US012383025B2

(12) **United States Patent**
Andrews et al.

(10) **Patent No.: US 12,383,025 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ARTICLE OF FOOTWEAR HAVING A GEOMETRIC CUSHIONING SYSTEM**

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(72) Inventors: **Michael Andrews**, East Falmouth, MA (US); **Daniel R. Hobson**, Waltham, MA (US); **Jeffrey J. Acheson**, Canton, MA (US)

(73) Assignee: **Reebok International Limited**, Altrincham (GB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 139 days.

(21) Appl. No.: **17/739,525**

(22) Filed: **May 9, 2022**

(65) **Prior Publication Data**

US 2023/0354959 A1 Nov. 9, 2023

(51) **Int. Cl.**
A43B 13/18 (2006.01)
A43B 7/32 (2006.01)

(52) **U.S. Cl.**
CPC ***A43B 13/181*** (2013.01); ***A43B 7/32*** (2013.01)

(58) **Field of Classification Search**
CPC A43B 13/181; A43B 13/20; A43B 13/18; A43B 13/14; A43B 13/12; A43B 7/32
See application file for complete search history.

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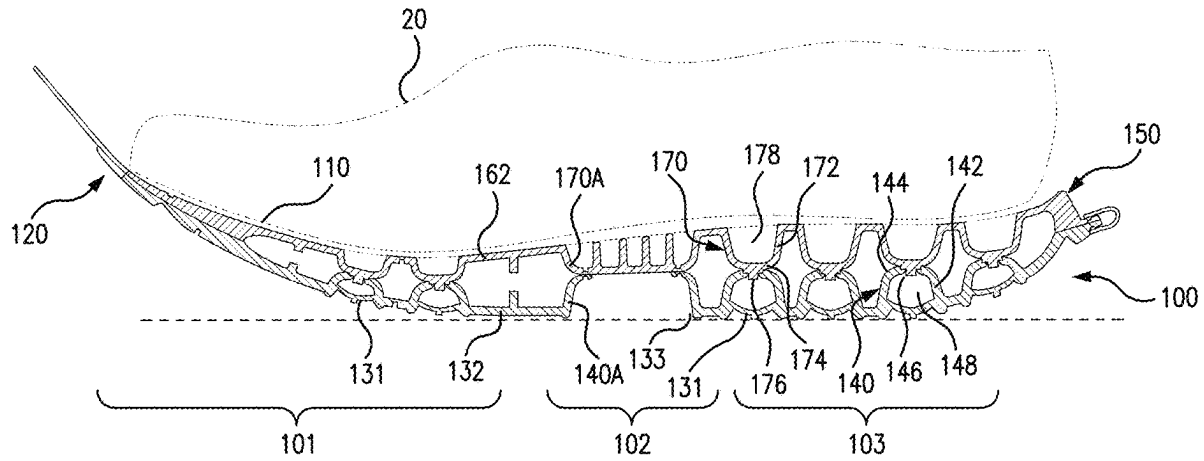
Primary Examiner — Patrick J. Lynch
Assistant Examiner — Brianna T. Duckworth
(74) *Attorney, Agent, or Firm* — STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

(57) **ABSTRACT**

An article of footwear includes an upper and a sole coupled to the upper. The sole includes an insole for receiving a foot of a wearer and a sole member disposed below the insole to support the foot of the wearer. The sole member includes a web extending along a length of the sole and a plurality of pillars projecting upwardly from the web toward the insole. Each of the pillars includes a curved sidewall and a lid extending from an upper end of the curved sidewall. The curved sidewall and the lid define a cavity. The web and the plurality of pillars of the sole member are unitary and made of an elastomeric material that allows the pillars to flex or deform at a compressed state and return to an upright position at a relaxed state.

