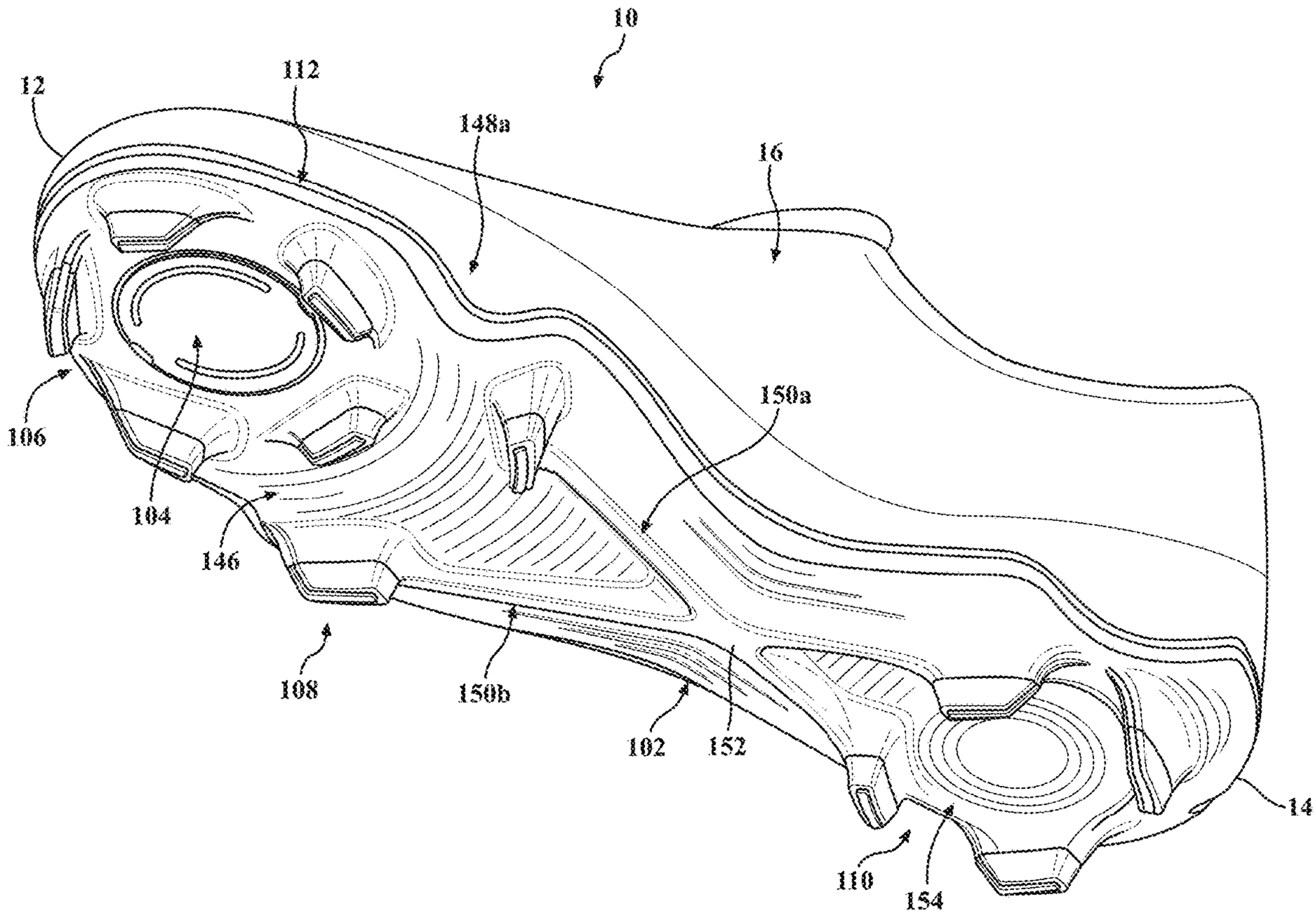
A43B 13/12	(2006.01)
A43C 15/02	(2006.01)

(52) **U.S. Cl.**

CPC ***A43C 15/162*** (2013.01); ***A43B 13/122*** (2013.01); ***A43C 15/02*** (2013.01)

(57) **ABSTRACT**

A sole structure for an article of footwear includes a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure. The sole structure further includes a first cleat set disposed in a forefoot region and having a first plurality of traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region. The sole structure also A second cleat set is disposed in a heel region of the sole structure and includes a second plurality of the traction elements arranged in a second annular pattern about a second axis disposed in the heel region.



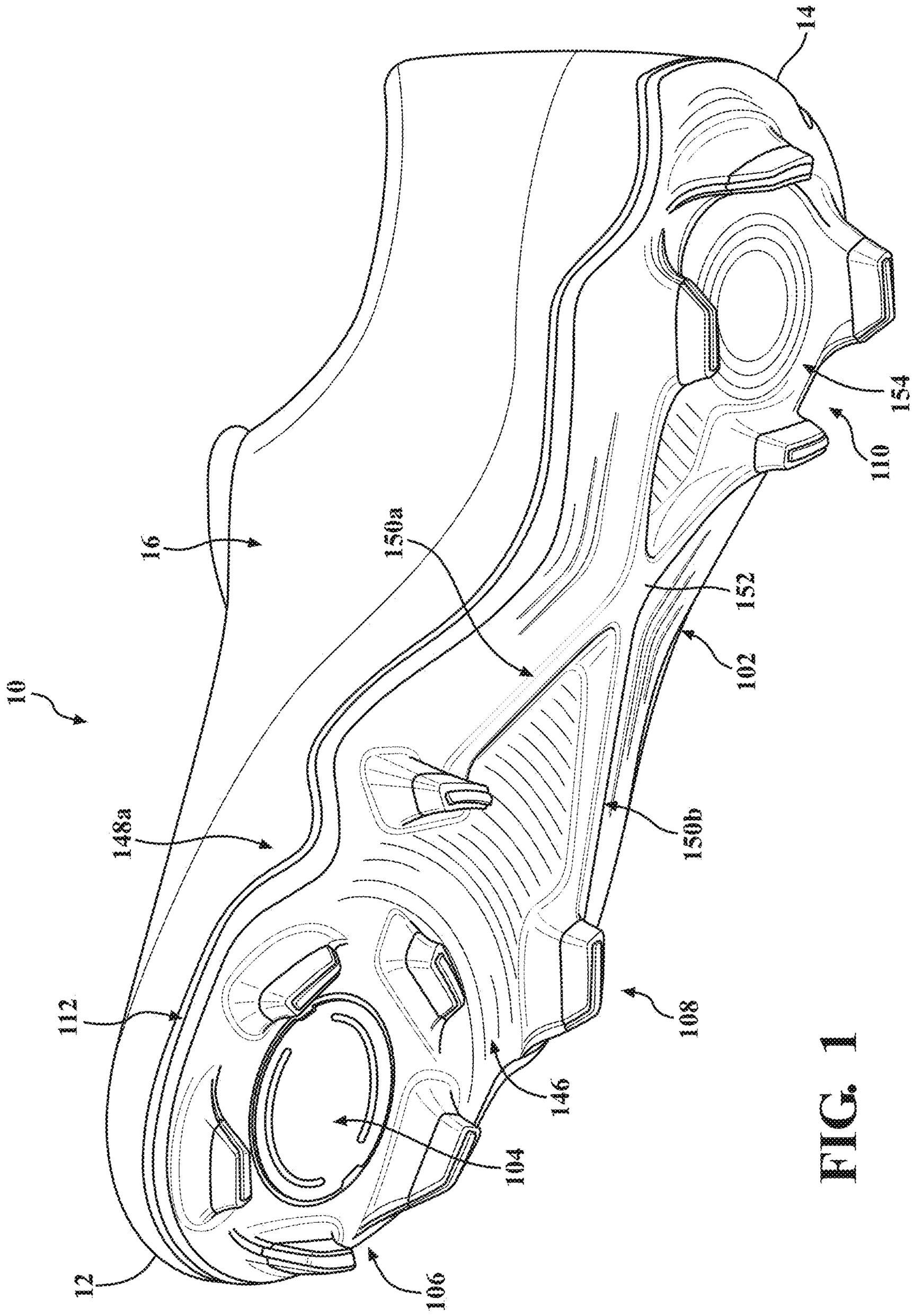


FIG. 1

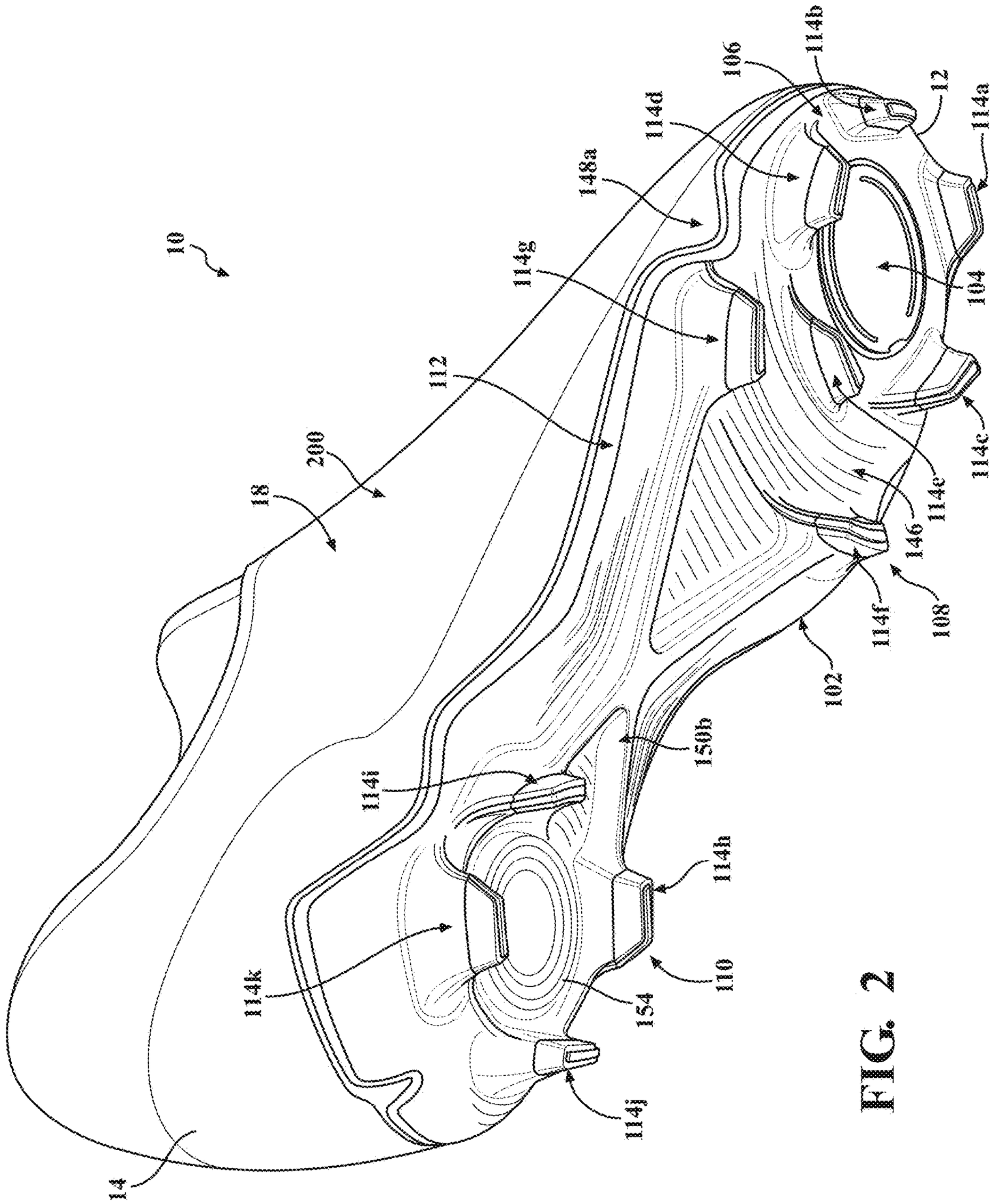

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FIG. 2

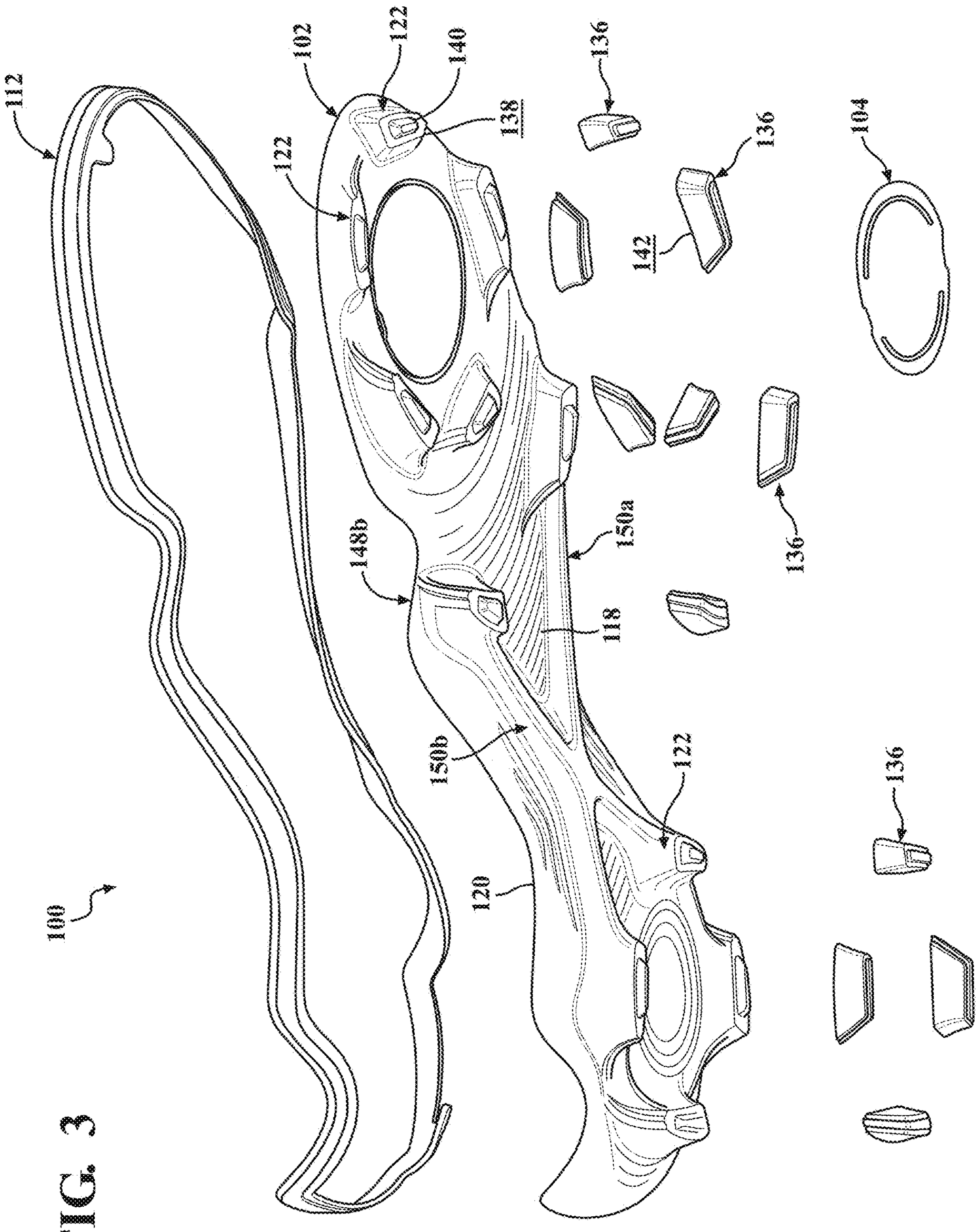

FIG. 3

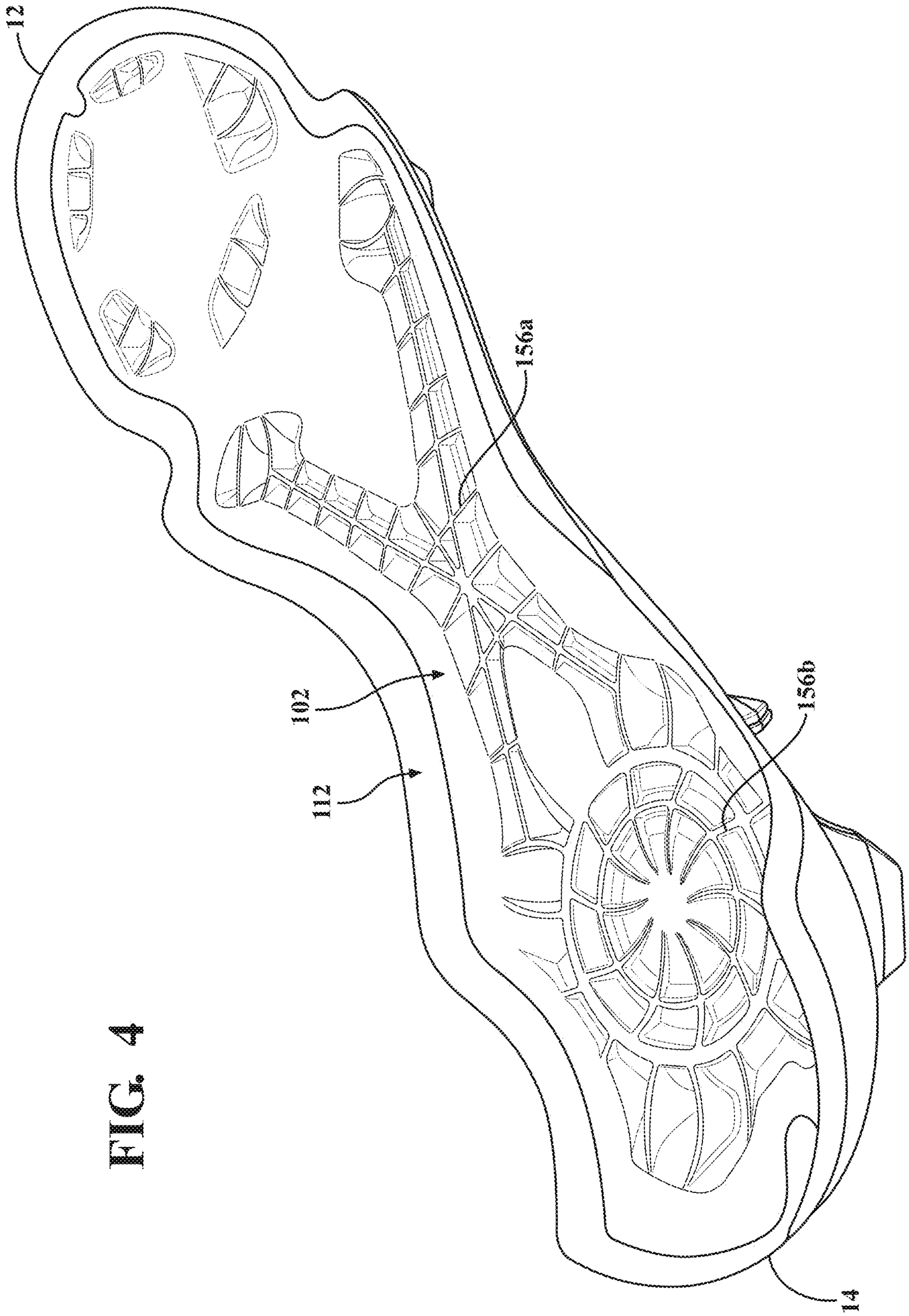

FIG. 4

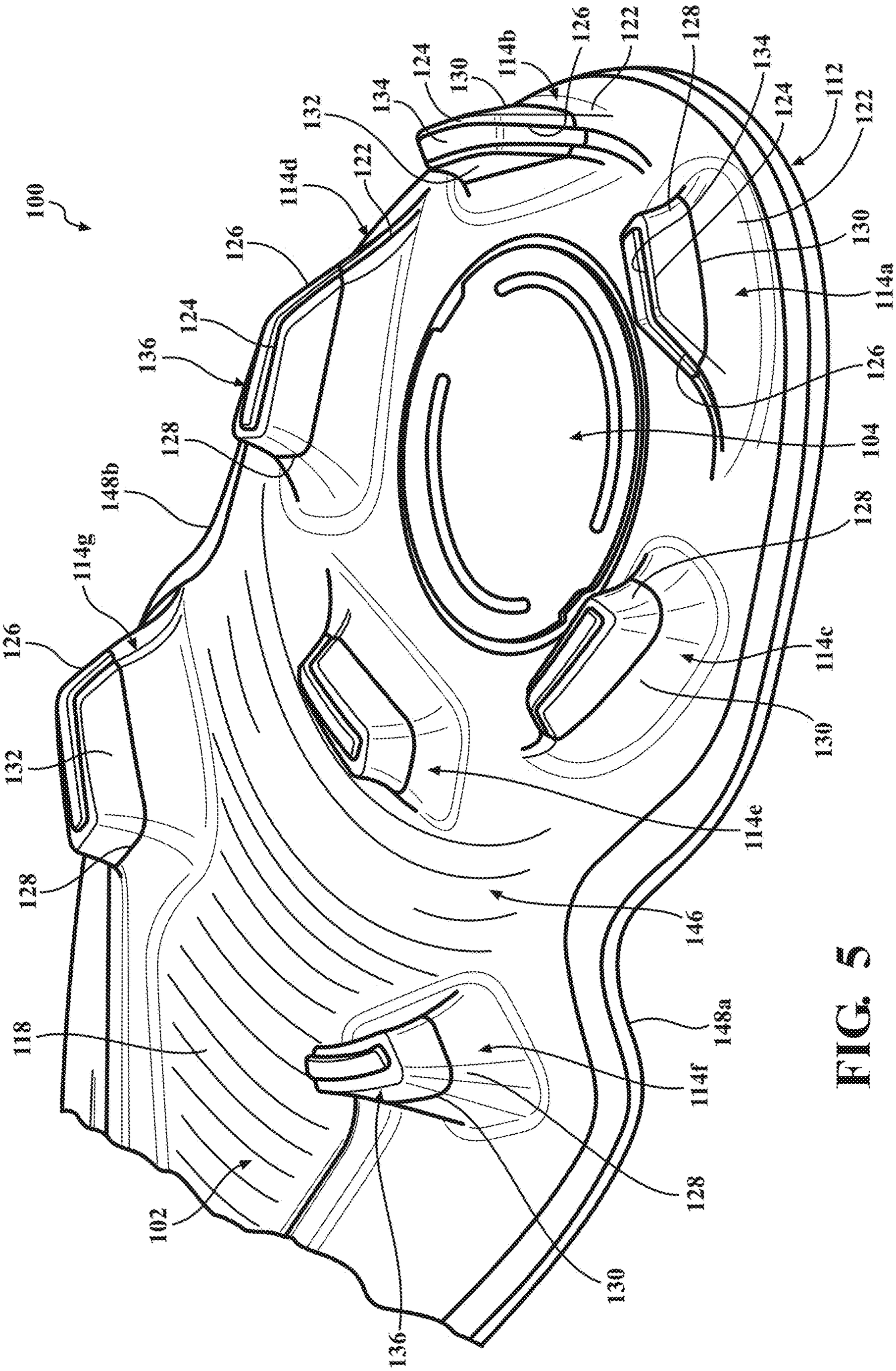
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FIG. 5

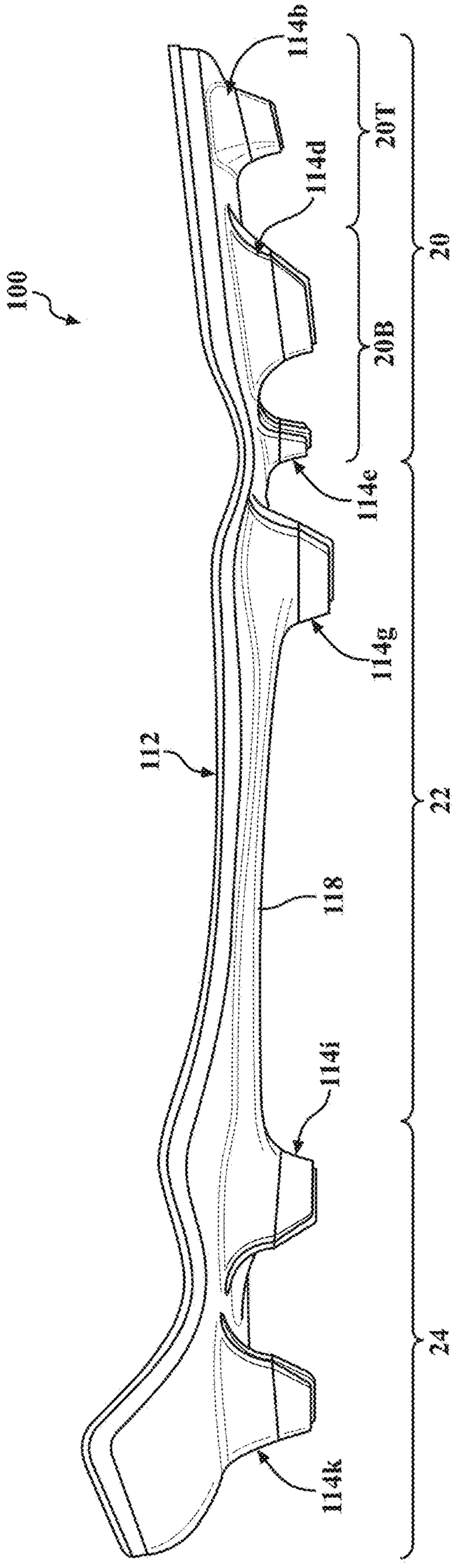
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FIG. 6

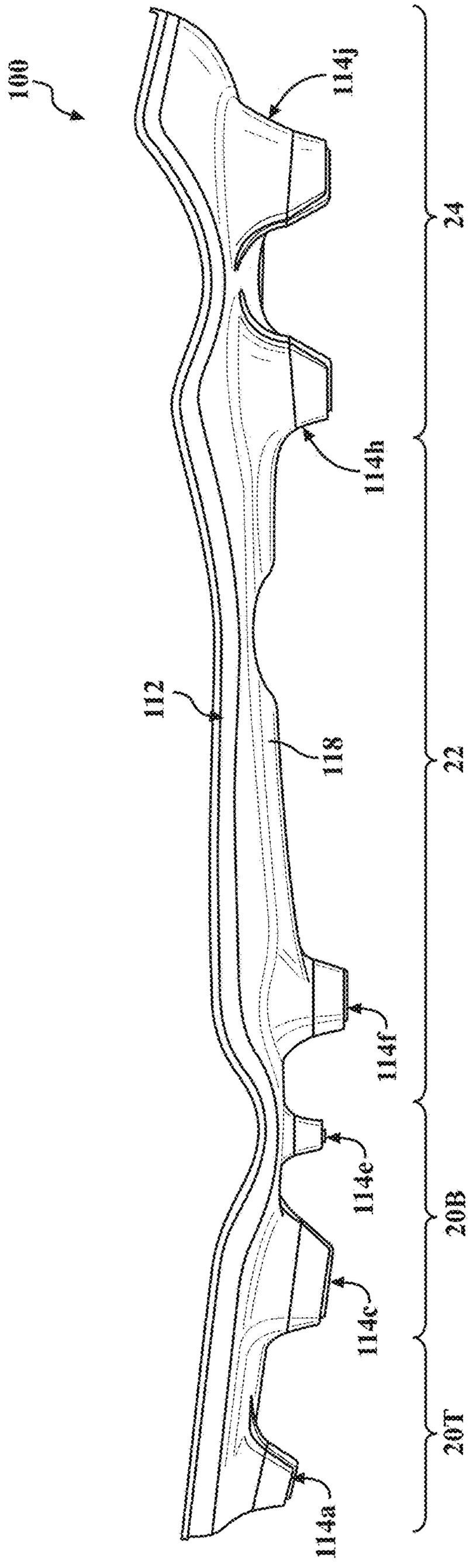
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FIG. 7

FIG. 8A

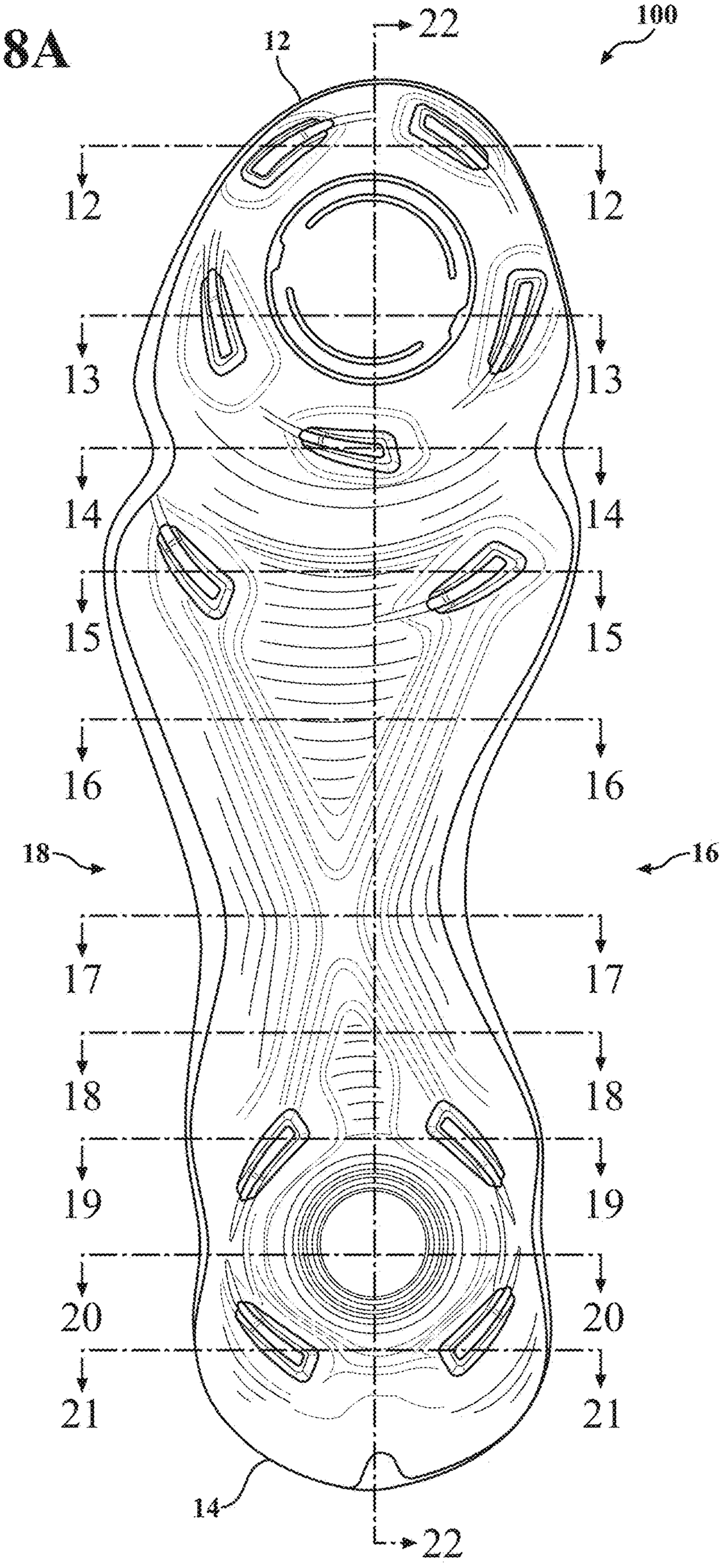
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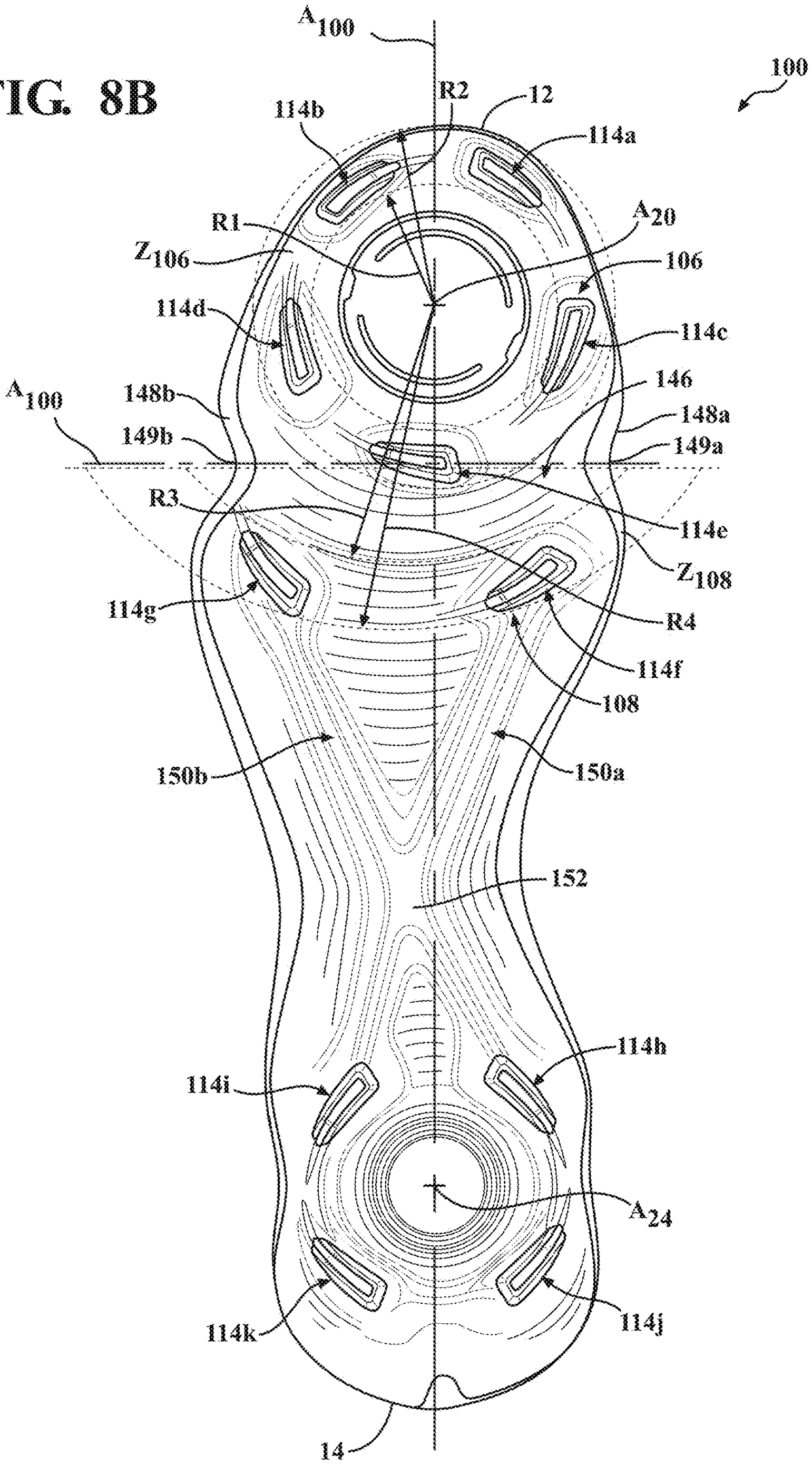
FIG. 8B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149b
149a
R3
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Z108
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R4
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114i
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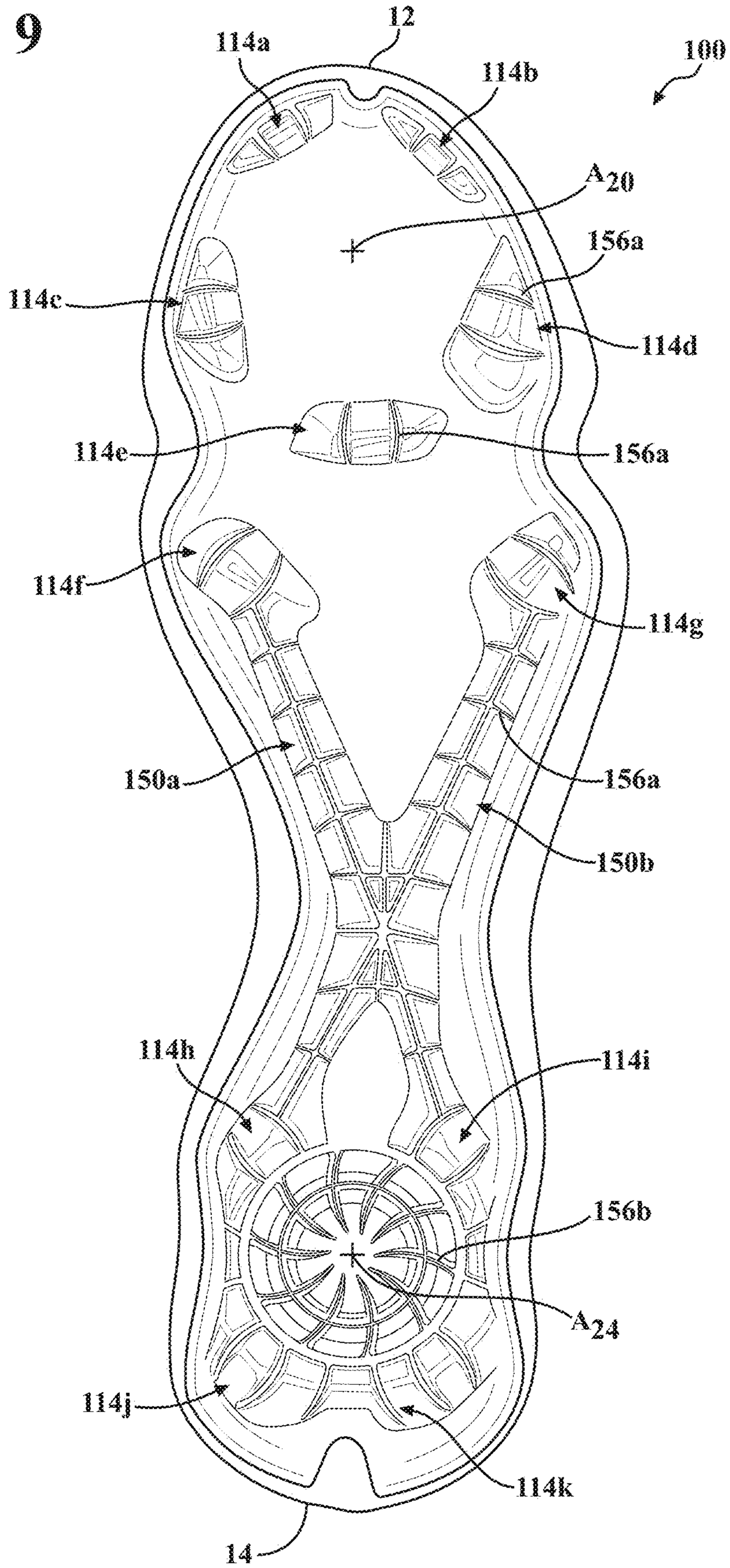
114k
114j
14

FIG. 9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114j
114k
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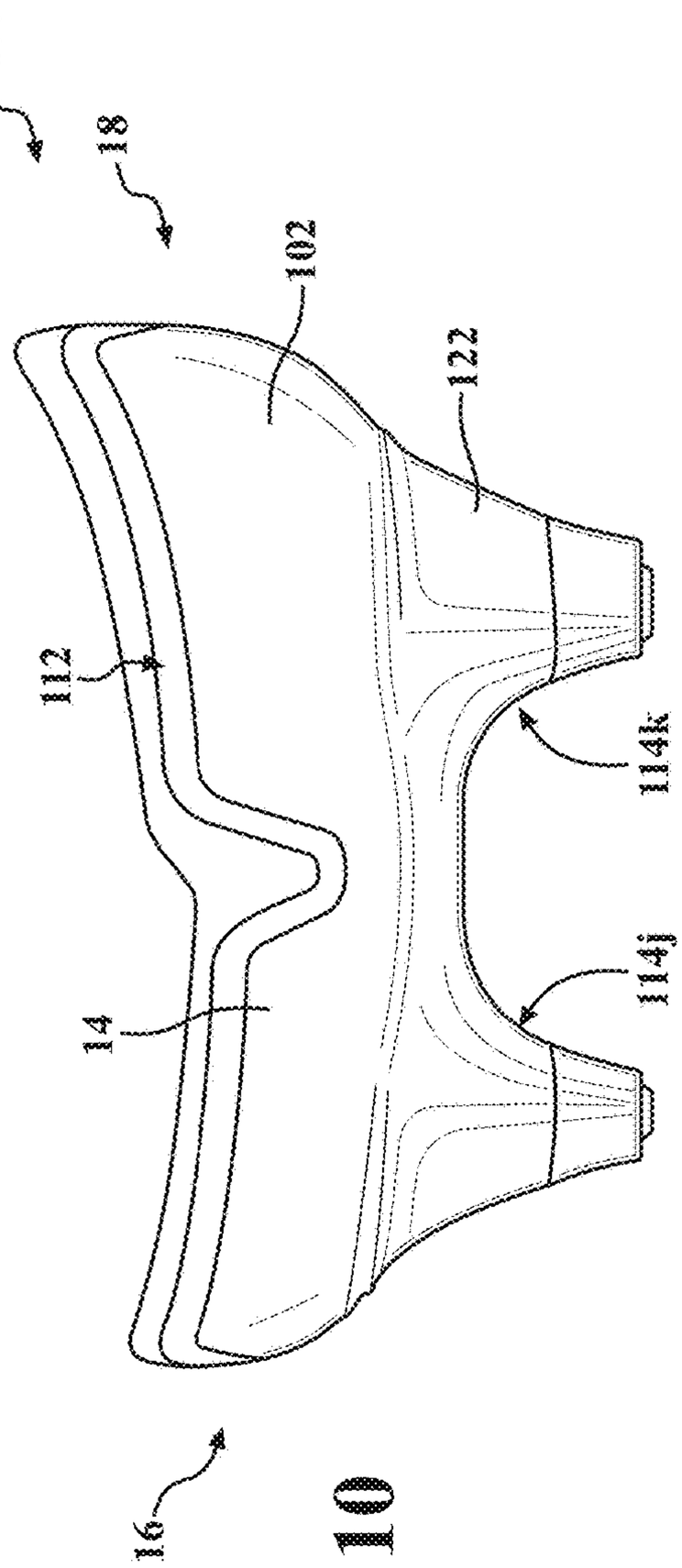
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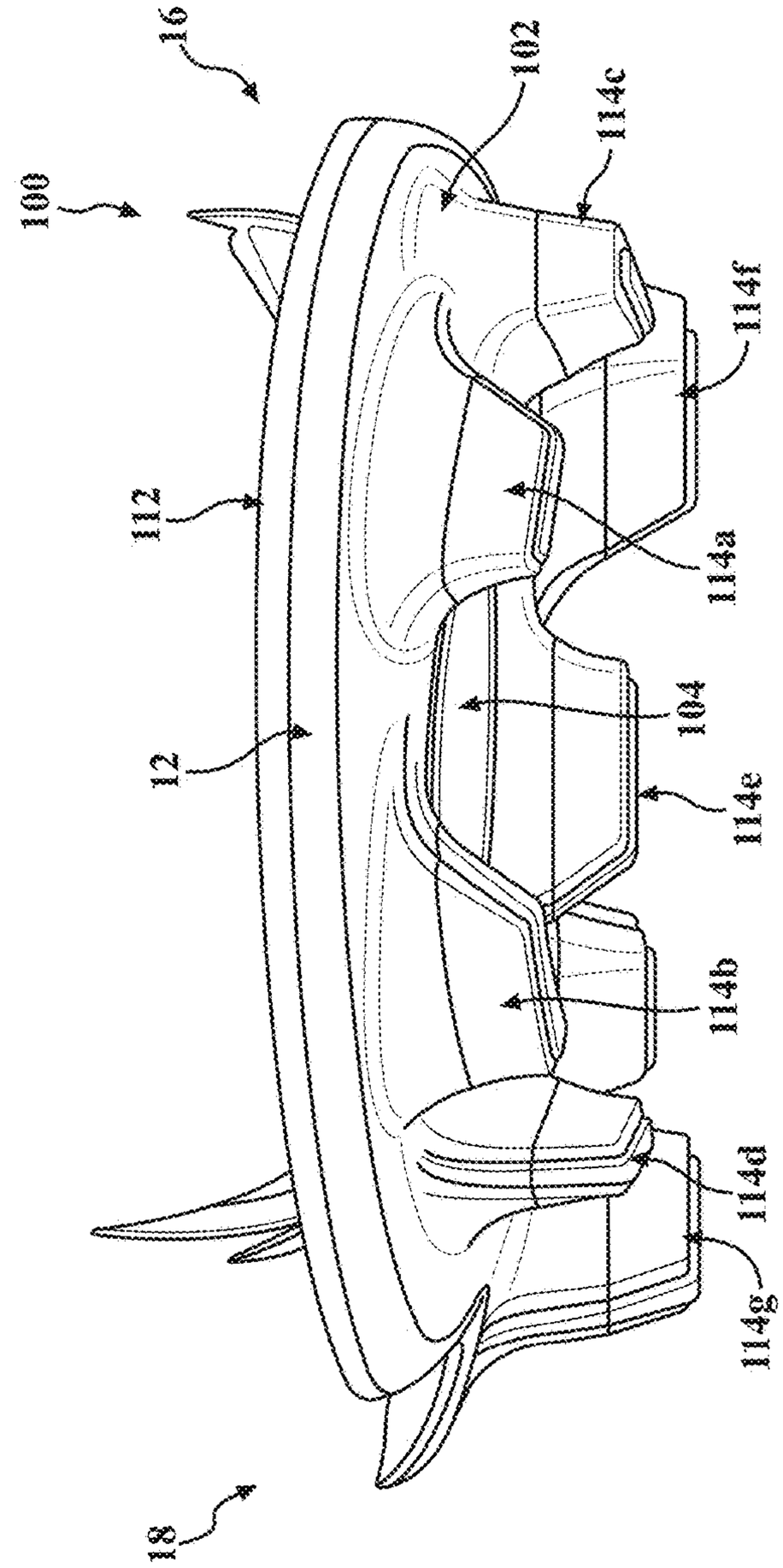
FIG. 10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114g
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FIG. 11