15 Claims, 48 Drawing Sheets



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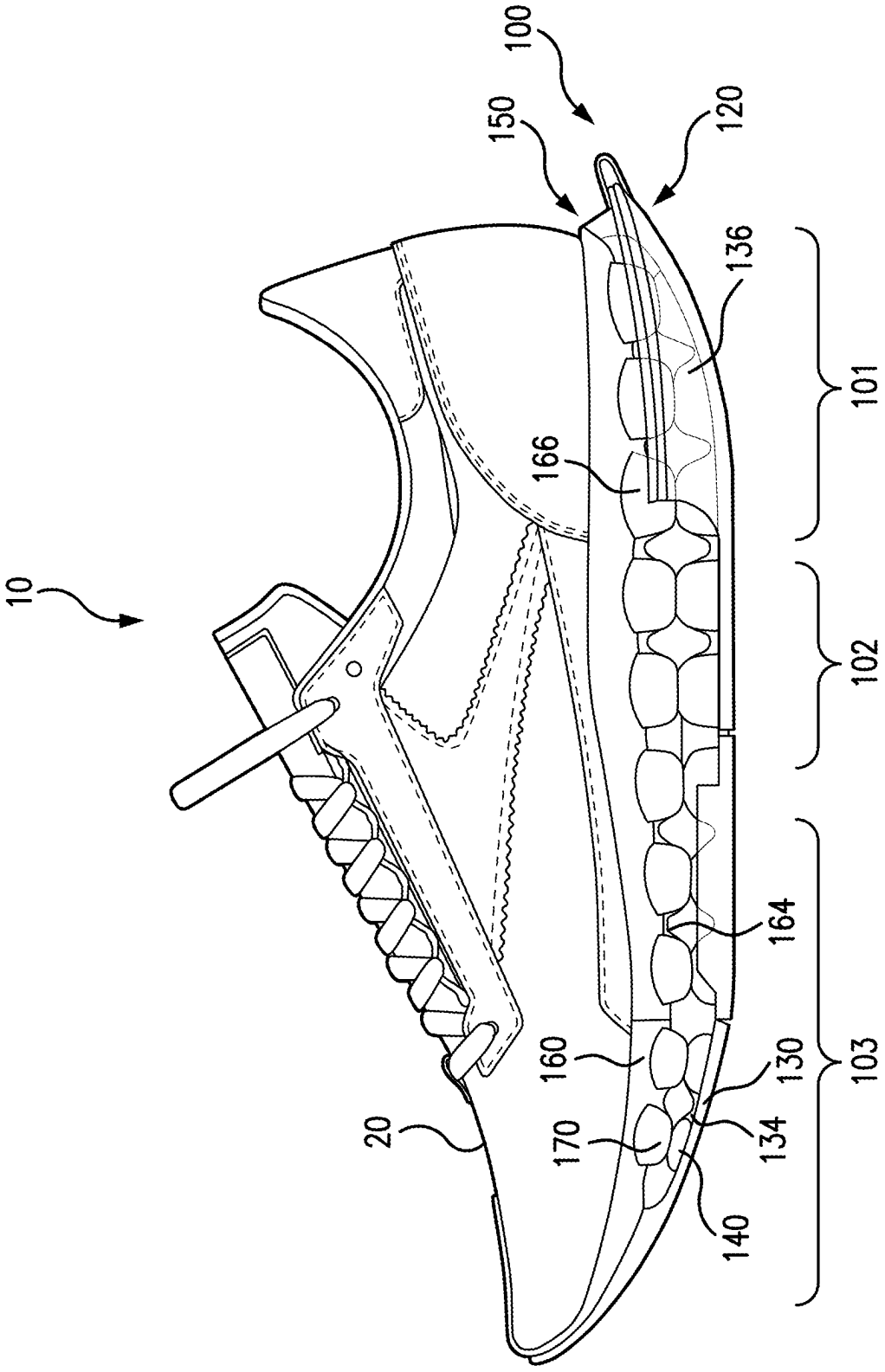
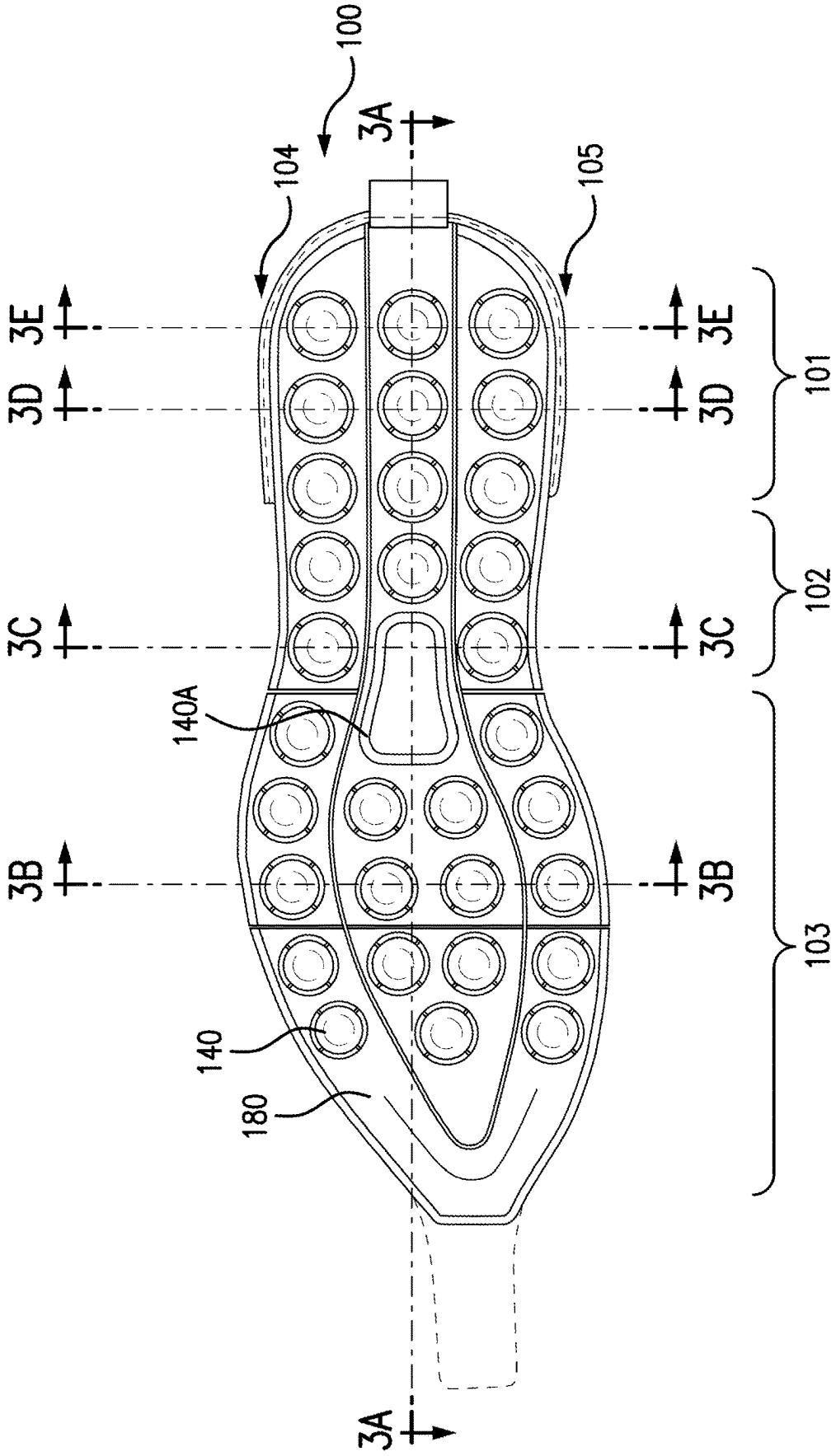