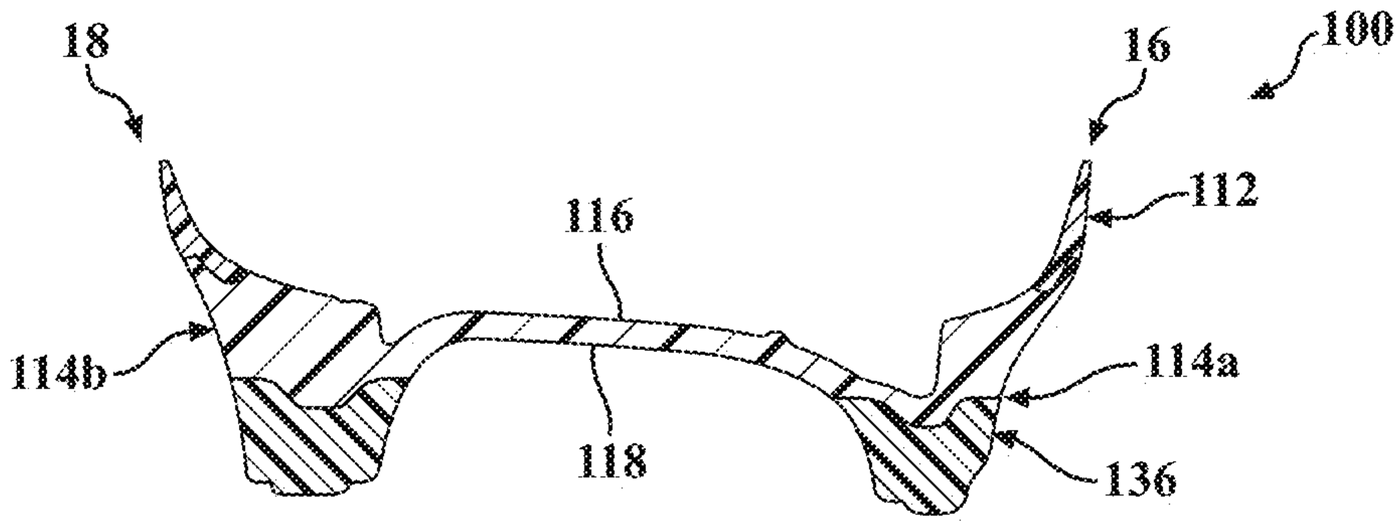


FIG. 12

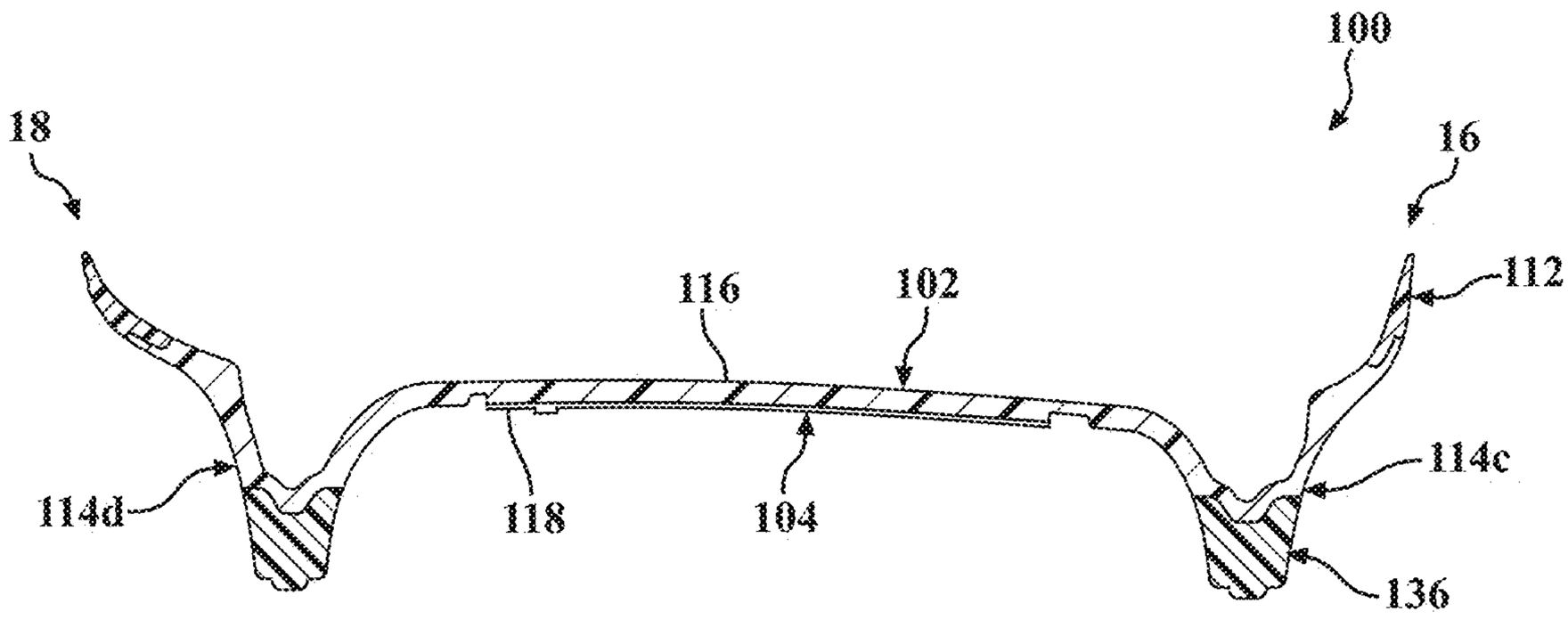


FIG. 13

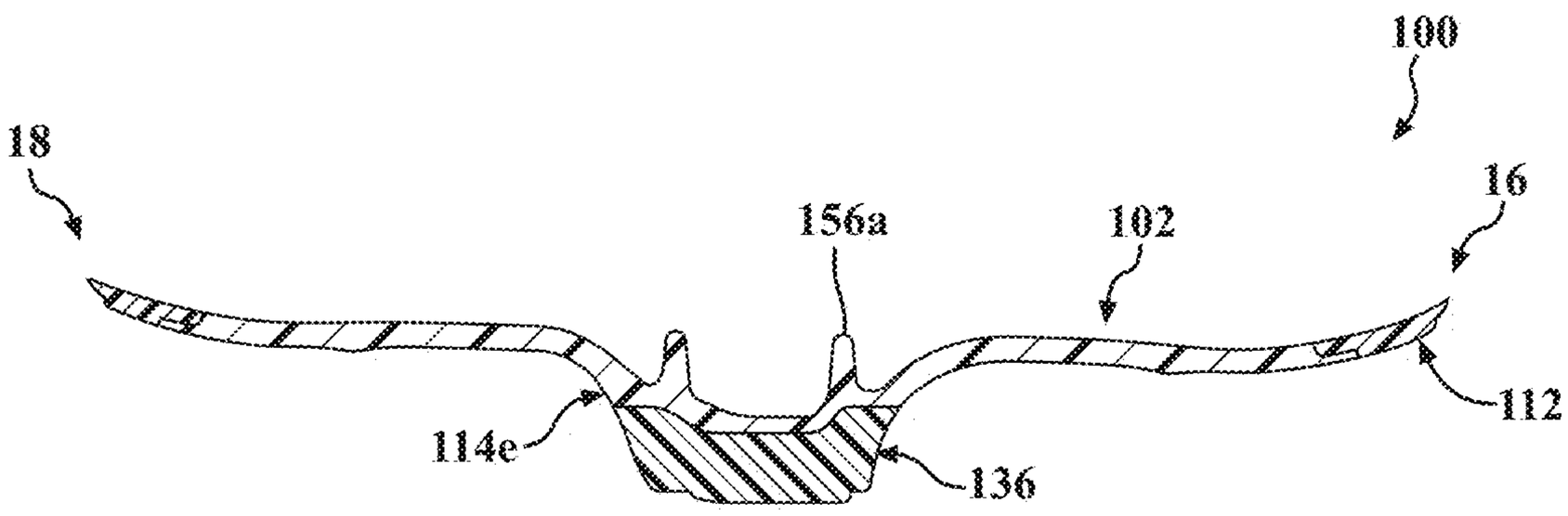


FIG. 14

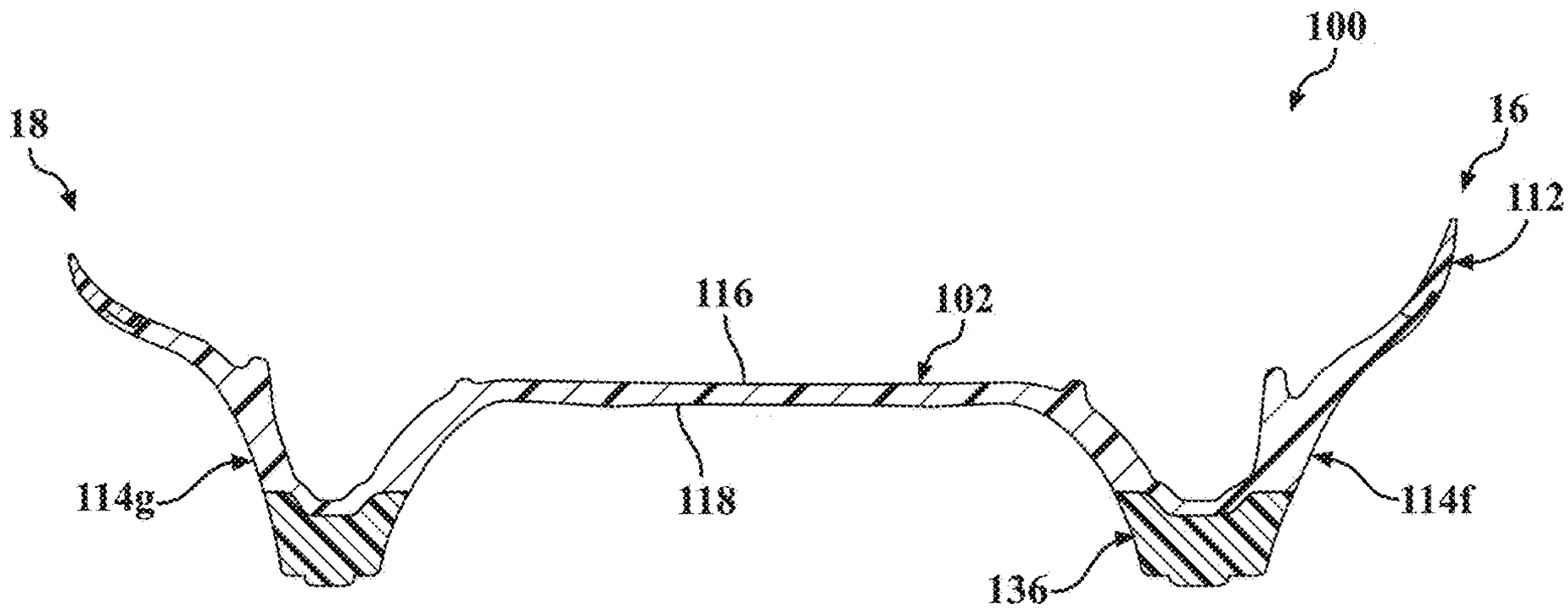
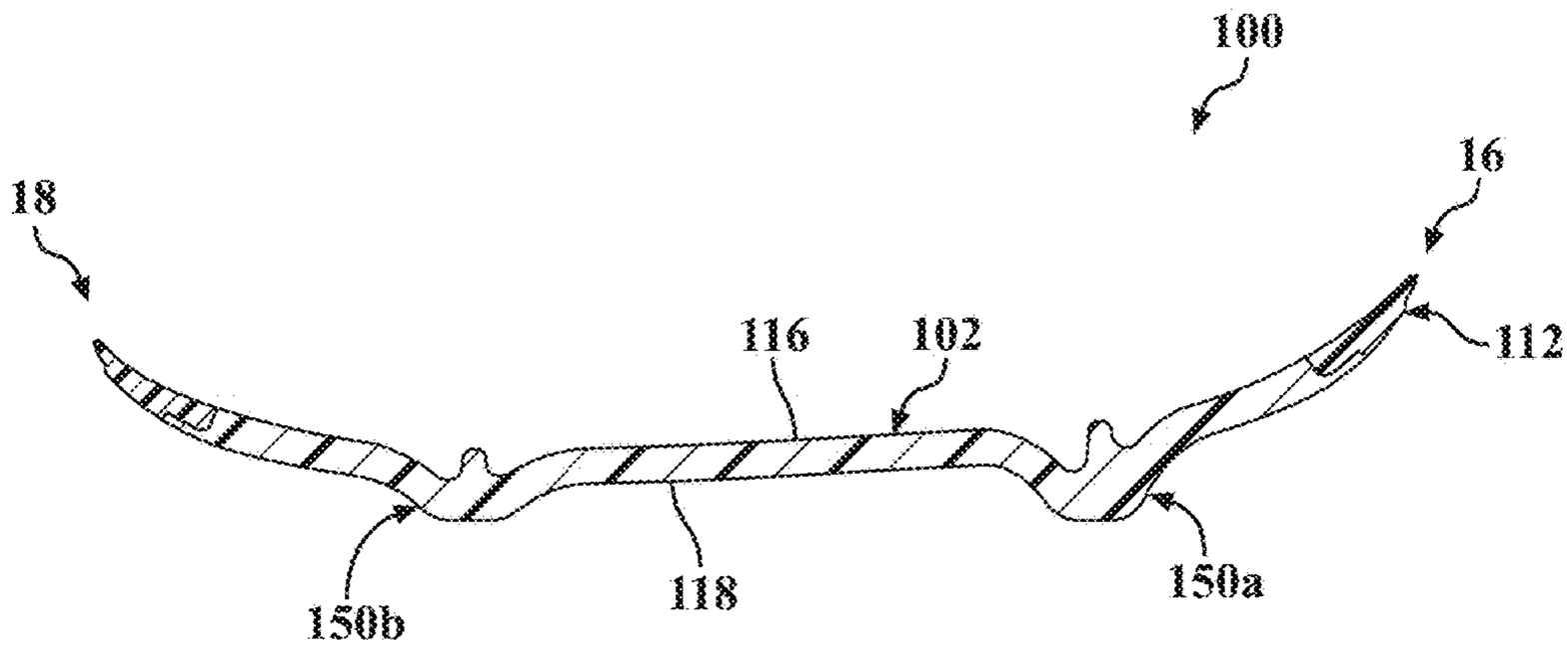


FIG. 15



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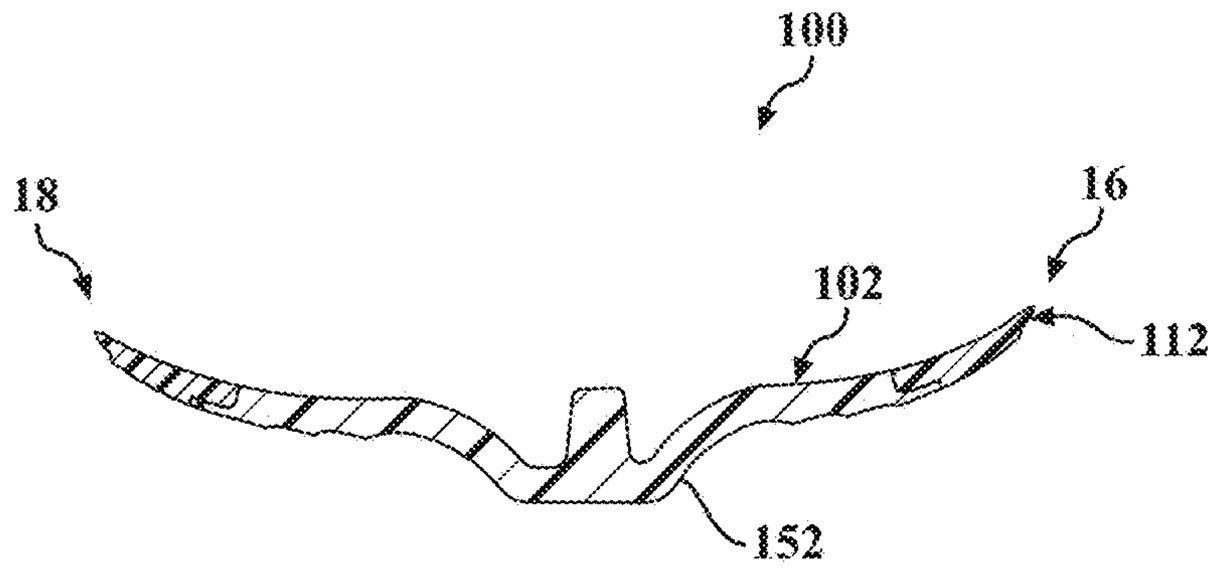

FIG. 17

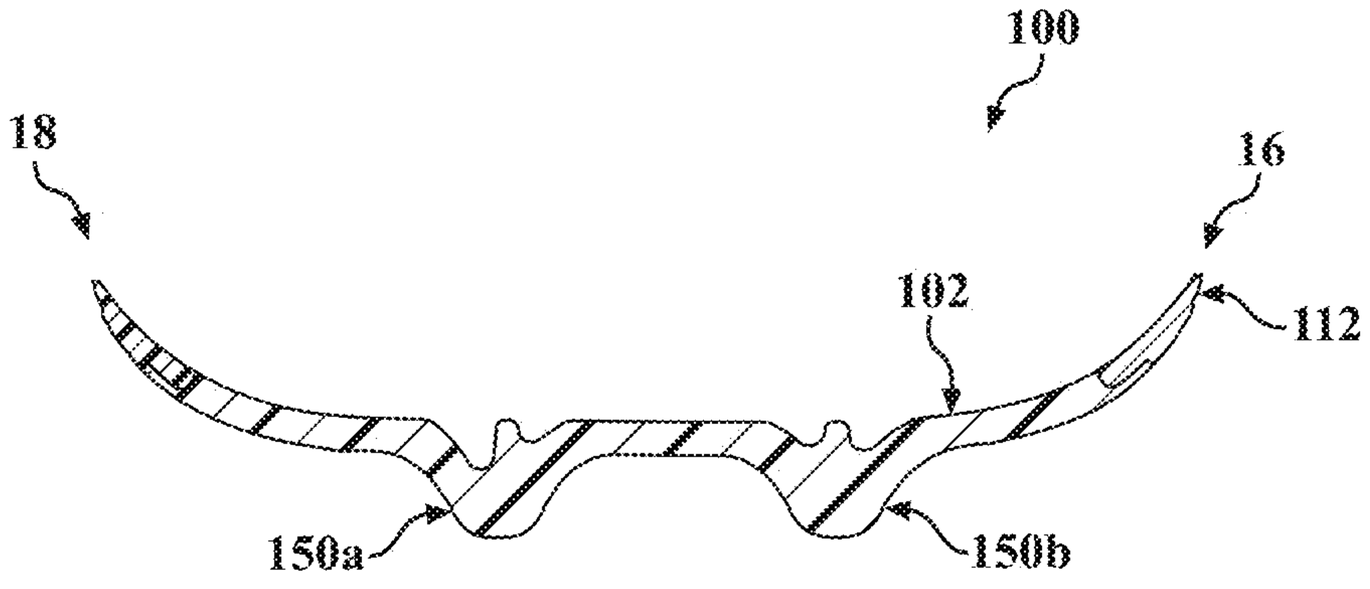

FIG. 18

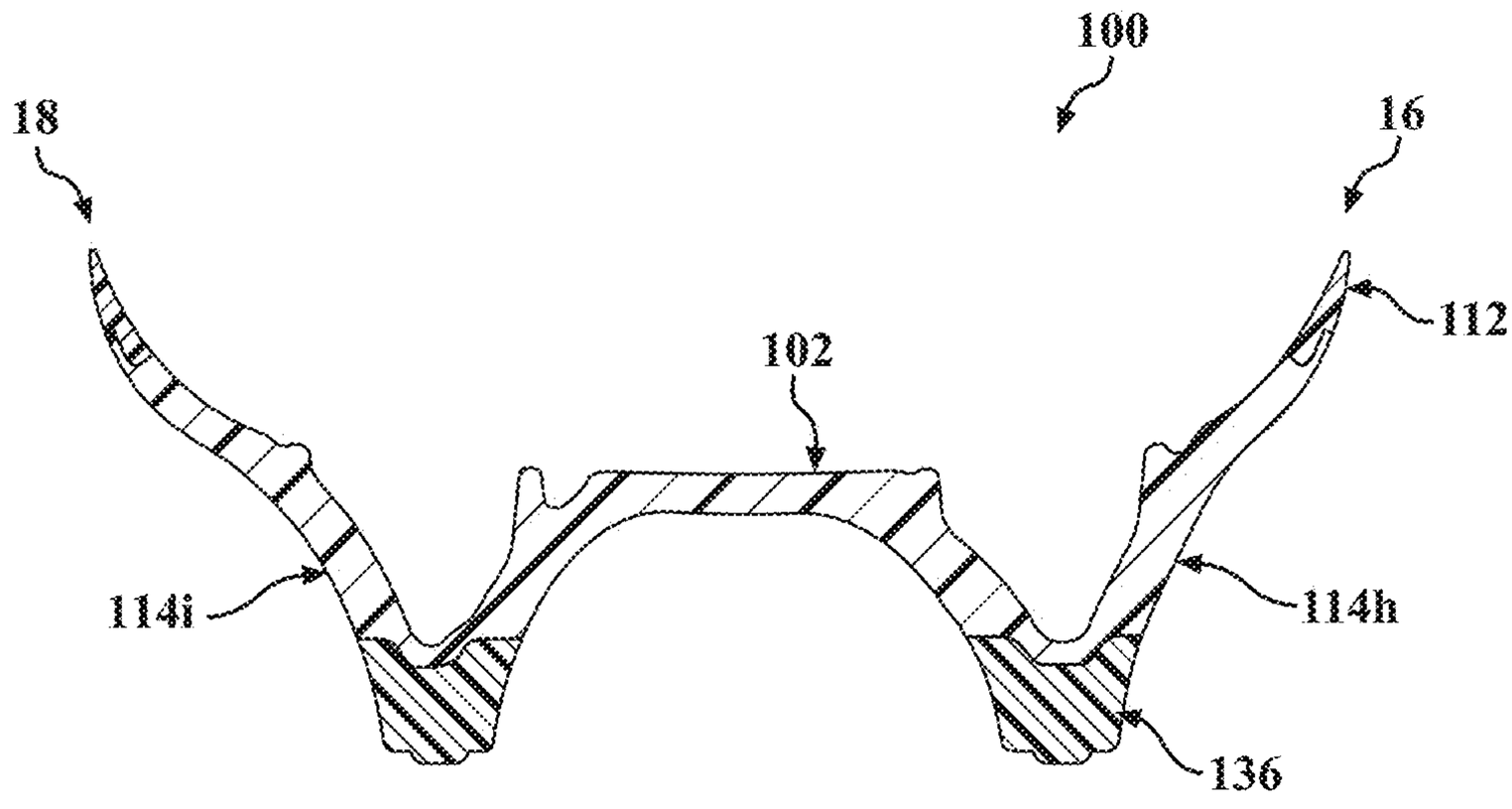

FIG. 19

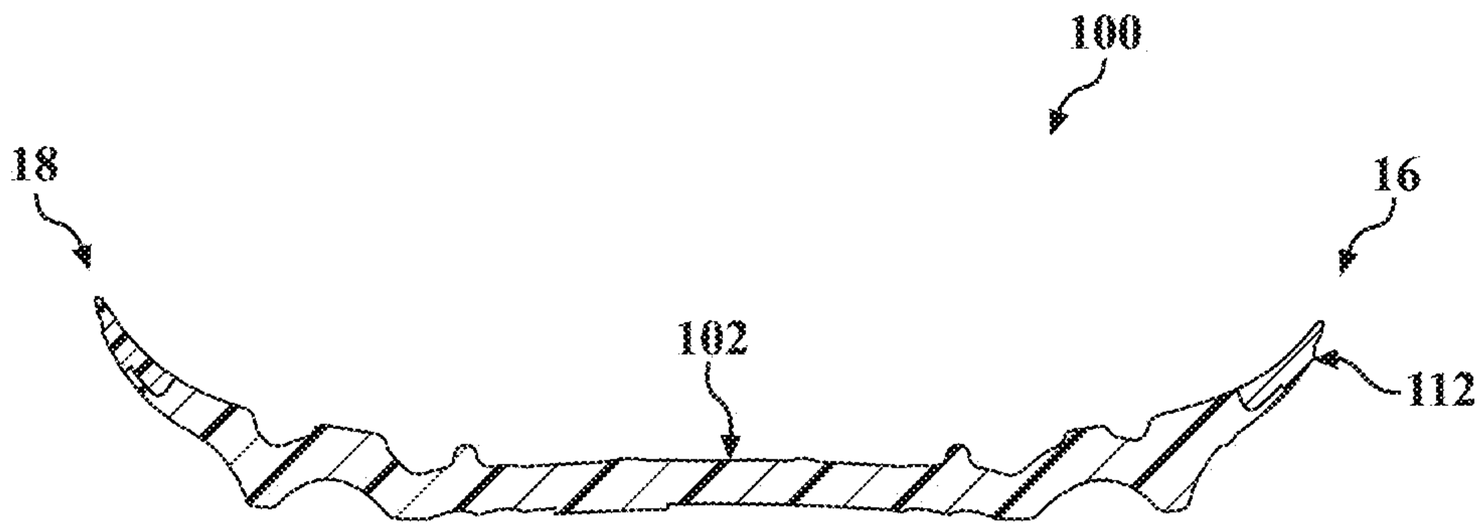

FIG. 20

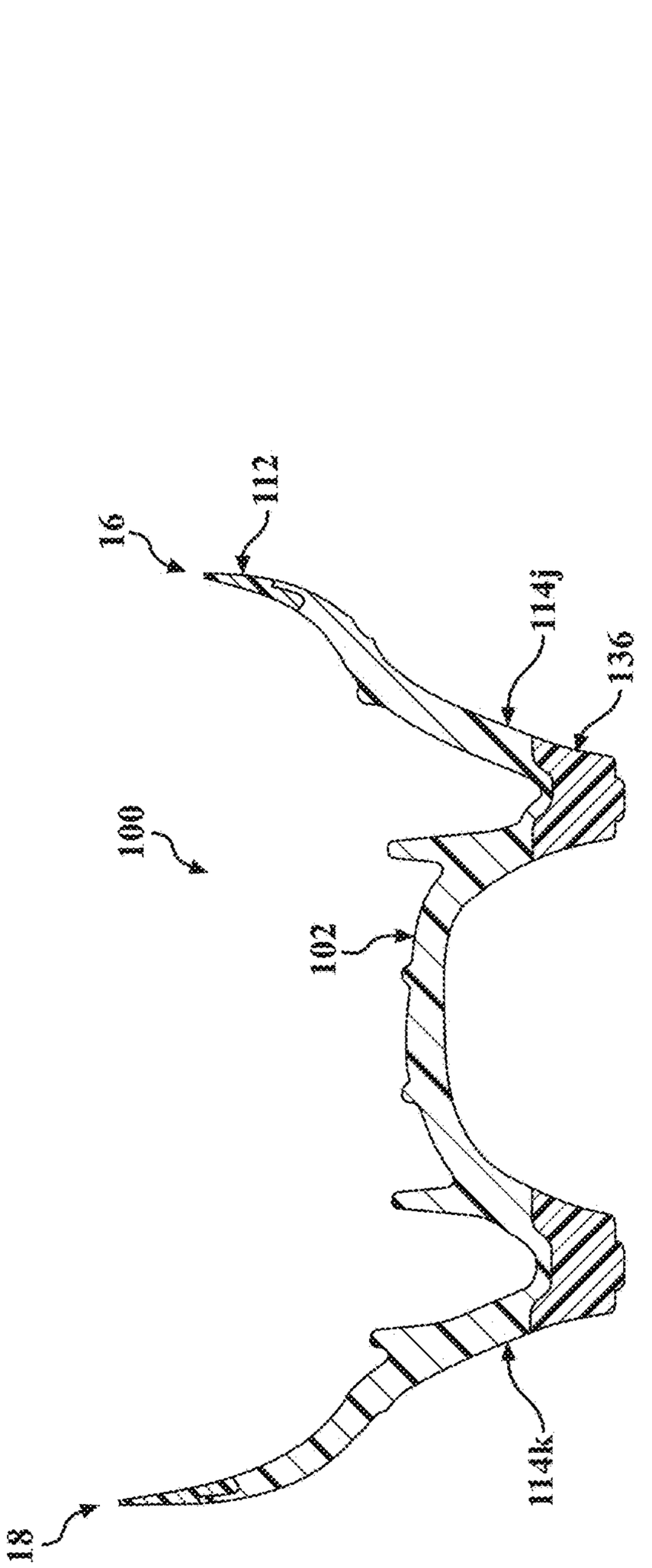

FIG. 21

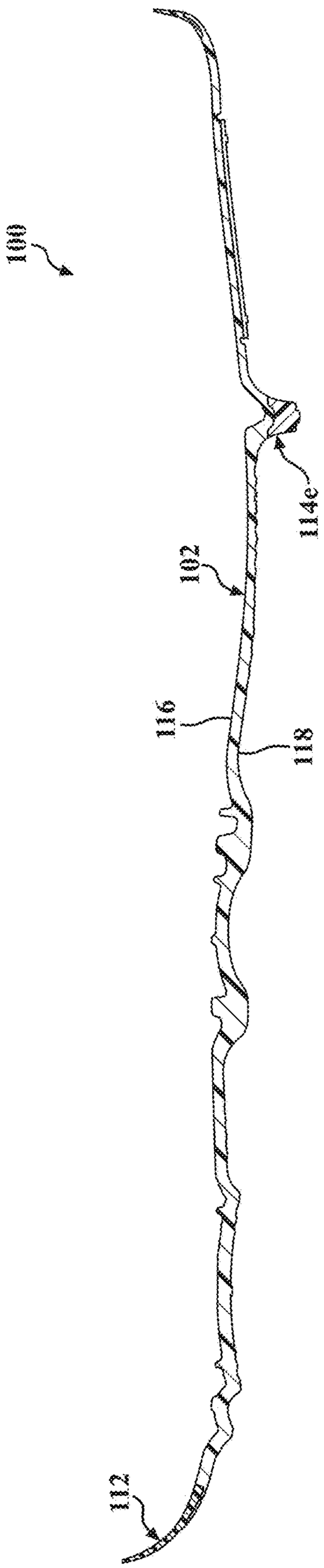

FIG. 22

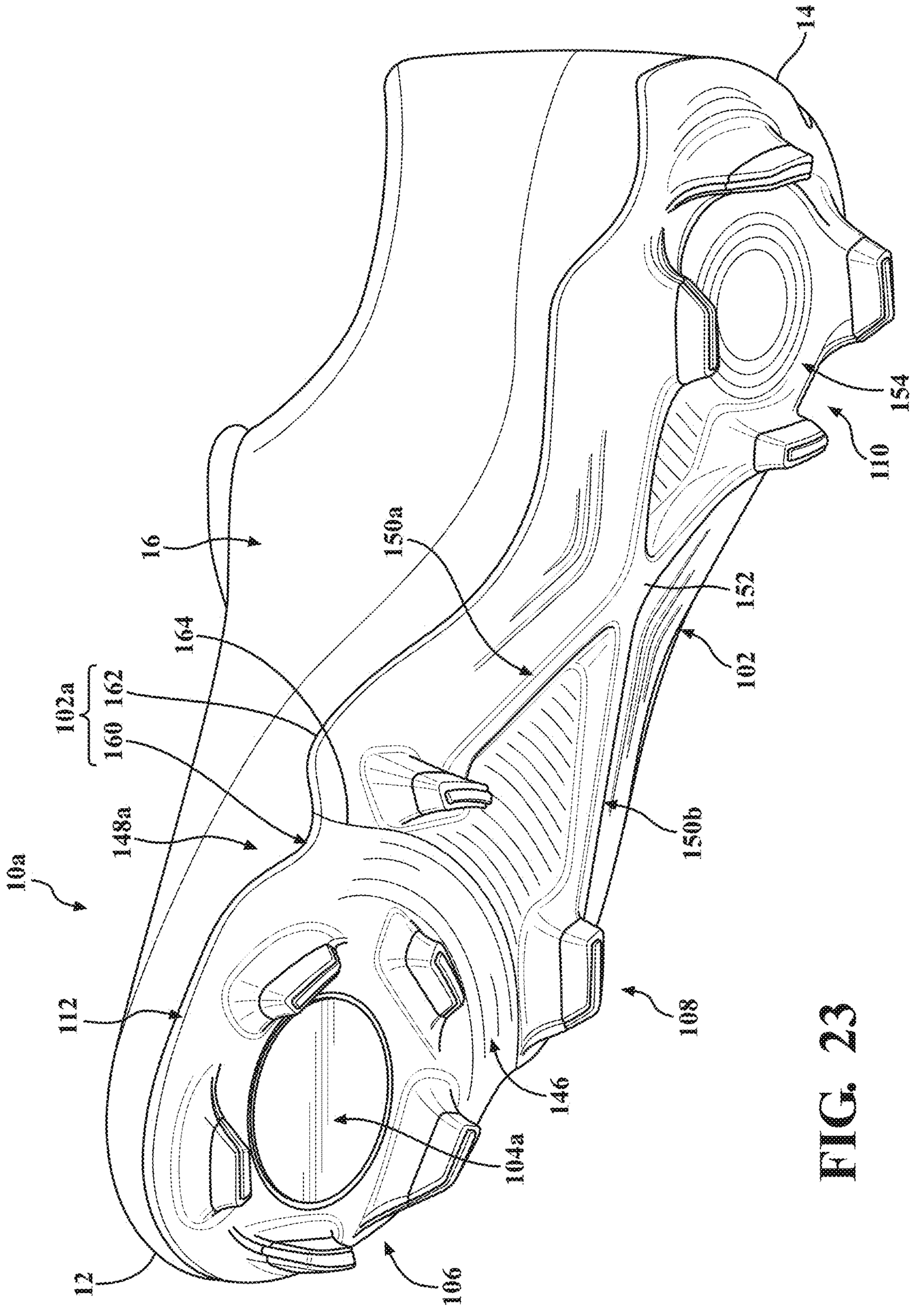
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FIG. 23

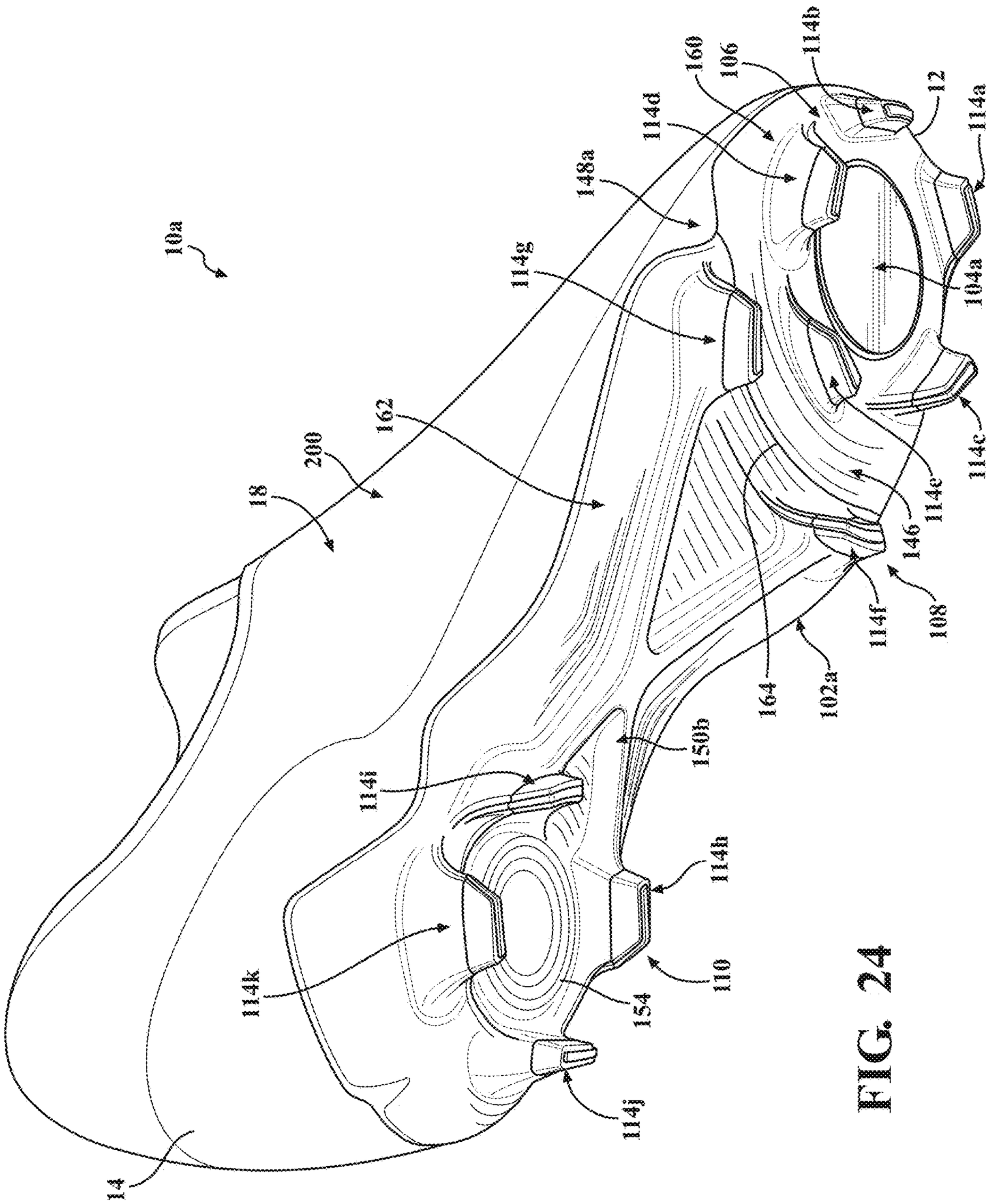
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FIG. 24

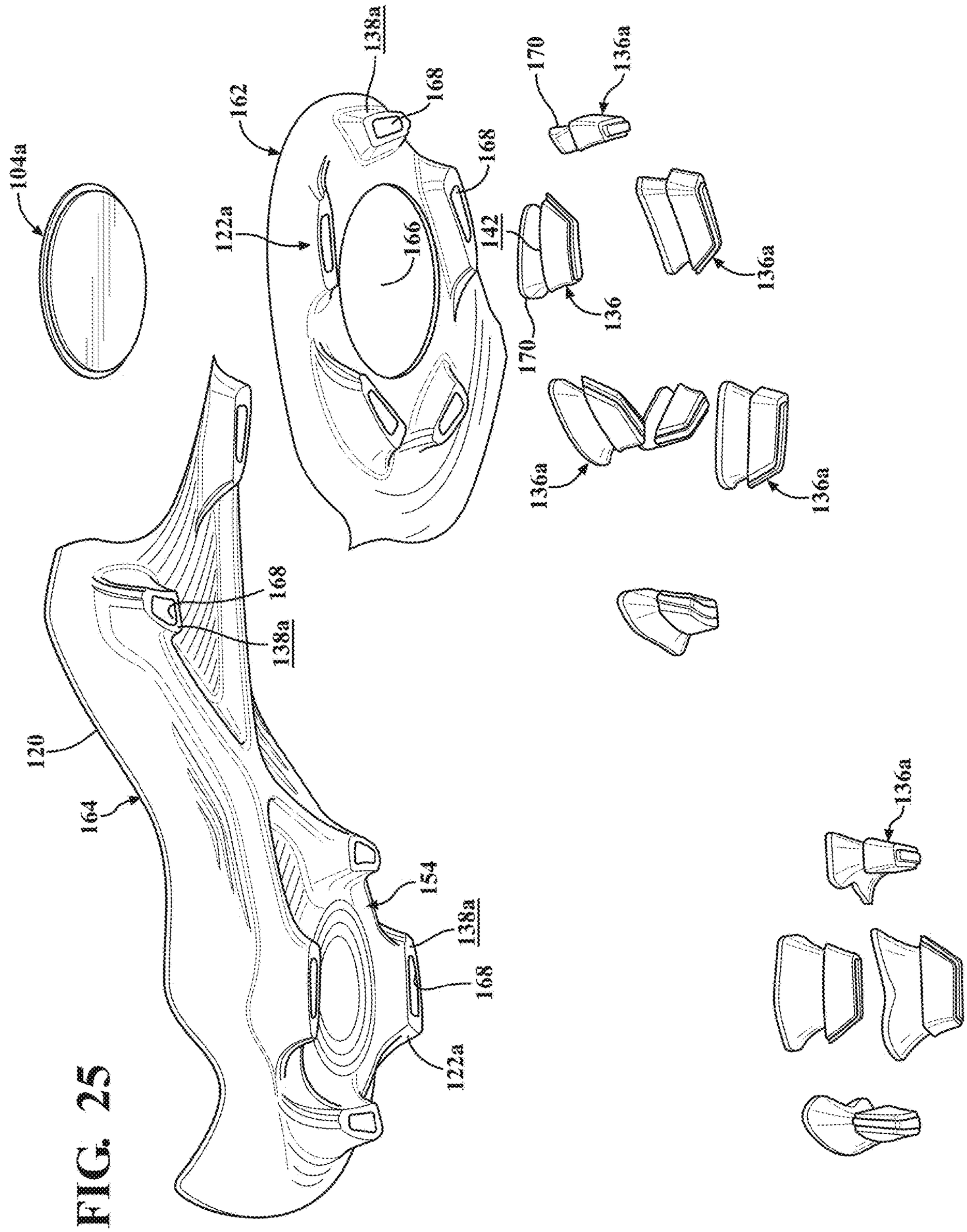
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FIG. 25