FIG. 1



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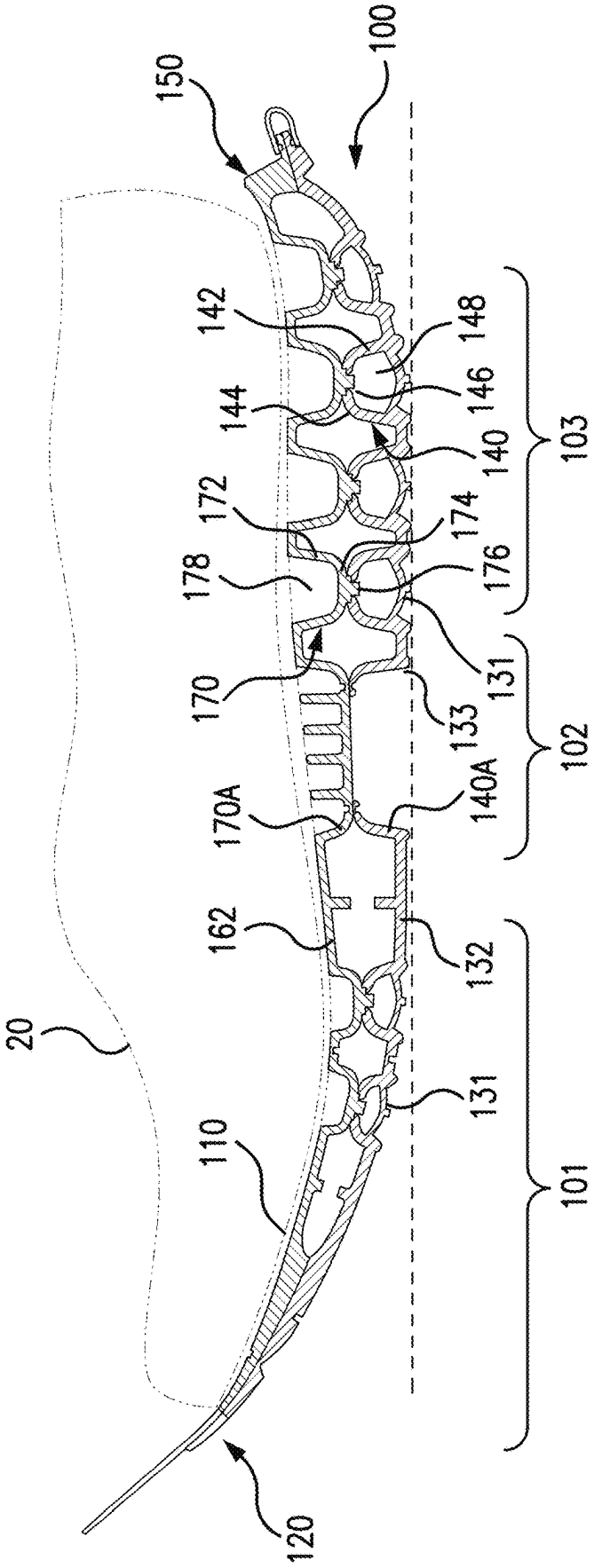
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FIG. 3A

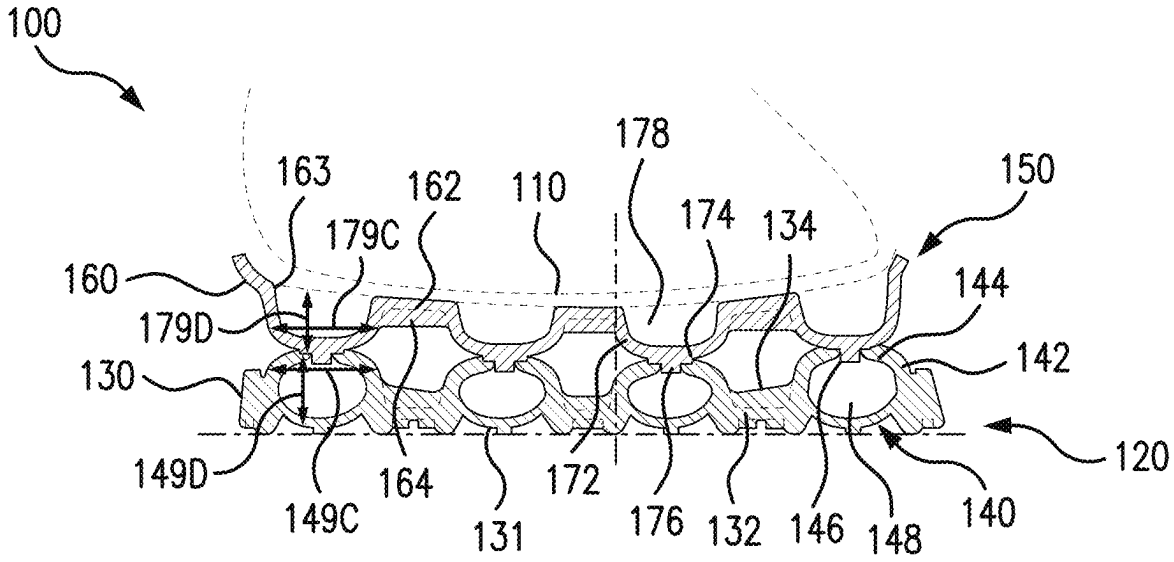
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FIG. 3B

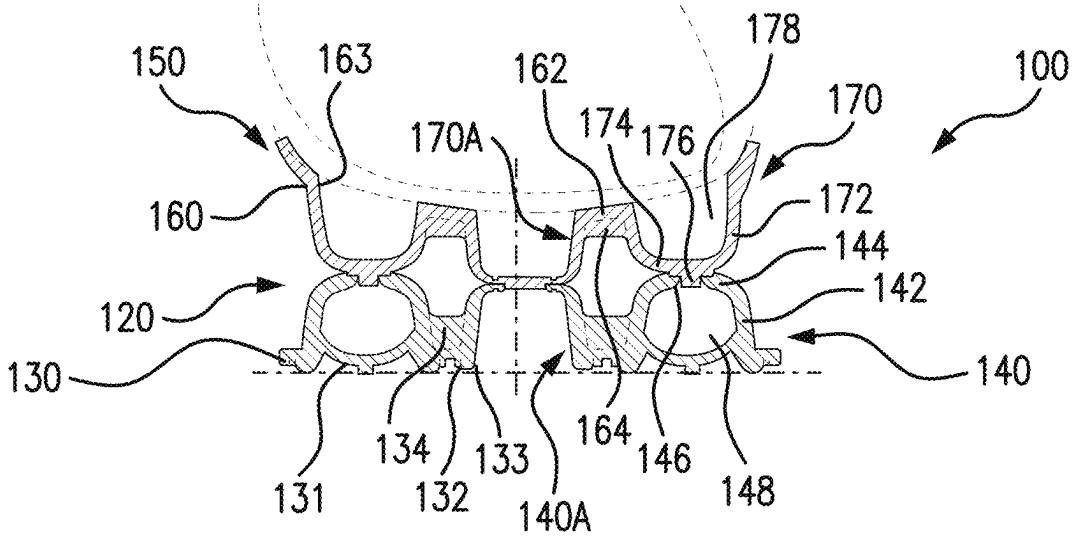
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FIG. 3C

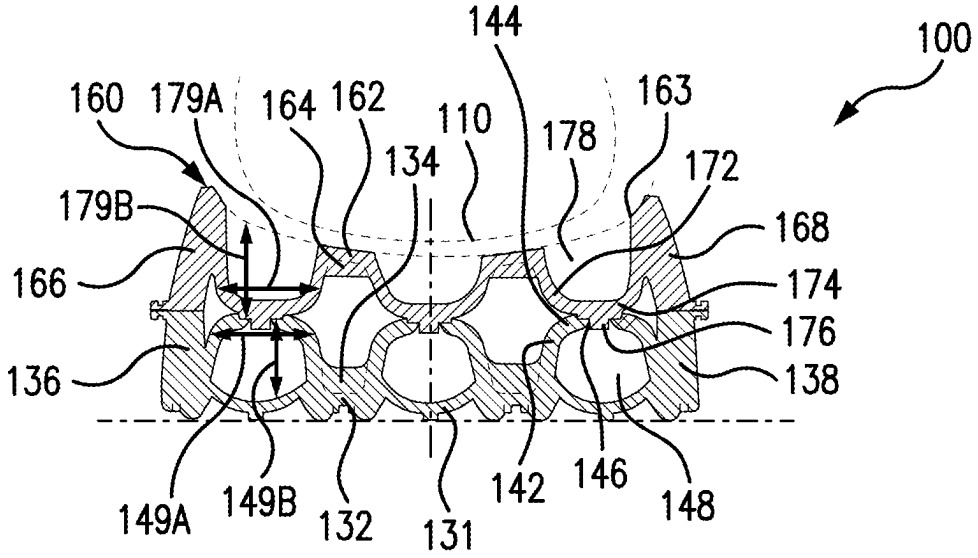
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FIG. 3D