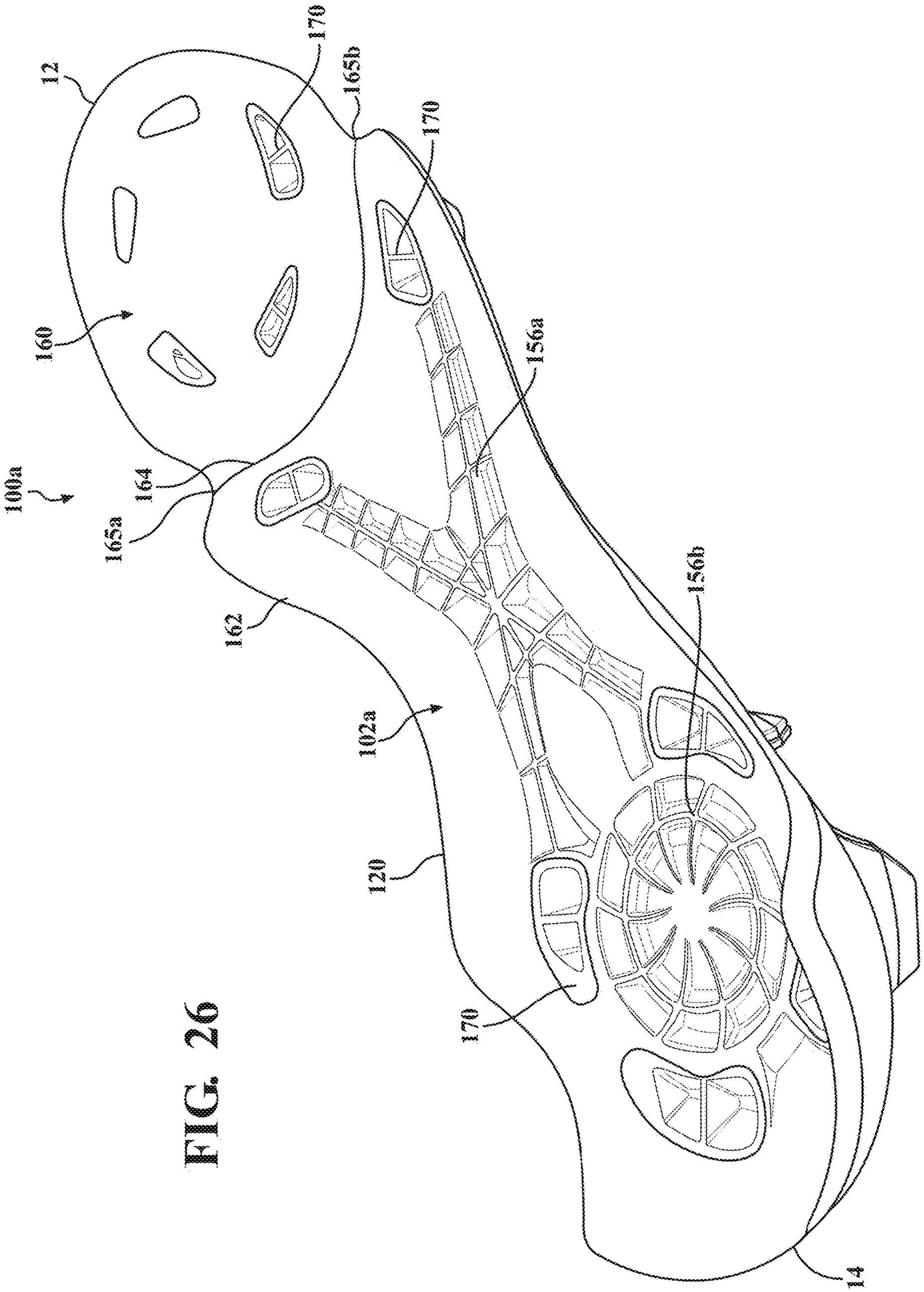

FIG. 26

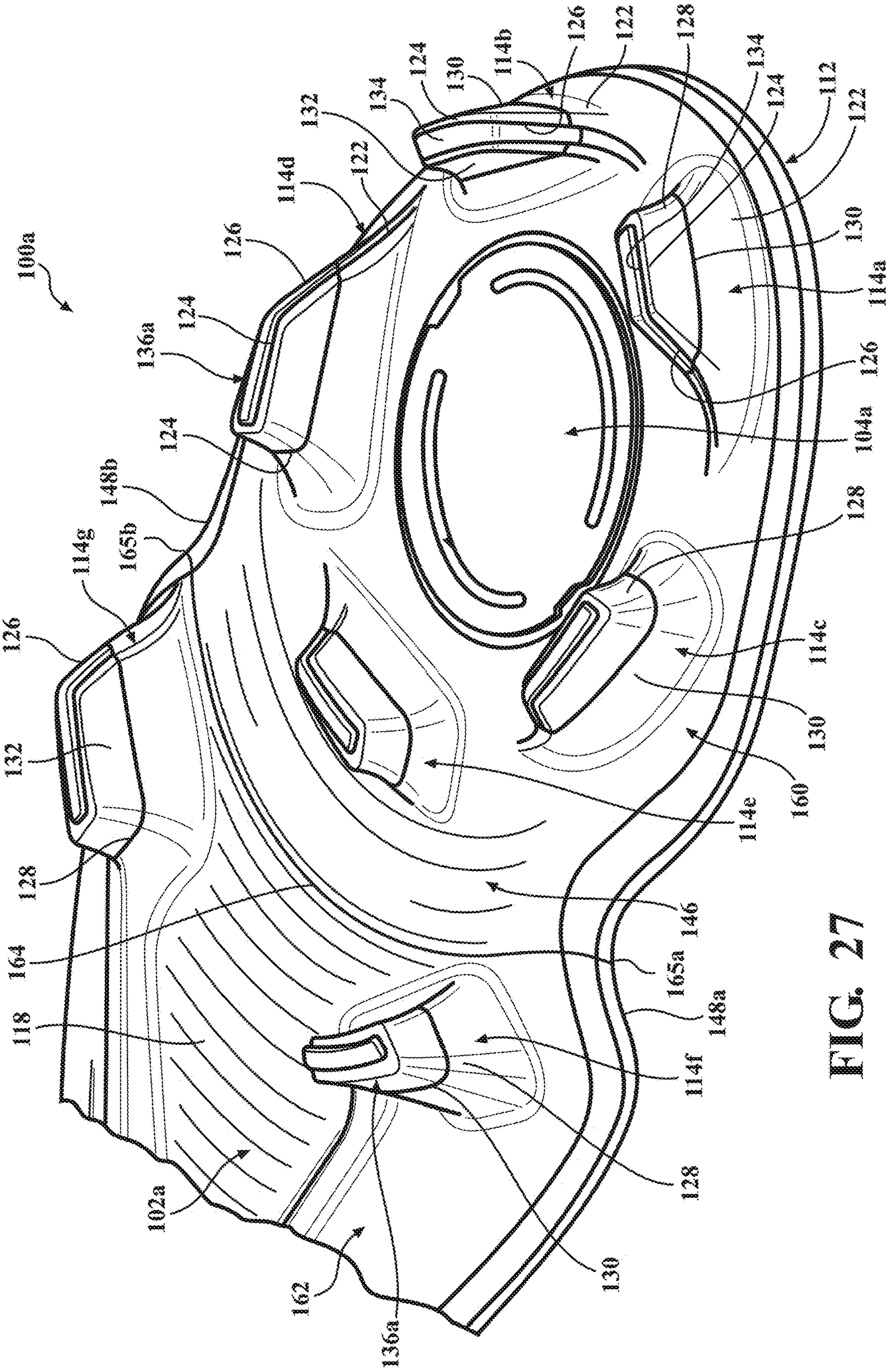
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FIG. 27

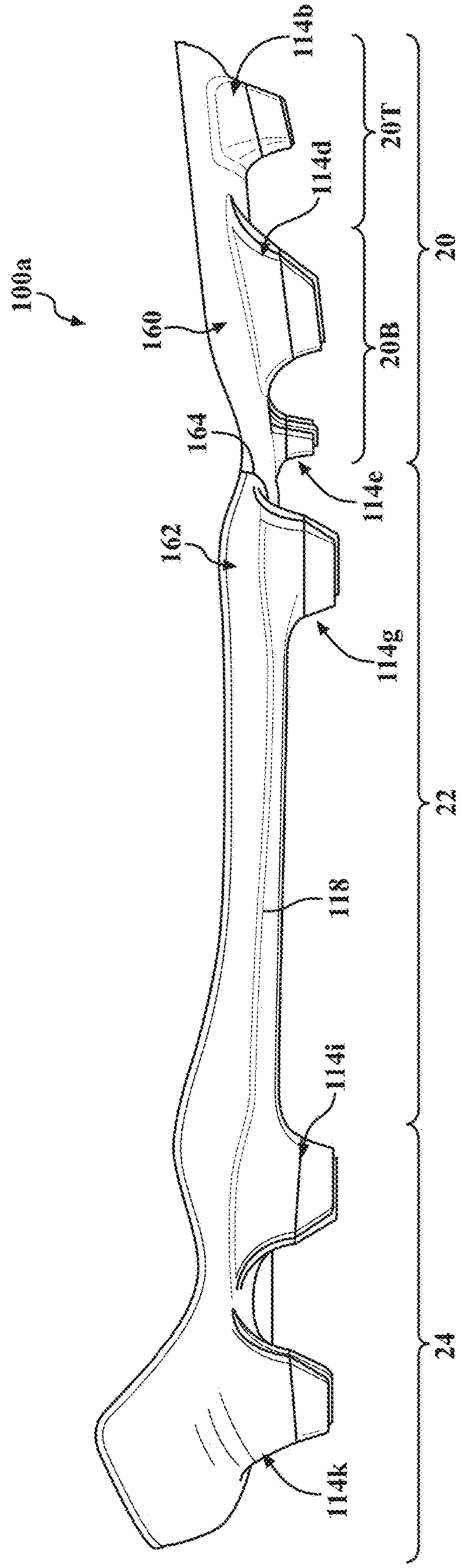
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FIG. 28

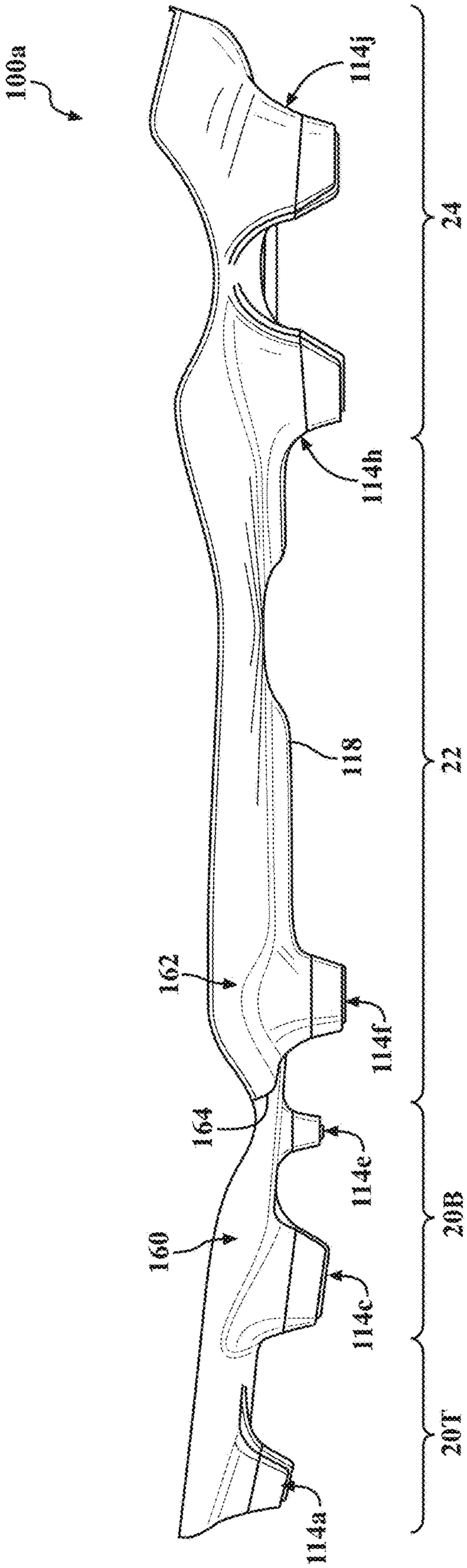
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FIG. 29

FIG. 30A

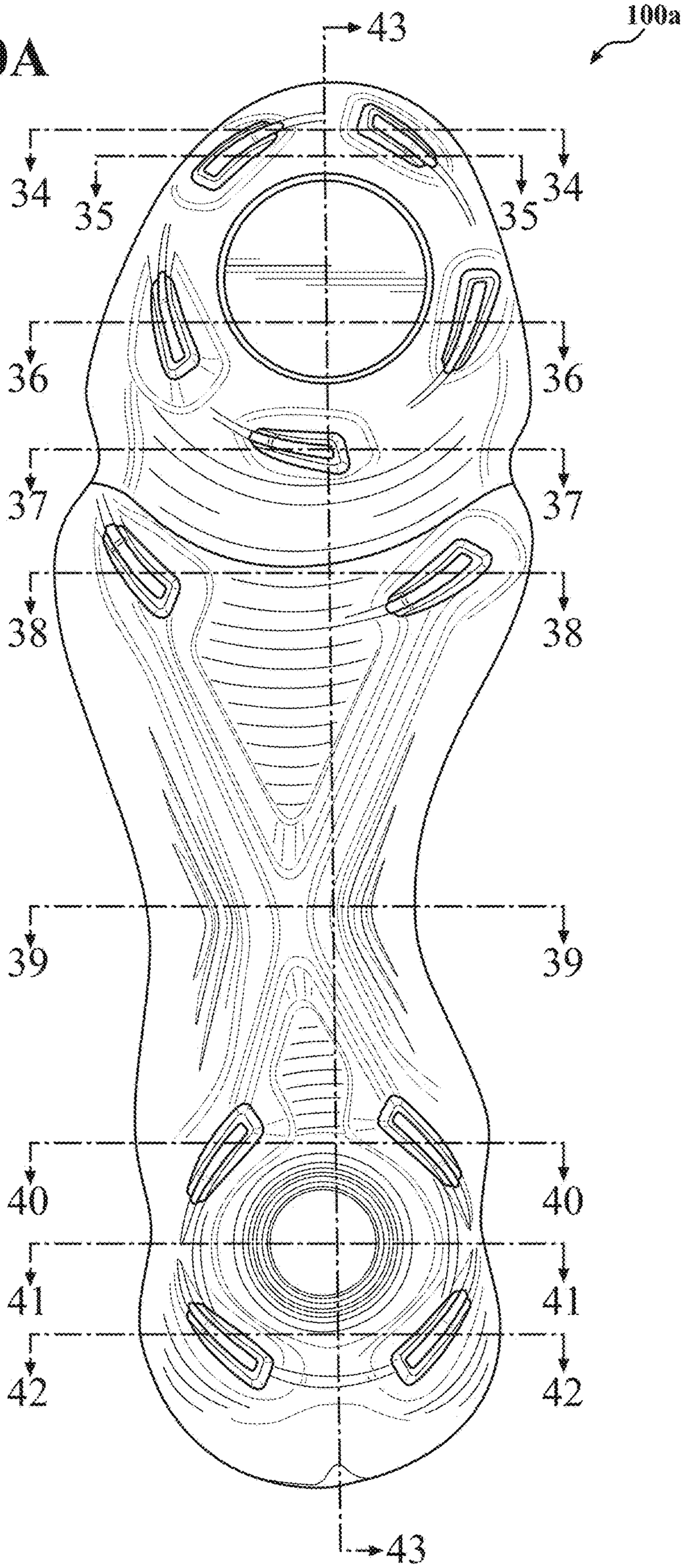
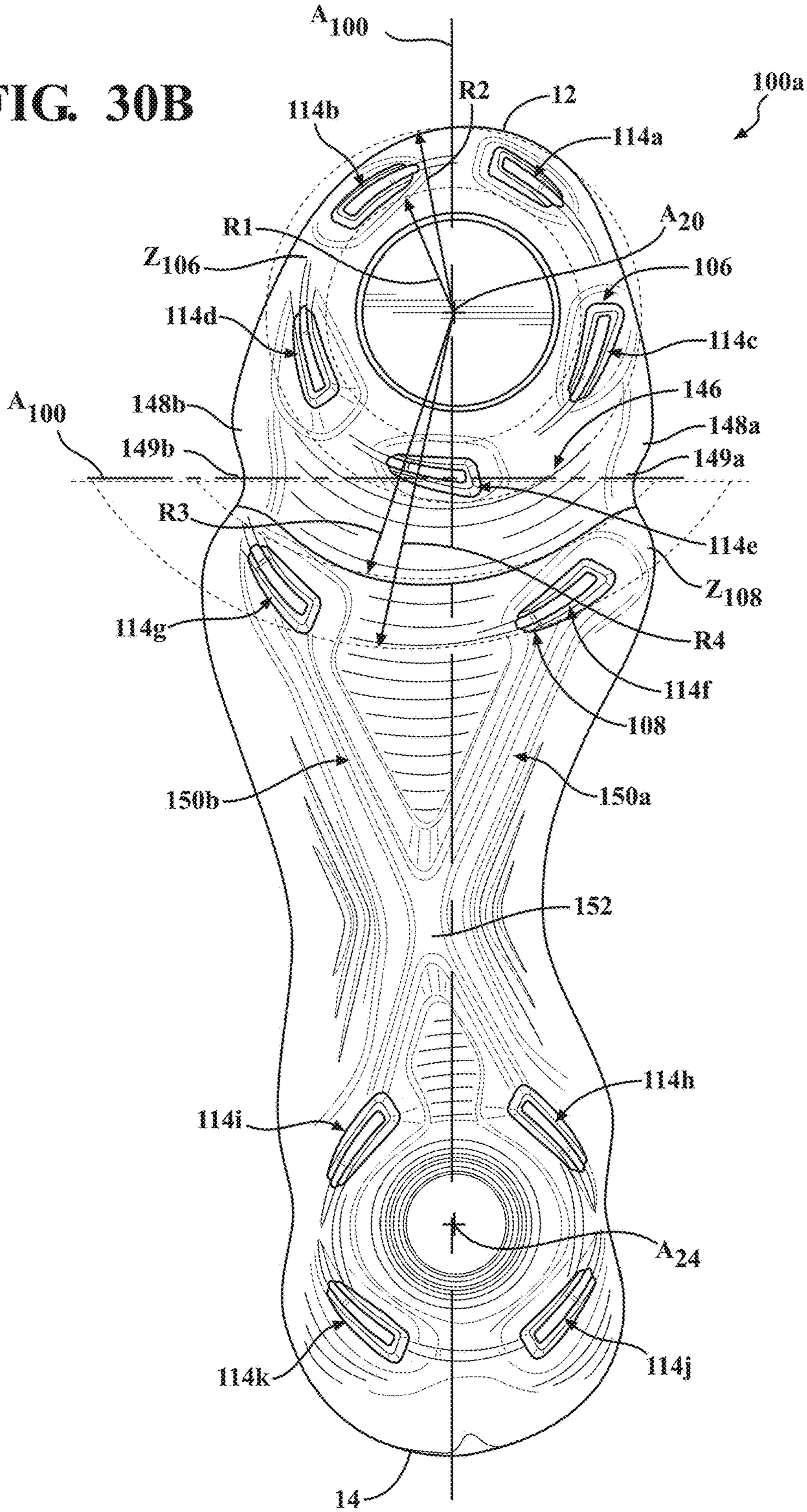


FIG. 30B


A100
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R1
A20
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A100
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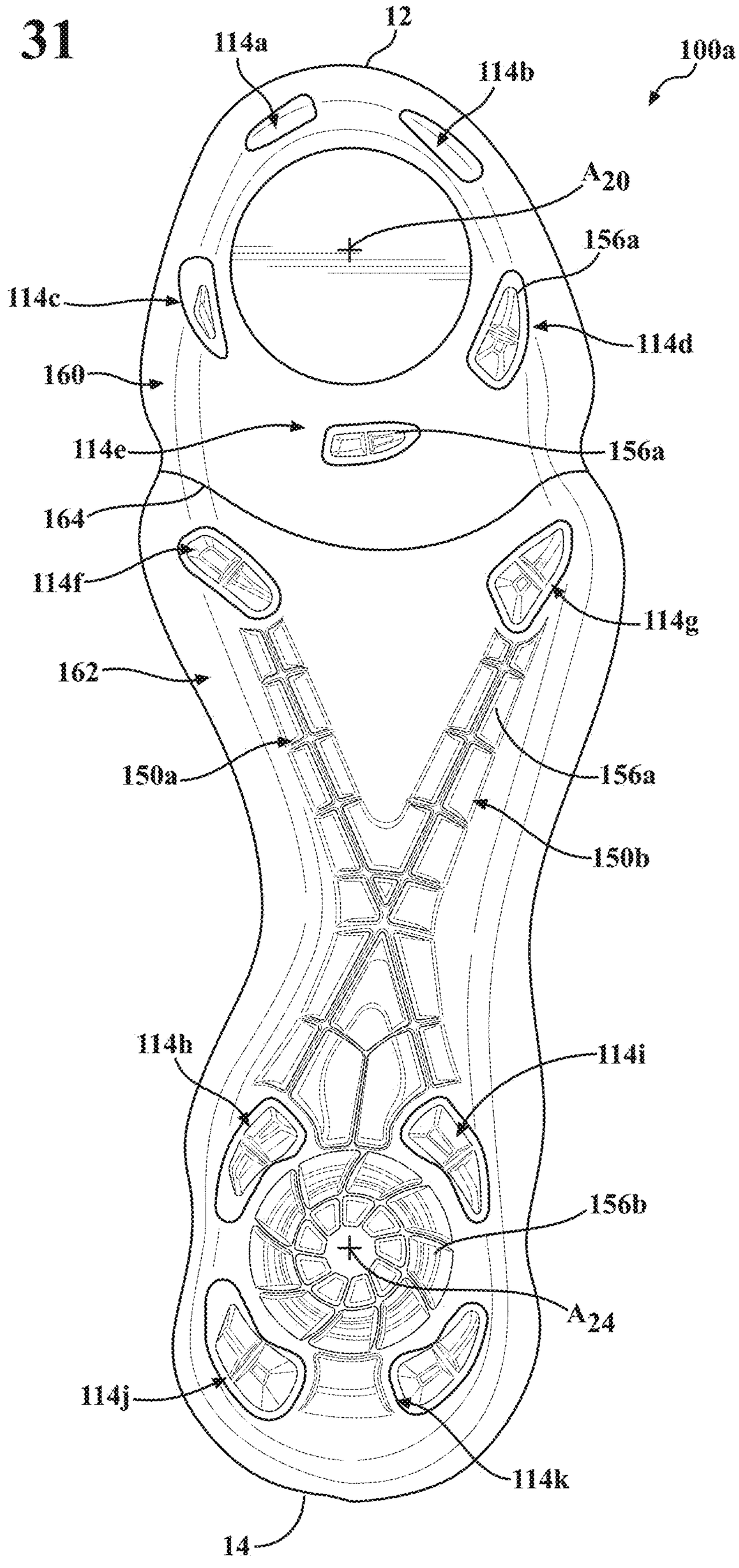
FIG. 31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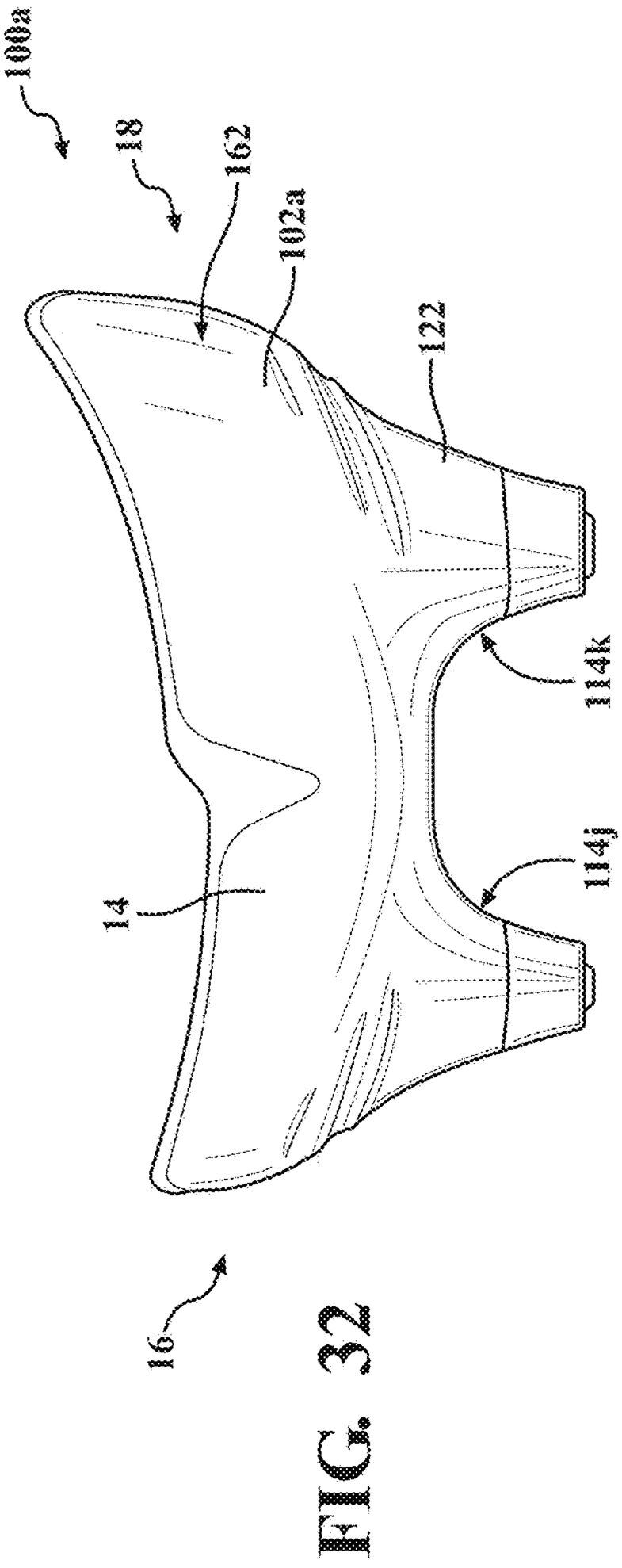
100a
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114j
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FIG. 32

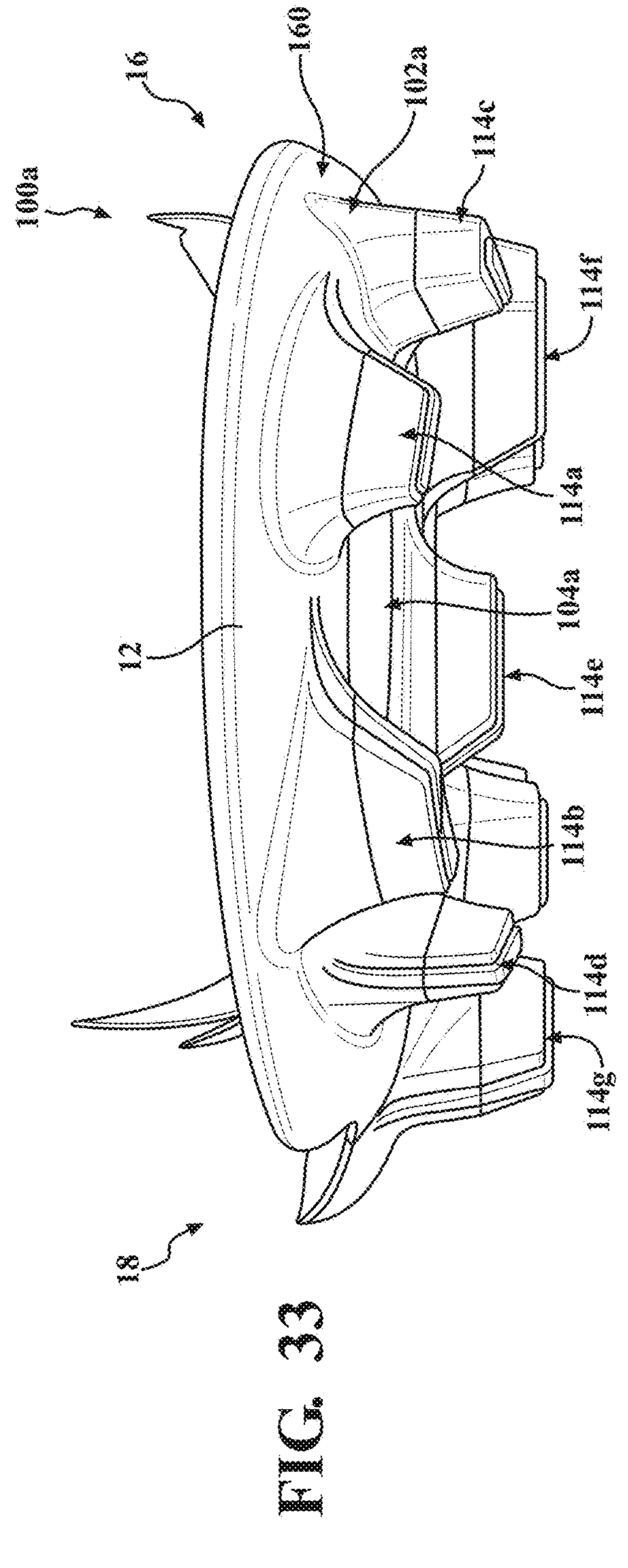
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FIG. 33