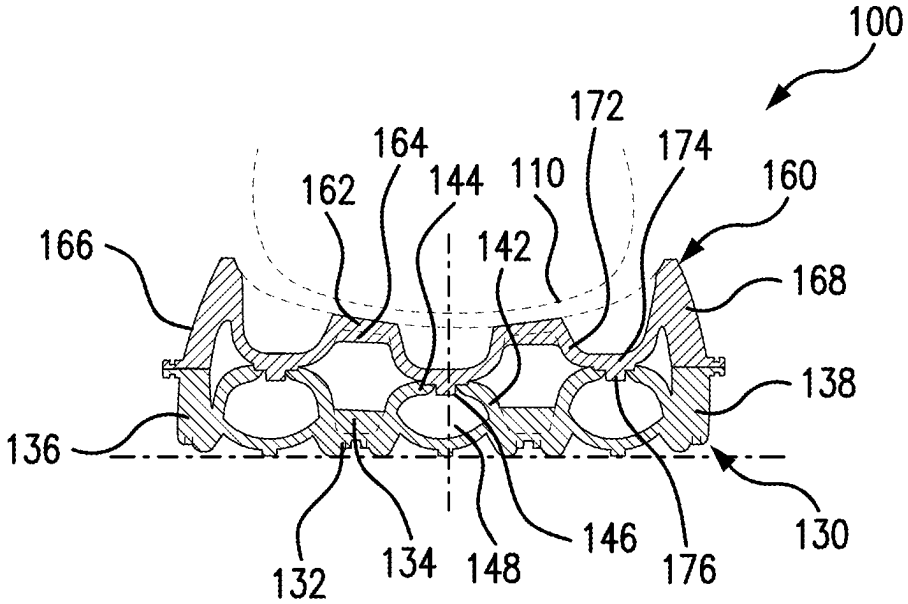
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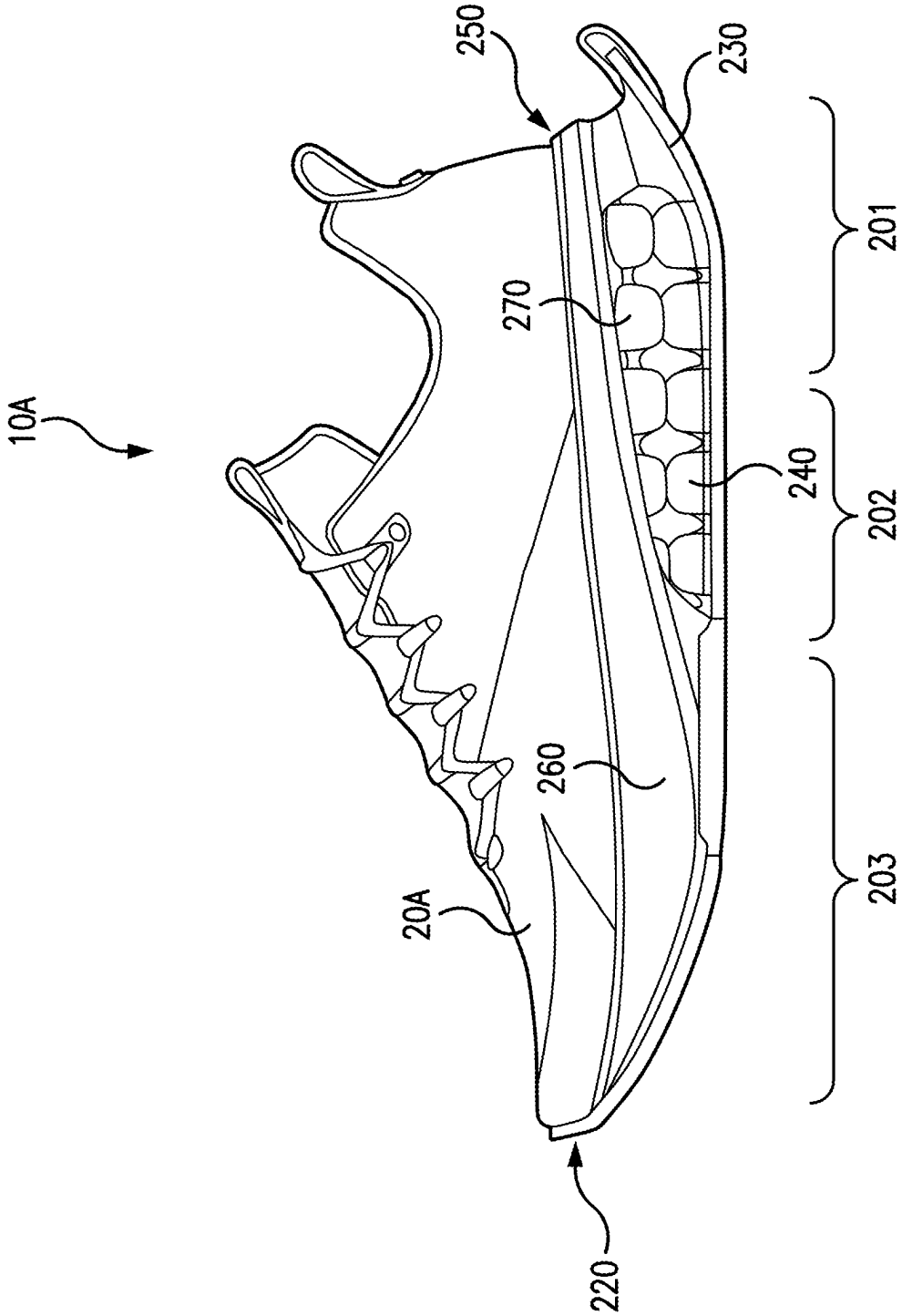
FIG. 3E