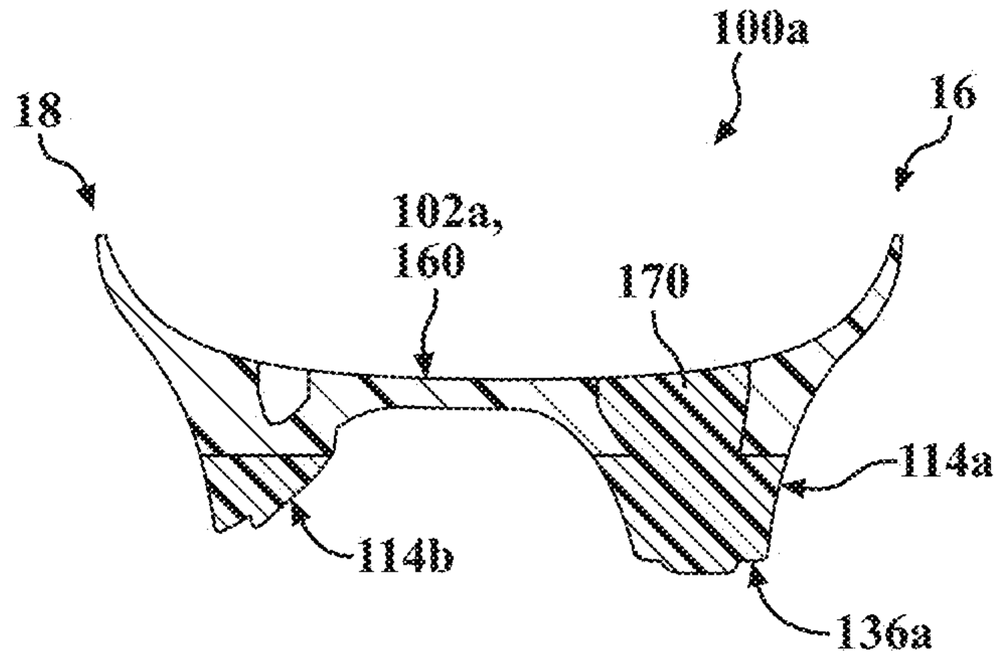

FIG. 34

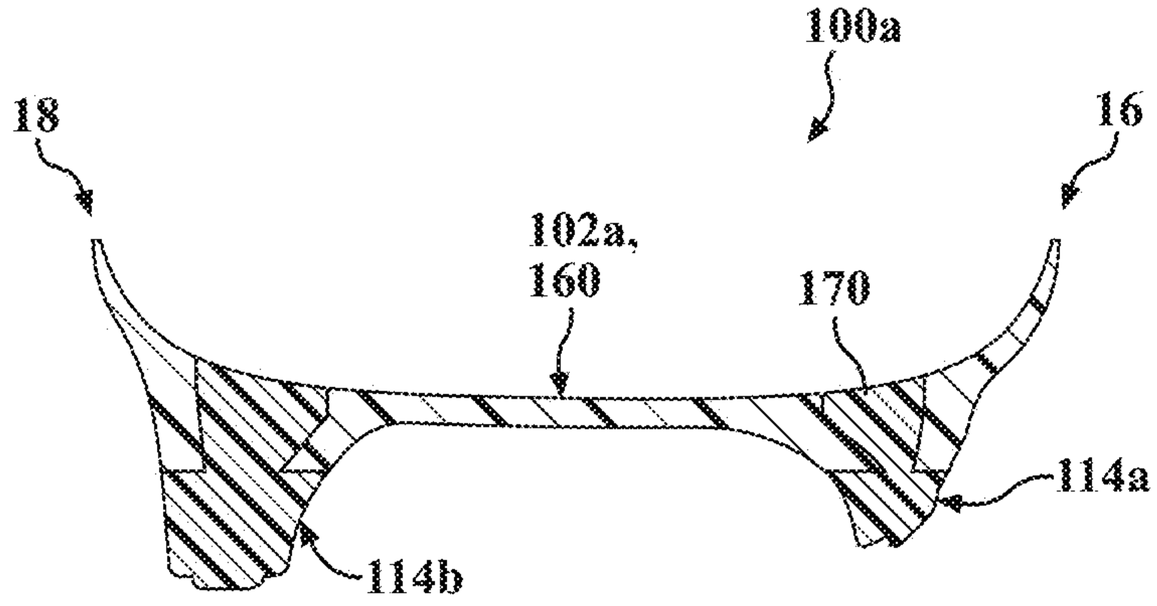

FIG. 35

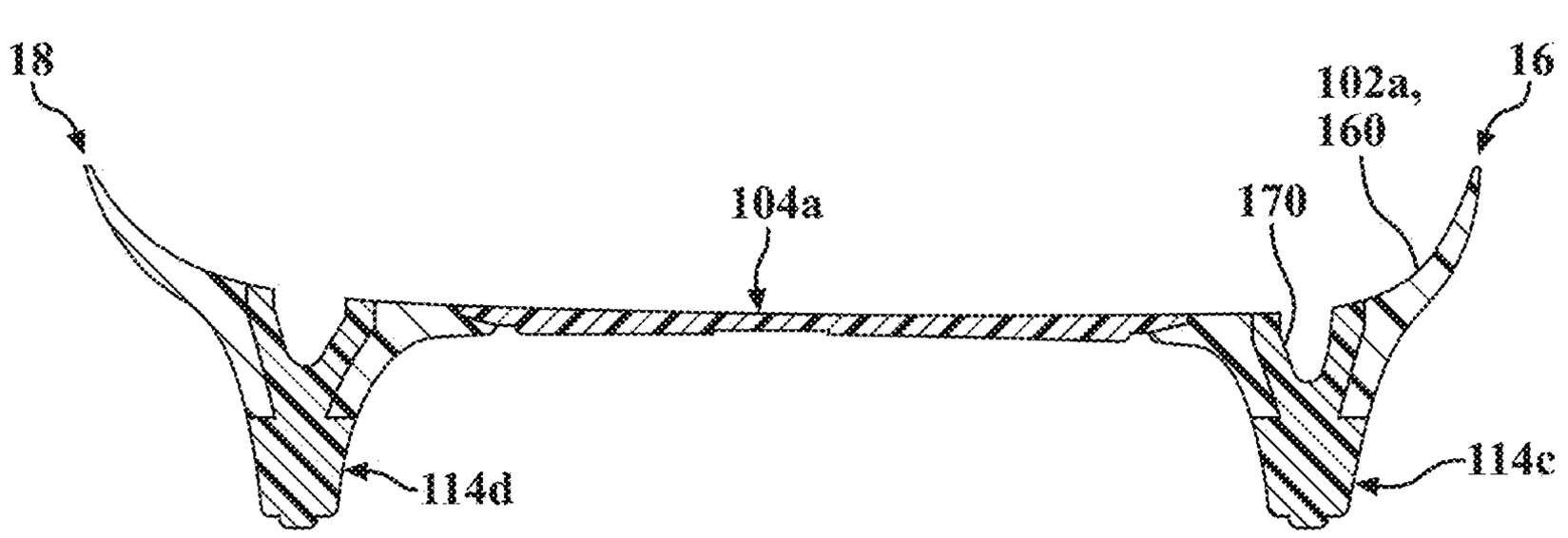

FIG. 36

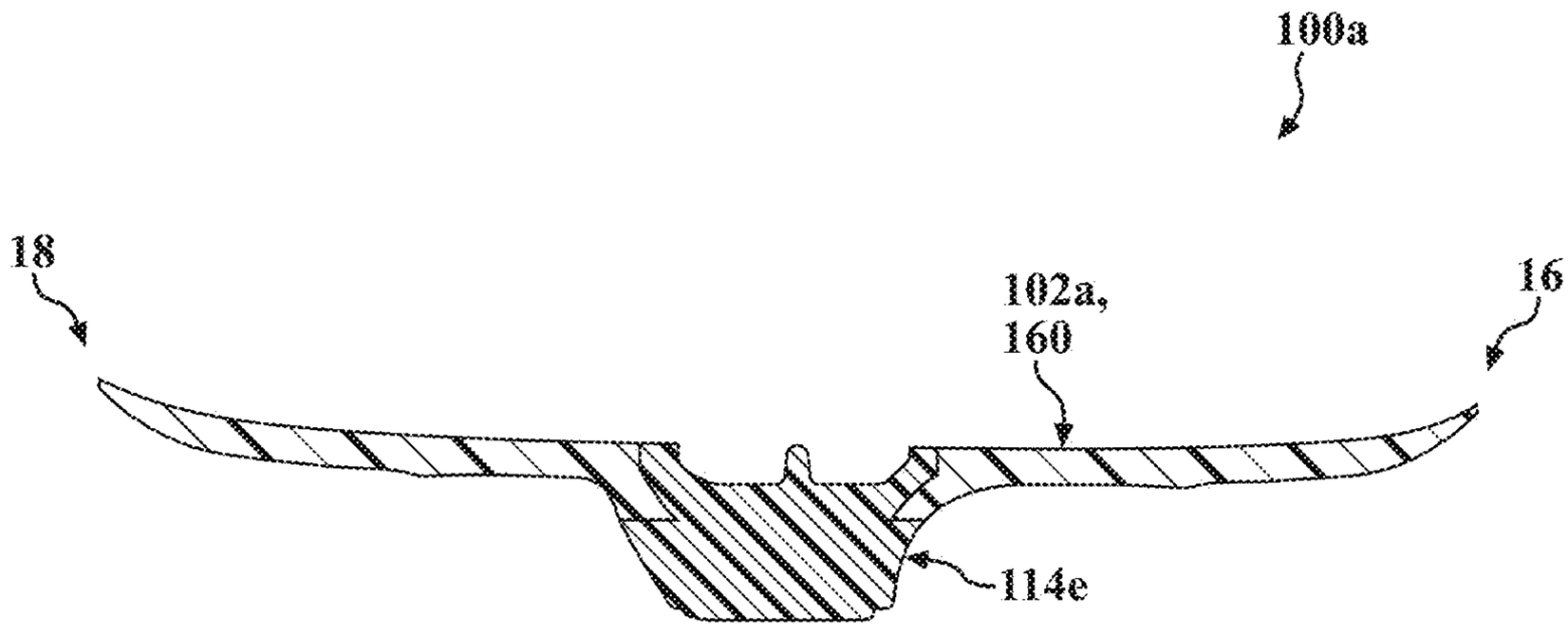

FIG. 37

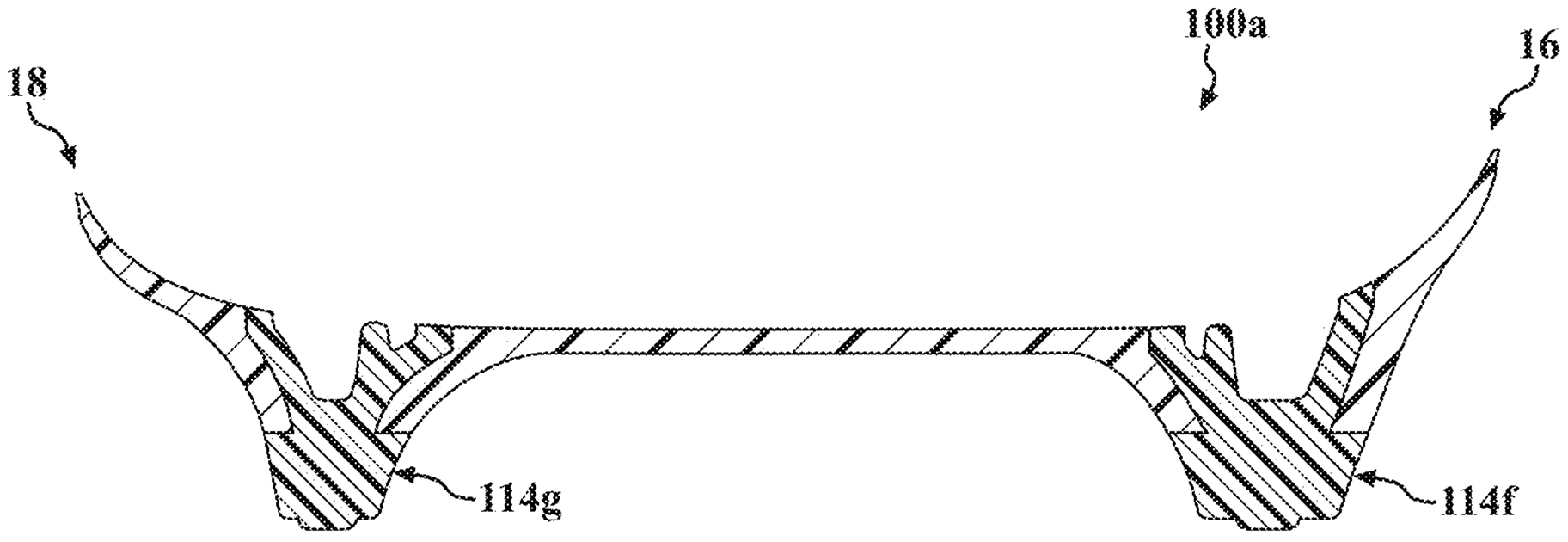

FIG. 38

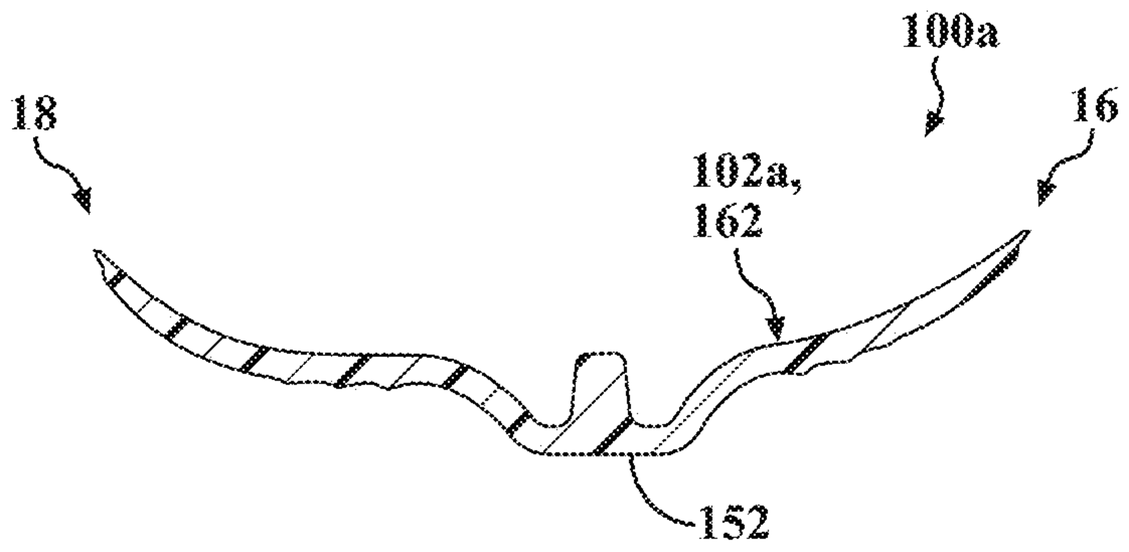

FIG. 39

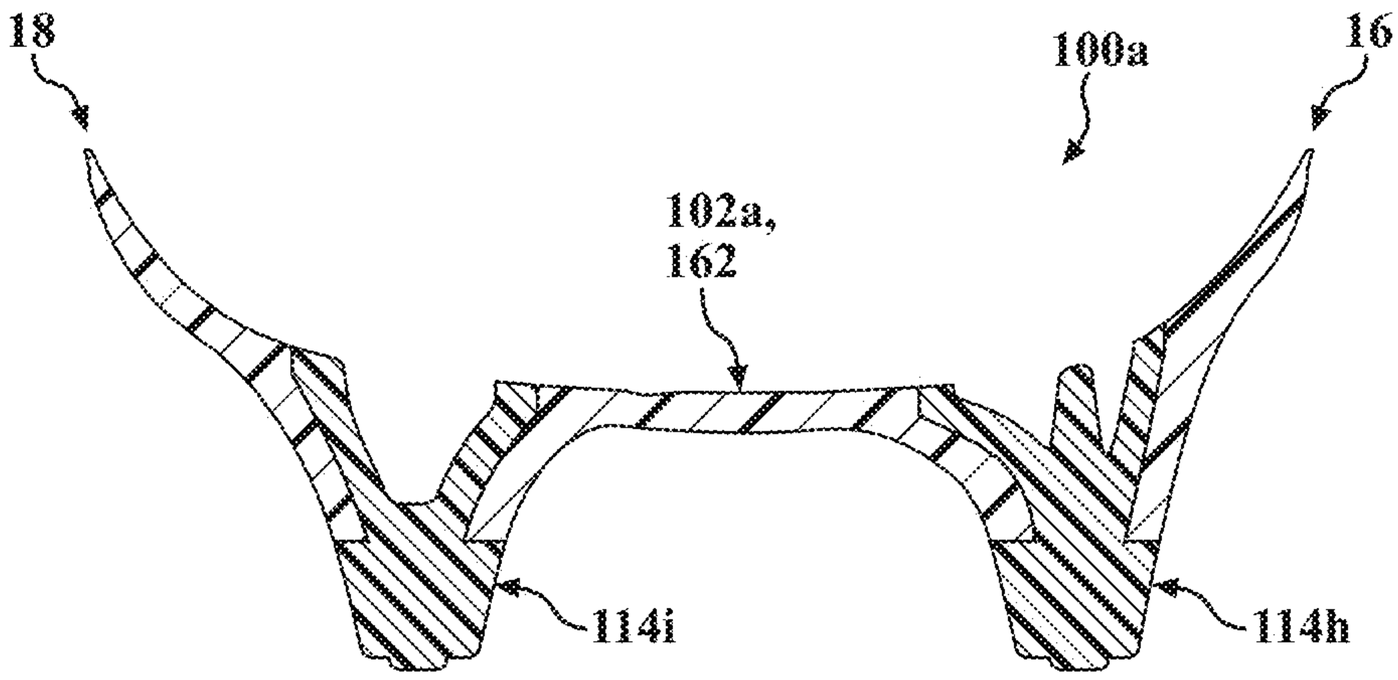

FIG. 40

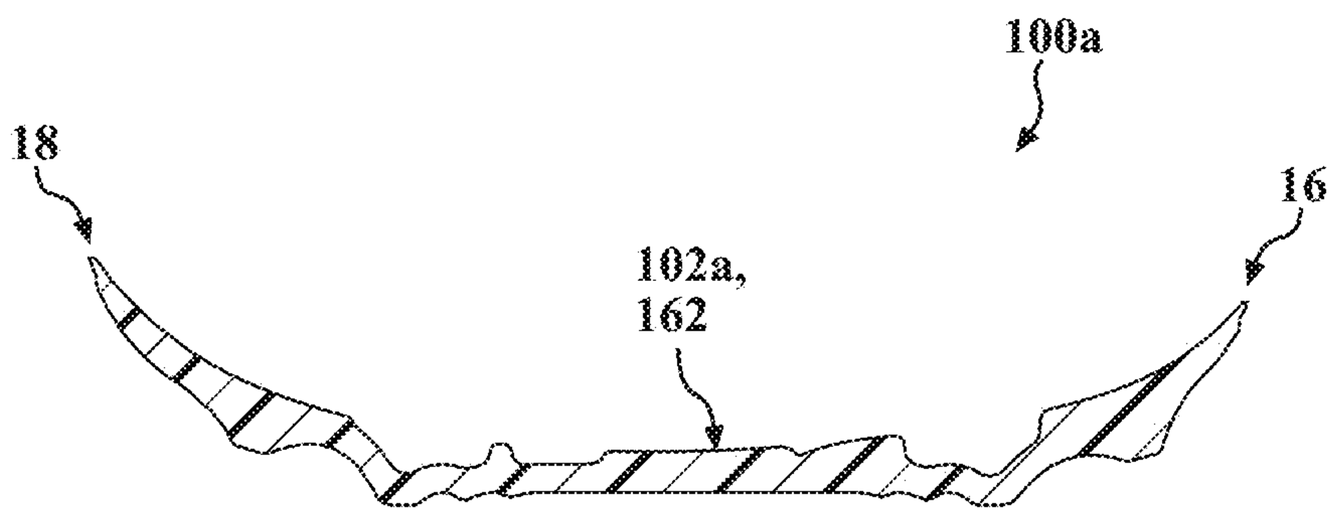

FIG. 41

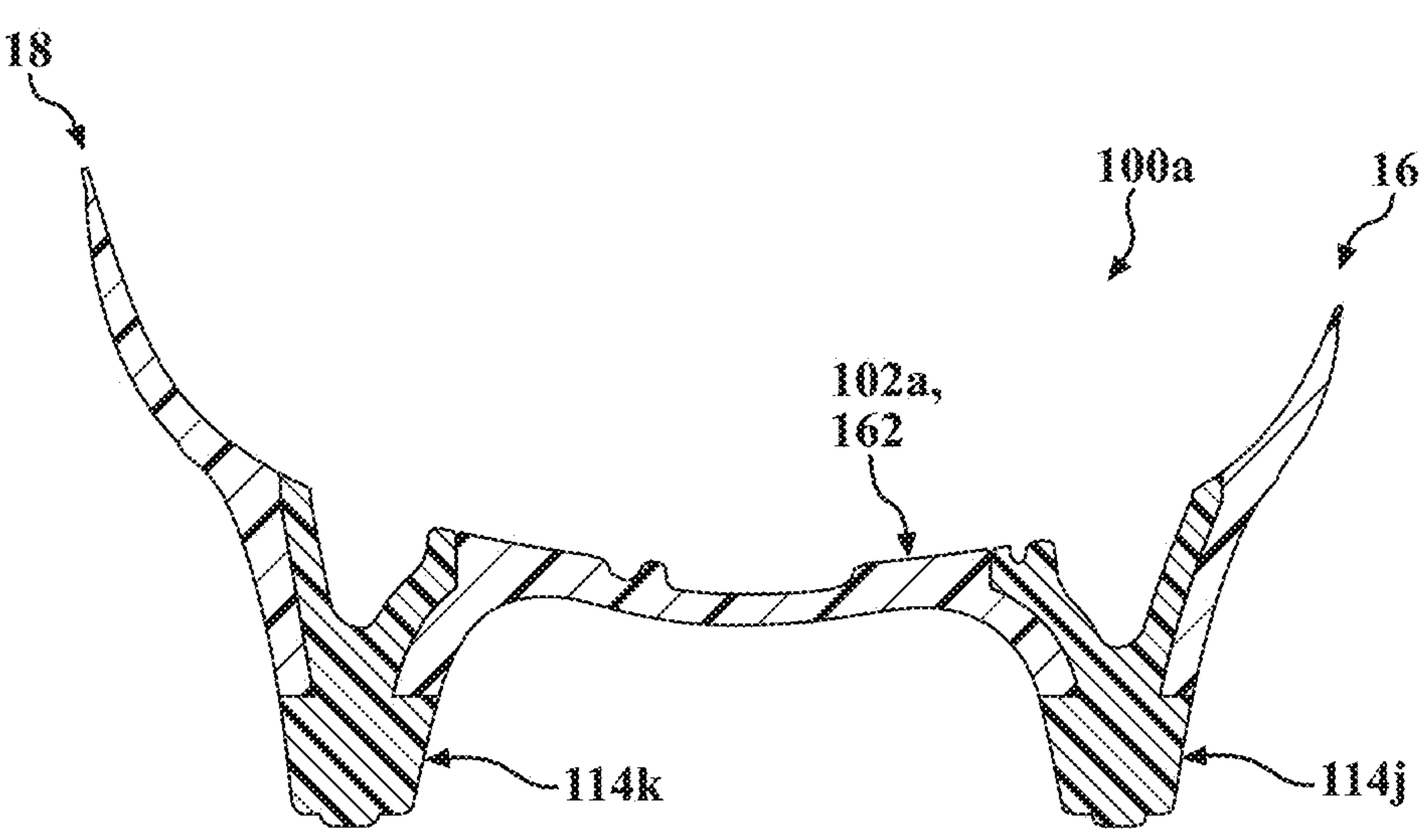

FIG. 42

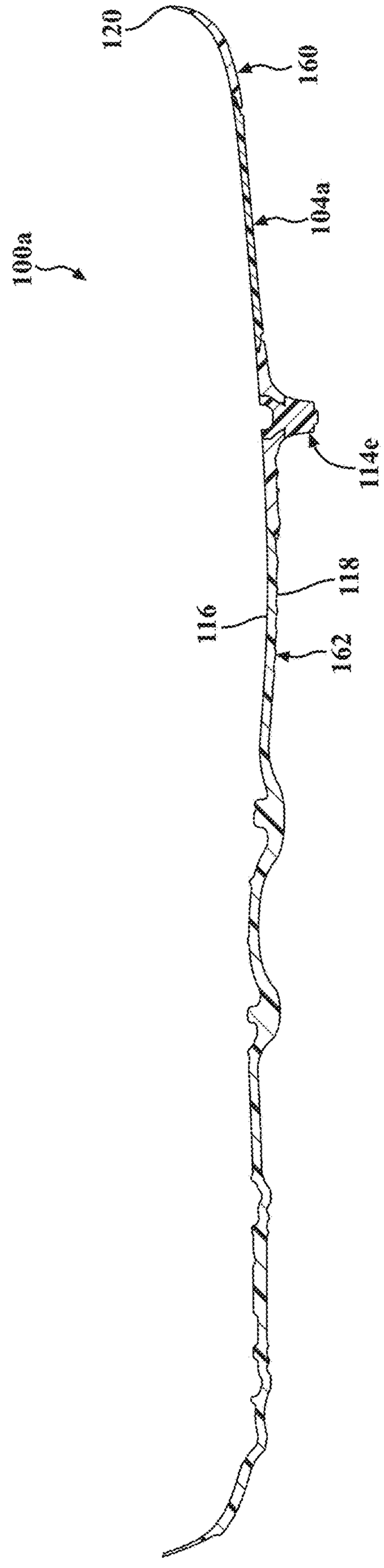

FIG. 43

SOLE STRUCTURE FOR ARTICLE OF FOOTWEAR

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. § 119 (e) to U.S. Provisional Application No. 63/499,896, filed on May 3, 2023. The disclosure of this prior application is considered part of the disclosure of this application and is hereby incorporated by reference in its entirety.

FIELD

[0002] The present disclosure relates generally to an article of footwear and more particularly to a sole structure for an article of footwear

BACKGROUND

[0003] This section provides background information related to the present disclosure and is not necessarily prior art.

[0004] Articles of footwear conventionally include an upper and a sole structure. The upper may be formed from any suitable material(s) to receive, secure, and support a foot on the sole structure. The upper may cooperate with laces, straps, or other fasteners to adjust the fit of the upper around the foot. A bottom portion of the upper, proximate to a bottom surface of the foot, attaches to the sole structure.

[0005] Sole structures generally include a layered arrangement extending between a ground surface and the upper and include an outsole. The outsole may include a baseplate formed of a rigid or semi-rigid material that provides rigidity and energy distribution across the sole structure. The baseplate may be provided with one or more ground-engaging members for engagement with a ground surface.

BRIEF DESCRIPTION OF DRAWINGS

[0006] The drawings described herein are for illustrative purposes only of selected configurations and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0007] FIG. **1** is a medial side perspective view of an example of an article of footwear according to the present disclosure;

[0008] FIG. **2** is a lateral side perspective view of the article of footwear of FIG. **1**;

[0009] FIG. **3** is an exploded perspective view of the article of footwear of FIG. **1**;

[0010] FIG. **4** is a top perspective view of an example of a sole structure for the article of footwear of FIG. **1**;

[0011] FIG. **5** is a partial perspective view showing a forefoot region of the sole structure of FIG. **4**;

[0012] FIG. **6** is a lateral side elevation view of the sole structure of FIG. **4**;

[0013] FIG. **7** is a medial side elevation view of the sole structure of FIG. **4**;

[0014] FIGS. **8**A and **8**B are bottom plan views of the sole structure of FIG. **4**;

[0015] FIG. **9** is a top plan view of the sole structure of FIG. **4**;

[0016] FIG. **10** is a front elevation view of the sole structure of FIG. **4**;

[0017] FIG. **11** is a rear elevation view of the sole structure of FIG. **4**;

[0018] FIG. **12** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **12-12** of FIG. **8**A;

[0019] FIG. **13** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **13-13** of FIG. **8**A;

[0020] FIG. **14** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **14-14** of FIG. **8**A;

[0021] FIG. **15** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **15-15** of FIG. **8**A;

[0022] FIG. **16** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **16-16** of FIG. **8**A;

[0023] FIG. **17** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **17-17** of FIG. **8**A;

[0024] FIG. **18** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **18-18** of FIG. **8**A;

[0025] FIG. **19** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **19-19** of FIG. **8**A;

[0026] FIG. **20** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **20-20** of FIG. **8**A;

[0027] FIG. **21** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **21-21** of FIG. **8**A;

[0028] FIG. **22** is a cross-sectional view of the sole structure of FIG. **4**, taken along Line **22-22** of FIG. **8**A;

[0029] FIG. **23** is a medial side perspective view of another example of an article of footwear according the present disclosure;

[0030] FIG. **24** is a lateral side perspective view of the article of footwear of FIG. **23**;

[0031] FIG. **25** is an exploded perspective view of the article of footwear of FIG. **23**;

[0032] FIG. **26** is a top perspective view of an example of a sole structure for the article of footwear of FIG. **23**;

[0033] FIG. **27** is a partial perspective view showing a forefoot region of the sole structure of FIG. **26**;

[0034] FIG. **28** is a lateral side elevation view of the sole structure of FIG. **26**;

[0035] FIG. **29** is a medial side elevation view of the sole structure of FIG. **26**;

[0036] FIGS. **30**A and **30**B are bottom plan views of the sole structure of FIG. **26**;

[0037] FIG. **31** is a top plan view of the sole structure of FIG. **26**;

[0038] FIG. **32** is a front elevation view of the sole structure of FIG. **26**;

[0039] FIG. **33** is a rear elevation view of the sole structure of FIG. **26**;

[0040] FIG. **34** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **34-34** of FIG. **30**A;

[0041] FIG. **35** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **35-35** of FIG. **30**A;

[0042] FIG. **36** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **36-36** of FIG. **30**A;

[0043] FIG. **37** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **37-37** of FIG. **30**A;

[0044] FIG. **38** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **38-38** of FIG. **30**A;

[0045] FIG. **39** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **39-39** of FIG. **30**A;

[0046] FIG. **40** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **40-40** of FIG. **30**A;

[0047] FIG. **41** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **41-41** of FIG. **30**A;

[0048] FIG. **42** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **42-42** of FIG. **30**A; and

[0049] FIG. **43** is a cross-sectional view of the sole structure of FIG. **26**, taken along Line **43-43** of FIG. **30**A.

[0050] Corresponding reference numerals indicate corresponding parts throughout the drawings.

DETAILED DESCRIPTION

[0051] Example configurations will now be described more fully with reference to the accompanying drawings. Example configurations are provided so that this disclosure will be thorough, and will fully convey the scope of the disclosure to those of ordinary skill in the art. Specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of configurations of the present disclosure. It will be apparent to those of ordinary skill in the art that specific details need not be employed, that example configurations may be embodied in many different forms, and that the specific details and the example configurations should not be construed to limit the scope of the disclosure.

[0052] The terminology used herein is for the purpose of describing particular exemplary configurations only and is not intended to be limiting. As used herein, the singular articles "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. Additional or alternative steps may be employed.

[0053] When an element or layer is referred to as being "on," "engaged to," "connected to," "attached to," or "coupled to" another element or layer, it may be directly on, engaged, connected, attached, or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to," "directly connected to," "directly attached to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0054] The terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections. These elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example configurations.

[0055] An aspect of the disclosure provides a sole structure for an article of footwear. The sole structure includes a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure. A first cleat set is disposed in a forefoot region and includes a first plurality of traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region. A second cleat set is disposed in a heel region of the sole structure and including a second plurality of the traction elements arranged in a second annular pattern about a second axis disposed in the heel region.

[0056] Aspects of the disclosure may include one or more of the following optional features. In some implementations, the sole structure includes a third cleat set including a third plurality of traction elements arranged in a third annular pattern about the first axis. In some examples, the first sole plate defines a flex zone formed between the first cleat set and the third cleat set. Optionally, the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

[0057] In some configurations, each of the first plurality of traction elements are oriented in a first rotational direction about the first axis. In some implementations, the second cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis. Optionally, the second cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis. In some examples, the first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

[0058] In some implementations, the sole structure includes a second sole plate attached to the first sole plate and surrounded by the first plurality of traction elements. In some examples, each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

[0059] Another aspect of the disclosure provides sole structure for an article of footwear. The sole structure includes a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure. A first cleat set is disposed in a forefoot region and includes a first plurality of elongate traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region. A second cleat set includes a second plurality of elongate traction elements arranged in a second annular pattern about the first axis.

[0060] Aspects of the disclosure may include one or more of the following optional features. In some examples, the sole structure further includes a third cleat set disposed in a heel region of the sole structure and including a third plurality of elongate traction elements arranged in a third annular pattern about a second axis disposed in the heel region. In some implementations, the first sole plate defines a flex zone formed between the first cleat set and the second cleat set. In some configurations, the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

[0061] In some configurations, the third cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis. In some examples, the third cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis. In some implementations, first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

[0062] In some examples, each of the first plurality of elongate traction elements are oriented in a first rotational direction about the first axis. In some examples, the sole structure includes a second sole plate attached to the first sole plate and surrounded by the first plurality of elongate traction elements. In some implementations, each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

[0063] An article of footwear may incorporate the sole structure described above.

[0064] Referring to FIGS. **1-3**, an article of footwear **10** includes a sole structure **100** and an upper **200** attached to the sole structure **100**. The article of footwear **10** may further include an anterior end **12** associated with a forward-most point of the footwear **10** and a posterior end **14** corresponding to a rearward-most point of the footwear **10**. A longitudinal axis A**10** (FIG. **8**A) of the footwear **10** extends along a length of the footwear **10** from the anterior end **12** to the posterior end **14** parallel to a ground surface, and generally divides the footwear **10** into a medial side **16** and a lateral side **18**. Accordingly, the medial side **16** and the lateral side **18** respectively correspond with opposite sides of the footwear **10** and extend from the anterior end **12** to the posterior end **14**. As used herein, a longitudinal direction refers to the direction extending from the anterior end **12** to the posterior end **14**, while a lateral direction refers to the direction transverse to the longitudinal direction and extending from the medial side **16** to the lateral side **18**.

[0065] The article of footwear **10** may be divided into one or more regions. The regions may include a forefoot region **20**, a mid-foot region **22**, and a heel region **24**. The forefoot region **20** may include a ball portion **20***r* corresponding with the phalanges and a ball portion **20**B associated with the metatarsal bones of a foot. The mid-foot region **22** may correspond with an arch area of the foot, and the heel region **24** may correspond with rear portions of the foot, including a calcaneus bone.

[0066] The upper **200** includes interior surfaces that define an interior void configured to receive and secure a foot for support on the sole structure **100**. The upper **200** may be formed from one or more materials that are stitched or adhesively bonded together to form the interior void. Suitable materials of the upper may include, but are not limited to, mesh, textiles, foam, leather, and synthetic leather. The materials may be selected and located to impart properties of durability, air-permeability, wear-resistance, flexibility, and comfort. In some examples, one or more fasteners extend along the upper **200** to adjust a fit of the interior void around the foot and to accommodate entry and removal of the foot therefrom. The upper **200** may include apertures such as eyelets and/or other engagement features such as fabric or mesh loops that receive the fasteners. The fasteners may include laces, straps, cords, hook-and-loop, or any other suitable type of fastener. The upper **200** may include a tongue portion that extends between the interior void and the fasteners.

[0067] Referring to FIGS. **1** and **2**, the sole structure **100** of the illustrated example includes a primary sole plate **102**, a secondary sole plate **104** attached to a bottom surface of the primary sole plate **102**, a forefoot cleat set **106** disposed in the forefoot region **20**, a mid-foot cleat set disposed in the mid-foot region **22**, and a heel cleat set **110** disposed in the heel region **24**. Optionally, the sole structure **100** incudes a rand **112** extending along a peripheral edge of the primary sole plate **102** to provide a cushioned interface between the primary sole plate **102** and the upper **200**. As discussed in greater detail below, the cleat sets **106**, **108**, **110** each incorporate a respective group of traction elements **114***a*-**114***k*.

[0068] The primary sole plate **102** may be described as including an upper or interior side **116** and a lower or exterior side **118** formed on an opposite side from the interior side **116**. Thus, the interior side **116** generally corresponds to a footbed of the article of footwear **10** and the exterior side **118** corresponds to a ground-engaging surface of the article of footwear **10**. A distance from the interior side **116** to the exterior side **118** defines a thickness of the primary sole plate **102**. The interior side **116** and the exterior side **118** are connected to each other by a peripheral edge **120** that extends along the periphery of the primary sole plate **102**. Thus, the peripheral edge **120** defines a peripheral profile of the primary sole plate **102**.

[0069] Referring to FIG. **5**, in the illustrated example each of the traction elements **114***a*-**114***k* includes a substantially similar construction and are provided on the exterior side **118** of the primary sole plate **102** at different positions and orientations. Each of the traction elements **114***a*-**114***k* includes a height extending from a base portion **122** to a distal tip portion **124** formed at an opposite end of the traction element **114***a*-**114***k* than the base portion **122**. As shown, the base portion **122** is attached at the exterior side **118** of the primary sole plate **102** and the distal tip portion **124** faces away from the exterior side **118**. A length of each of the traction elements **114***a*-**114***k* extends from a leading end **126** to a trailing end **128** formed at an opposite end from the leading end **126**. A width of each of the traction elements **114***a*-**114***k* is defined between a first side **130** that extends from the leading end **126** to the trailing end **128** on a first side (i.e., a left side) and a second side **132** that extends between the leading end **126** and the trailing end **128** on an opposite side (i.e., a right side) from the first side **130**. As shown, one or more of the traction elements **114***a*-**114***k* includes a traction rib **134** extending along the leading end **126** and the tip portion **124** of the traction element **114***a*-**114***k*. The traction rib **134** may be formed as a continuous rib having a width that is less than the respective widths of the leading end **126** and the tip portion **124** and may protrude from the traction element **114***a*-**114***k* at the leading end **126** and the tip portion **124**. Thus the traction rib **134** and the distal tip **124** may define a stepped configuration at the distal end of the traction element **114***a*-**114***k*.

[0070] With continued reference to FIG. **5**, each traction element **114***a*-**114***k* includes tapering geometries that facili-

tate desirable traction properties. For example, a length of one or more of the traction elements **114***a*-**114***k* may taper along a direction from the base portion **122** to the tip portion **124**. Particularly, at least one of the leading end **126** and the trailing end **128** may be formed at an oblique angle relative to the immediately adjacent surface of the exterior side **118** of the primary sole plate **102**, whereby the leading end **126** and the trailing end **128** converge with each other along the direction from the exterior side **118** to the tip portion **124**. Here, a relative angle between the leading end **126** and the exterior side **118** of the primary sole plate **102** may be less than an angle between the trailing end **128** and the exterior side **118** of the sole plate **102**.

[0071] In addition to the tapered length, each traction element **114***a*-**114***k* may include a tapering width (i.e., distance between the first side **130** and the second side **132**). For instance, the traction elements **114***a*-**114***k* may taper along the direction from the trailing end **128** to the leading end **126**. Thus, the width of the traction element is greater at the trailing end **128** than at the leading end **126**. The width of the traction elements **114***a*-**114***k* may also taper along the direction from the base portion **122** to the tip portion **124**. Accordingly, each of the traction elements **114***a*-**114***k* may be described as including a compound taper, whereby the width tapers along the lengthwise direction and the height direction.

[0072] The combination of the tapering width(s) and length may be configured to optimize traction properties for each traction element. For example, the leading end **126** may be provided at less of an incline than the trailing end **128**, whereby the leading end **126** functions to knife through a ground surface while the trailing end **128** functions to engage the ground surface to minimize movement through the ground surface in a direction towards the trailing end **128**. Likewise, the tapering width along the height direction facilitates insertion of the traction elements **114***a*-**114***k* into the ground surface, while the tapering width along the lengthwise direction facilitates a knifing property as each traction element **114***a*-**114***k* moves through the ground surface in a direction towards the leading end **126**.

[0073] In the illustrated example, the traction elements **114***a*-**114***k* are formed as composite structures, whereby portions of the traction elements **114***a*-**114***k* are defined by various components and/or materials. For example, the base portion **122** of each traction element **114***a*-**114***k* is defined by the primary sole plate **102** while the tip portion **124** of each traction element **114***a*-**114***k* is defined by a stud element **136** that is formed separately and attached to the base portion **122**. With reference to FIG. **3**, the base portion **122** of each traction element **122** is formed on the exterior side **118** of the primary sole plate **102** and extends to a substantially planar lower attachment surface **138**. The lower attachment surface **138** may include one or more protuberances **140**. Conversely, the stud element **136** includes an upper attachment surface **142** including a socket (not shown) configured to receive the protuberance **140** to provide a mechanical interface for aligning the tip portion **124** (i.e., the stud element **136**) and the base portion **122** of the traction element **114**. In this example, the attachment interface is provided by a bonding relationship between the attachment surfaces **138**, **142**. Bonding may be accomplished by directly bonding the materials of the stud element **136** and the primary sole plate **102** during a co-molding process or by including an additional adhesive material between the attachment surfaces **138**, **142**.

[0074] Referring now to FIG. **8**B, the traction elements **114***a*-**114***k* of the sole structure **100** are arranged in groups defining the forefoot cleat set **106**, the mid-foot cleat set **108**, and the heel cleat set **110**. Generally, the traction elements **114***a*-**114***k* are positioned and oriented to provide each cleat set **106**, **108**, **110** with a unique function associated with the respective region of the sole structure **100**.

[0075] Referring still to FIG. **8**B, the forefoot cleat set **106** includes a plurality of traction elements **114***a*-**114***e* arranged in a annular pattern around a forefoot rotational axis A_{20} of the forefoot region **20**. Particularly, the traction elements **114***a*-**114***e* are arranged such that each traction element **114***a*-**114***e* of the forefoot cleat set **106** is oriented in the same direction (i.e., the forefoot rotational direction) along the circumference of the annular pattern. Here, the forefoot rotational direction is configured to facilitate rotation of the heel region **24** of the sole structure **100** in a lateral direction about the forefoot rotational axis A_{20} while minimizing rotation of the heel region **24** in the medial direction. Thus, in a right-footed sole structure **100**, as shown in FIG. **9**, the forefoot rotational direction is clockwise about the forefoot rotational axis A_{20}. Conversely, on a left-footed sole structure **100**, the forefoot rotational direction would be counter-clockwise about the forefoot rotational axis A_{20}. This configuration allows the forefoot region **20** of the sole structure **100** to rotate about the forefoot rotational axis A_{20} during locomotion, while limiting counter-rotation during a kicking movement with the opposite foot.

[0076] With continued reference to FIG. **8**B, the forefoot cleat set **106** includes five of the tractions elements **114***a*-**114***e*, including a pair of toe traction elements **114***a*, **114***b*, a pair of peripheral ball traction elements **114***c*, **114***d*, and a central ball traction element **114***e*. The toe traction elements **114***a*, **114***b* include a medial toe traction element **114***a* disposed adjacent to the peripheral edge **120** of the primary sole plate **102** on the medial side **16** adjacent to the anterior end **12** as well as a lateral toe traction element **114***b* disposed on the lateral side **18** adjacent to the anterior end **12**. The peripheral ball traction elements **114***c*, **114***d* include a medial peripheral ball traction element **114***c* disposed adjacent to the peripheral edge **120** in the ball portion **20***g* of the forefoot region **20** and a lateral peripheral ball traction element **114***d* disposed adjacent to the peripheral edge **120** in the ball portion **20**B of the forefoot region **20**. The central ball traction element **114***e* is disposed in the ball portion **20**B between the medial side **16** and the lateral side **18**. Generally, the central ball traction element **114***e* is positioned along the longitudinal axis A_{100} of the sole structure **100** and a length of the central ball traction element **114***e* (i.e. from leading end **126** to trailing end **128**) is oriented transverse to the longitudinal axis A_{100} (i.e., from medial side to lateral side).

[0077] Referring still to FIG. **8**B, the mid-foot cleat set **108** includes a pair of traction elements **114***f*, **114***g* that are arranged and oriented in an arcuate pattern with respect to the forefoot rotational axis A_{20}. As shown in FIG. **8**B and described in greater detail below, the mid-foot cleat set **108** includes a medial mid-foot traction element **114***f* disposed on the medial side of the longitudinal axis A_{100} of the sole

structure **100** and a lateral mid-foot traction element **114***g* disposed on the lateral side of the longitudinal axis A_{100} of the soles structure **100**.

[0078] The forefoot cleat set **106** and the mid-foot cleat set **108** may be generally described as being concentrically aligned about the forefoot rotational axis A_{20} such that the mid-foot cleat set **108** cooperates with the forefoot cleat set **106** during rotation of the sole structure **100**. For example, the traction elements **114***a*-**114***e* of the forefoot cleat set **106** may be arranged within a forefoot rotational zone Z_{106} defined between a first radius R1 and a second radius R2 and the traction elements **114***f*, **114***g* of the mid-foot cleat set **108** may be arranged within a mid-foot rotational zone Z_{108} defined between a third radius R3 and a fourth radius R4, whereby each of the radii are measured from the forefoot rotational axis A_{20}.

[0079] In the illustrated example, a space between the forefoot rotational zone Z_{106} and the mid-foot rotational zone Z_{108} (i.e., between the second radius R2 and the third radius R3) defines an arcuate flex zone **146** corresponding to a metatarsophalangeal (MTP) joint of the foot. The flex zone **146** extends continuously along an arcuate path from the peripheral edge **120** on the medial side **16** to the peripheral edge **120** on the lateral side **18**. Optionally, the flex zone **146** may be associated with a pair of reliefs **148***a*, **148***b* formed at opposite ends of the flex zone **146** on the medial side **16** and the lateral side **18**. As shown, each of the reliefs **148***a*, **148***b* is defined by a generally arcuate recess formed along the peripheral edge **120** between the forefoot region **20** and the mid-foot region **22**. Apexes **149***a*, **149***b* of each relief **148***a*, **148***b* are aligned with each other across the lateral direction of the primary sole plate **102**. In some examples, the apexes **149***a*, **149***b* of the reliefs **148***a*, **148***b* are further aligned with the central ball traction element **114***e* across the lateral direction of the primary sole plate **102**. Particularly, a lateral axis A_{114e} extending perpendicular to the longitudinal axis A_{100} of the sole structure may bisect the trailing end **128** of the central ball traction element **114***e*.

[0080] With continued reference to FIG. **6**, the heel cleat set **110** is arranged in the heel region **24** of the primary sole plate **102**. While the heel cleat set **110** includes a plurality of traction elements **114***h*-**114***k* arranged in a generally annular pattern, the heel cleat set **110** is configured in an anti-rotational manner. Particularly, the heel cleat set **110** includes at least one cleat oriented in a first rotational direction (e.g., clockwise) about a heel rotational axis A_{24} and at least one cleat oriented in an opposite second rotational direction (e.g. counter-clockwise) about the heel rotational axis A_{24}. Thus, the heel cleat set **110** is configured to provide relatively high lateral and longitudinal traction while providing similar resistance to rotation in the clockwise and counter-clockwise directions.

[0081] In the illustrated example, the heel cleat set **110** includes an anterior-medial heel traction element **114***h*, an anterior-lateral heel traction element **114***i*, a posterior-medial heel traction element **114***j*, and a posterior-lateral heel traction element **114***k*. For the sake of description, the respective pairs of the traction elements **114***h*-**114***k* of the heel cleat set **110** may be referred as anterior heel traction elements **114***h*, **114***i*, posterior heel traction elements **114***j*, **114***k*, medial heel traction elements **114***h*, **114***j*, or lateral heel traction elements **114***i*, **114***k*. In the illustrated example, one of the heel traction elements **114***h*-**114***k* of each respective pair is oriented in the opposite rotational direction from the other one of the heel traction elements **114***h*-**114***k* of the pair. For example, the anterior-medial heel traction element **114***h* is oriented in an opposite rotational direction from the anterior-lateral heel traction element **114***i* (anterior pair) and in an opposite rotational direction from the posterior-medial heel traction element **114***j* (medial pair). Put another way, pairs of diametrically opposed heel traction elements **114***h*-**114***k* are oriented in the same rotational direction as each other.

[0082] As provided in the preceding paragraphs, the traction elements **114***a*-**114***k* are referred to as being oriented along first and second rotational directions. For clarity, orientation along a rotational direction refers to a longitudinal axis A_{114} of the traction element **114***a*-**114***k* being substantially tangentially aligned with a radial arc associated with a respective one of the rotational axes A_{20}, A_{24}, whereby the leading end **126** of the traction element **114***a*-**114***k* faces the rotational direction and the trailing end **128** faces away from the rotational direction. Here, one of the sides **130**, **132** of the traction element **114***a*-**114***k* faces towards the rotational axis A_{20}, A_{24} such that a radius line taken from the rotational axis A_{20}, A_{24} intersects the side **130**, **132** of the respective traction element **114***a*-**114***k* at a substantially perpendicular angle.

[0083] Referring generally to FIGS. **1**-**20**, the primary sole plate **102** includes various structural features to promote desired torsional and stiffness properties. In the illustrated example, the primary sole plate **102** includes a pair of ribs **150***a*, **150***b* extending between the mid-foot cleat set **108** and the heel cleat set **110**. Particularly, a first one of the ribs **150***a* extends between and connects a base portion **122** of the medial mid-foot traction element **114***f* and a base portion **122** of the anterior-lateral heel traction element **114***i*. Similarly, a second one of the ribs **150***b* extends between and connects a base portion **122** of the lateral mid-foot traction element **114***g* and a base portion **122** of the anterior-medial heel traction element **114***h*. As shown, the ribs **150***a*, **150***b* are integrally and continuously formed with the base portions **122** of the traction elements **114***f*-**114***i*. The ribs **150***a*, **150***b* intersect each other at junction **152** an intermediate portion of the mid-foot region **22**. The junction **152** is substantially centered between opposing portions of the peripheral edge **120** in the mid-foot region **22** and, further, is longitudinally aligned with a narrowest portion of the primary sole plate **102**.

[0084] The primary sole plate **102** may further include one or more annular ribs **154** formed in the heel region **24** within the heel cleat set **110**. The annular ribs **154** protrude from the exterior side **118** and may define a cavity in the heel region **24** between the traction elements **114***i*-**114***k* of the heel cleat set **110**. In the illustrated example, the annular ribs **154** are circular (i.e., constant radius) and include a primary annular rib **154** and a pair of secondary annular ribs **154** having a smaller radius and height than the primary rib **154**.

[0085] The ribs **150***a*, **150***b*, **154** of the primary sole plate **102** are formed as shell structures that protrude from the exterior side **118** of the primary sole plate **102** (FIG. **2**) and define corresponding recesses on the opposite interior side **116** of the primary sole plate **102** (FIG. **9**). As best shown in FIG. **9**, the ribs **150***a*, **150***b*, **154** and the traction elements **114***a*-**114***k* may include interior torsion elements **156***a*, **156***b* formed within the recesses on the interior side **116**. In the illustrated example, the torsion elements **156***a*, **156***b* include braces **156***a*, **156***b* extending across the recesses. The braces

156*a*, **156***b* are generally aligned as a series of elongate braces **156***a* along the lengths of the longitudinal ribs **150***a*, **150***b* and are arranged as a radial array of helical braces **156***b* about the heel rotational axis A_{24} within the heel region **24**.

[0086] With renewed reference to FIGS. **1-3**, the secondary sole plate **104** includes a cylindrical element attached to the exterior side **118** of the primary sole plate **102** in the forefoot region **20**. A center axis of the secondary sole plate **104** is axially aligned with the forefoot rotational axis A_{20} of the primary sole plate **102**. Optionally, the exterior side **118** of the primary sole plate **102** may include a socket configured to receive the secondary sole plate **104**, whereby the secondary sole plate **104** sits flush with the exterior side **118** of the primary sole plate **102** (FIG. **13**).

[0087] The sole structure **100** is constructed such that the primary sole plate **102** includes a first material having a greater stiffness than the materials forming the secondary sole plate **104**, the rand **112**, and the stud elements **136**. For example, suitable materials for the primary sole plate **102** include a fiberglass reinforced polyamide material (e.g., Rilsan™ BZM materials produced by Arkema™). The rand **112** may include materials that are softer than the material of the primary sole plate **102**, such as a polyether block amide (e.g., Pebax™ materials produced by Arkema™). Suitable materials for the stud elements **136** include, but are not limited to, thermoplastic polyurethanes (TPUs), polyolefins, polyolefin based elastomers, and nylons, as these materials provide superior abrasion properties.

[0088] Referring again to FIG. **1**, the upper **200** may be formed from one or more materials that are stitched or adhesively bonded together to define the interior void. Suitable materials of the upper **200** may include, but are not limited to, textiles, foam, leather, and synthetic leather. The example upper **200** may be formed from a combination of one or more substantially inelastic or non-stretchable materials and one or more substantially elastic or stretchable materials disposed in different regions of the upper **200** to facilitate movement of the article of footwear **10** between a tightened state and a loosened state. The one or more elastic materials may include any combination of one or more elastic fabrics such as, without limitation, spandex, elastane, rubber or neoprene. The one or more inelastic materials may include any combination of one or more of thermoplastic polyurethanes, nylon, leather, vinyl, or another material/fabric that does not impart properties of elasticity.

[0089] With particular reference to FIGS. **23-43**, an article of footwear **10***a* is provided and includes a sole structure **100***a* and the upper **200** attached to the sole structure **100***a*. In view of the substantial similarity in structure and function of the components associated with the article of footwear **10** with respect to the article of footwear **10***a*, like reference numerals are used hereinafter and in the drawings to identify like components while like reference numerals containing letter extensions are used to identify those components that have been modified. The assembled sole structure **100***a* of FIGS. **23-43** includes substantially similar geometries to the sole structure **100** described above with respect to FIGS. **1-22**. However, the sole structure **100***a* is constructed using different subcomponents and materials, described as follows.

[0090] With reference to FIGS. **23-25**, the sole structure **100***a* includes a primary sole plate **102***a* and a secondary sole plate **104***a*. Similar to the foregoing sole structure **100**, the sole structure **100***a* includes the forefoot cleat set **106**, the mid-foot cleat set **108**, and the heel cleat set **110**, which respectively include the traction elements **114***a*-**114***k*. Again, the cleat sets **106**, **108**, **110** and traction elements **114***a*-**114***k* of the sole structure **100***a* are substantially similar to the cleat sets **106**, **108**, **110** and traction elements **114***a*-**114***k* of the sole structure **100** when the sole structure **100***a* is in the assembled state. However, the subcomponents of the traction elements **114***a*-**114***k* may be configured in a different manner, as described below.

[0091] With reference to FIG. **25**, the primary sole plate **102***a* of the present disclosure includes two plate portions **160**, **162** attached along a joint **164**. Particularly, the primary sole plate **102***a* includes an anterior plate portion **160** and a posterior plate portion **162** that are attached to each other along a joint **164** formed along the flex zone **146** (as defined previously) of the primary sole plate **102***a*. As shown in FIG. **27**, the joint **164** extends along an arcuate path about the forefoot rotational axis A_{20} from the medial side **16** to the lateral side **18**. Thus, the joint **164** extends from a first end **165***a* at the relief **148***a* on the medial side **16** to a second end **165***b* at the relief **148***b* on the lateral side **18**. The ends **165***a*, **165***b* may be longitudinally offset from the respective apexes **149***a*, **149***b* of the reliefs **148***a*, **148***b*. For example, the illustrated example shows the ends **165***a*, **165***b* of the joint **164** formed at the posterior side of the apexes **149***a*, **149***b*.

[0092] The anterior plate portion **160** may include an aperture **166** formed through the thickness of the anterior plate portion **160** from the interior side **116** to the posterior side **118**. As shown in FIG. **36**, the aperture **166** is configured to receive the secondary sole plate **104***a* such that the secondary sole plate **104***a* is flush with the primary sole plate **102***a* on each of the interior side **116** and the exterior side **118**.

[0093] Referring again to FIG. **25**, the traction elements **114***a*-**114***k* of the sole structure **100***a* are constructed using a mechanical attachment interface between a base portion **122***a* of the traction element **114***a*-**114***k* and the stud element **136***a*. The base portions **122***a* of the traction elements **114***a*-**114***k* are integrally formed with the primary sole plate **102***a* and extend to a lower attachment surface **138***a*. In this example, the lower attachment surface **138***a* of the base portion **122***a* includes an opening **168** formed through the thickness of the base portion **122***a*, thereby providing fluid communication between the exterior of the base portion **122***a* and an interior of the base portion **122***a*.

[0094] The stud elements **136***a* of the present example include the distal tip portion **124** of the traction elements **114***a*-**114***k*. An upper attachment surface **142** of the stud element **136***a* is configured to interface with the lower attachment surface **138***a* of the base portion **122***a*. Additionally, the stud elements **136***a* include an anchor portion **170** that extends from the upper attachment surface **142**. When the sole structure **100***a* is assembled, the anchor portion **170** of the stud element **136***a* is received in the interior of the base portion **122***a* and connects to the tip portion **124** through the opening **168** formed in the lower attachment surface **138***a* of the base portion **122***a*. Here, the anchor portion **170** may conform to the interior of the base portion **122***a* and includes a larger cross section than the opening **168**. Thus, the lower attachment surface **138***a* of the base portion **122***a* is captured between the tip portion **124** and the

anchor portion **170** to provide a mechanical attachment interface between the stud element **136***a* and the base portion **122***a*.

[0095] The sole structure **100***a* is constructed such that the primary sole plate **102***a*, the secondary sole plate **104***a*, and the stud elements **136** include the same materials. Suitable materials for the stud elements **136** include, but are not limited to, thermoplastic polyurethanes (TPUs), polyolefins, polyolefin based elastomers, and nylons, as these materials provide superior abrasion properties. Thus, while the anterior plate portion **160** and the posterior plate portion **162** may be molded as separate components that are attached or bonded along the joint **164**, these components may include the same material properties.

[0096] The following Clauses provide an exemplary configuration for a sole structure for an article of footwear, an article of footwear, and a composite structure described above.

[0097] Clause 1: A sole structure for an article of footwear, the sole structure comprising: a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure; a first cleat set disposed in a forefoot region and including a first plurality of traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region; and a second cleat set disposed in a heel region of the sole structure and including a second plurality of the traction elements arranged in a second annular pattern about a second axis disposed in the heel region.

[0098] Clause 2: The sole structure of Clause 1, further comprising a third cleat set including a third plurality of traction elements arranged in a third annular pattern about the first axis.

[0099] Clause 3: The sole structure of Clause 2, wherein the first sole plate defines a flex zone formed between the first cleat set and the third cleat set.

[0100] Clause 4: The sole structure of Clause 3, wherein the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

[0101] Clause 5: The sole structure of Clause 1, wherein each of the first plurality of traction elements are oriented in a first rotational direction about the first axis.

[0102] Clause 6: The sole structure of Clause 1, wherein the second cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis.

[0103] Clause 7: The sole structure of Clause 6, wherein the second cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis.

[0104] Clause 8: The sole structure of Clause 7, wherein the first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

[0105] Clause 9: The sole structure of Clause 1, further comprising a second sole plate attached to the first sole plate and surrounded by the first plurality of traction elements.

[0106] Clause 10: The sole structure of Clause 1, wherein each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

[0107] Clause 11: A sole structure for an article of footwear, the sole structure comprising: a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure; a first cleat set disposed in a forefoot region and including a first plurality of elongate traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region; and a second cleat set including a second plurality of elongate traction elements arranged in a second annular pattern about the first axis.

[0108] Clause 12: The sole structure of Clause 11, further comprising a third cleat set disposed in a heel region of the sole structure and including a third plurality of elongate traction elements arranged in a third annular pattern about a second axis disposed in the heel region.

[0109] Clause 13: The sole structure of Clause 12, wherein the first sole plate defines a flex zone formed between the first cleat set and the second cleat set.

[0110] Clause 14: The sole structure of Clause 13, wherein the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

[0111] Clause 15: The sole structure of Clause 12, wherein the third cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis.

[0112] Clause 16: The sole structure of Clause 15, wherein the third cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis.

[0113] Clause 17: The sole structure of Clause 16, wherein the first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

[0114] Clause 18: The sole structure of Clause 11, wherein each of the first plurality of elongate traction elements are oriented in a first rotational direction about the first axis.

[0115] Clause 19: The sole structure of Clause 11, further comprising a second sole plate attached to the first sole plate and surrounded by the first plurality of elongate traction elements.

[0116] Clause 20: The sole structure of Clause 11, wherein each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

[0117] The foregoing description has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular configuration are generally not limited to that particular configuration, but, where applicable, are interchangeable and can be used in a selected configuration, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. A sole structure for an article of footwear, the sole structure comprising:

a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure;

a first cleat set disposed in a forefoot region and including a first plurality of traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region; and

a second cleat set disposed in a heel region of the sole structure and including a second plurality of the traction elements arranged in a second annular pattern about a second axis disposed in the heel region.

2. The sole structure of claim **1**, further comprising a third cleat set including a third plurality of traction elements arranged in a third annular pattern about the first axis.

3. The sole structure of claim **2**, wherein the first sole plate defines a flex zone formed between the first cleat set and the third cleat set.

4. The sole structure of claim **3**, wherein the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

5. The sole structure of claim **1**, wherein each of the first plurality of traction elements are oriented in a first rotational direction about the first axis.

6. The sole structure of claim **1**, wherein the second cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis.

7. The sole structure of claim **6**, wherein the second cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis.

8. The sole structure of claim **7**, wherein the first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

9. The sole structure of claim **1**, further comprising a second sole plate attached to the first sole plate and surrounded by the first plurality of traction elements.

10. The sole structure of claim **1**, wherein each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

11. A sole structure for an article of footwear, the sole structure comprising:

a first sole plate extending from an anterior end of the sole structure to a posterior end of the sole structure;

a first cleat set disposed in a forefoot region and including a first plurality of elongate traction elements arranged in a first annular pattern about a first axis disposed in the forefoot region; and

a second cleat set including a second plurality of elongate traction elements arranged in a second annular pattern about the first axis.

12. The sole structure of claim **11**, further comprising a third cleat set disposed in a heel region of the sole structure and including a third plurality of elongate traction elements arranged in a third annular pattern about a second axis disposed in the heel region.

13. The sole structure of claim **12**, wherein the first sole plate defines a flex zone formed between the first cleat set and the second cleat set.

14. The sole structure of claim **13**, wherein the flex zone extends from a first relief on a medial side of the first sole plate to a second relief on a lateral side of the first sole plate.

15. The sole structure of claim **12**, wherein the third cleat set includes a first one of the traction elements oriented in a first rotational direction about the second axis and a second one of the traction elements oriented in an opposite second rotational direction about the second axis.

16. The sole structure of claim **15**, wherein the third cleat set includes a third one of the traction elements oriented in the first rotational direction about the second axis and a fourth one of the traction elements oriented in the second rotational direction about the second axis.

17. The sole structure of claim **16**, wherein the first one of the traction elements is diametrically opposed to the third one of the traction elements across the second axis and the second one of the traction elements is diametrically opposed to the fourth one of the traction elements across the second axis.

18. The sole structure of claim **11**, wherein each of the first plurality of elongate traction elements are oriented in a first rotational direction about the first axis.

19. The sole structure of claim **11**, further comprising a second sole plate attached to the first sole plate and surrounded by the first plurality of elongate traction elements.

20. The sole structure of claim **11**, wherein each of the traction elements includes a base portion including a first material of the first sole plate and a tip portion including a second material different than the first material.

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