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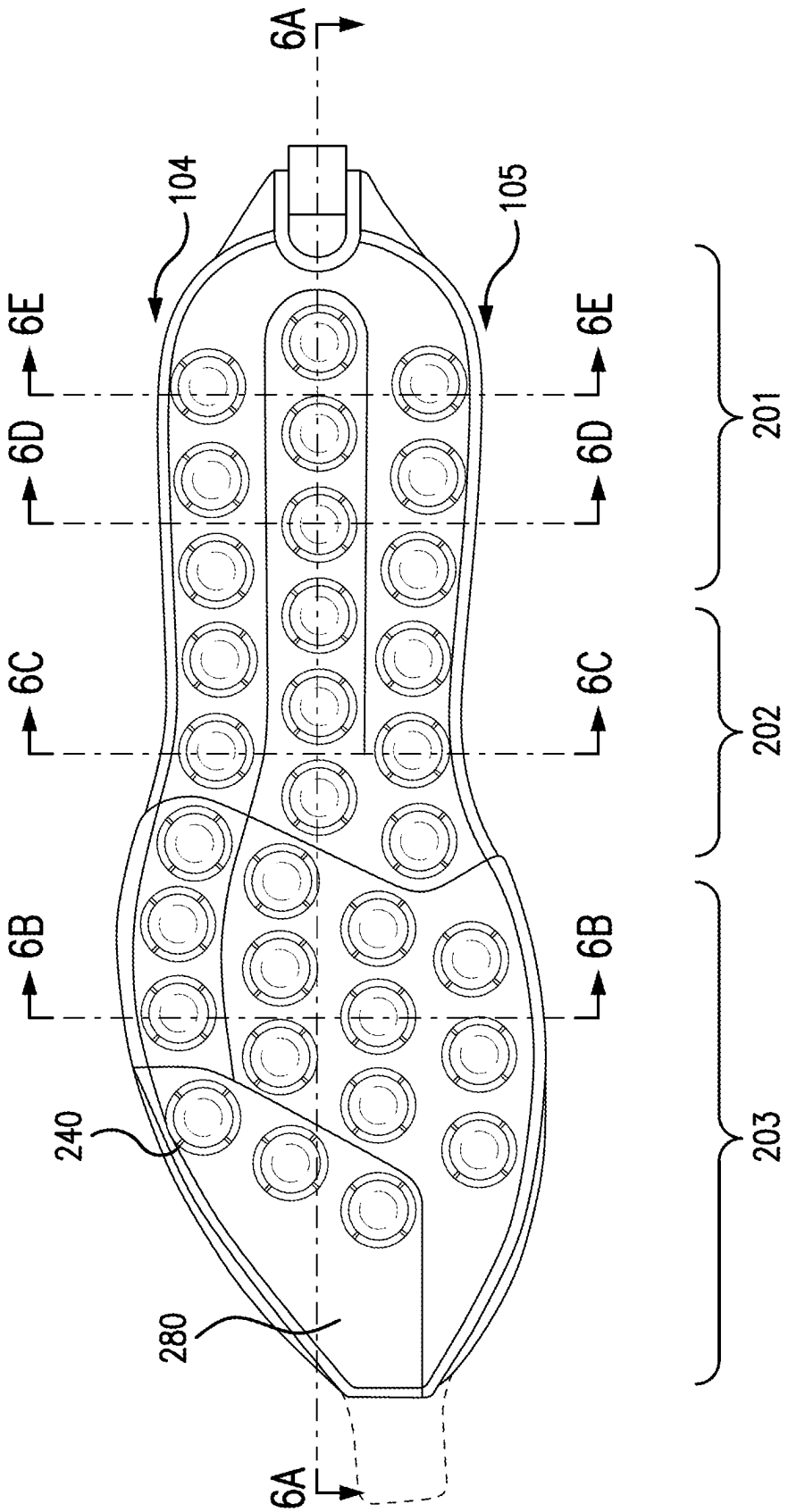

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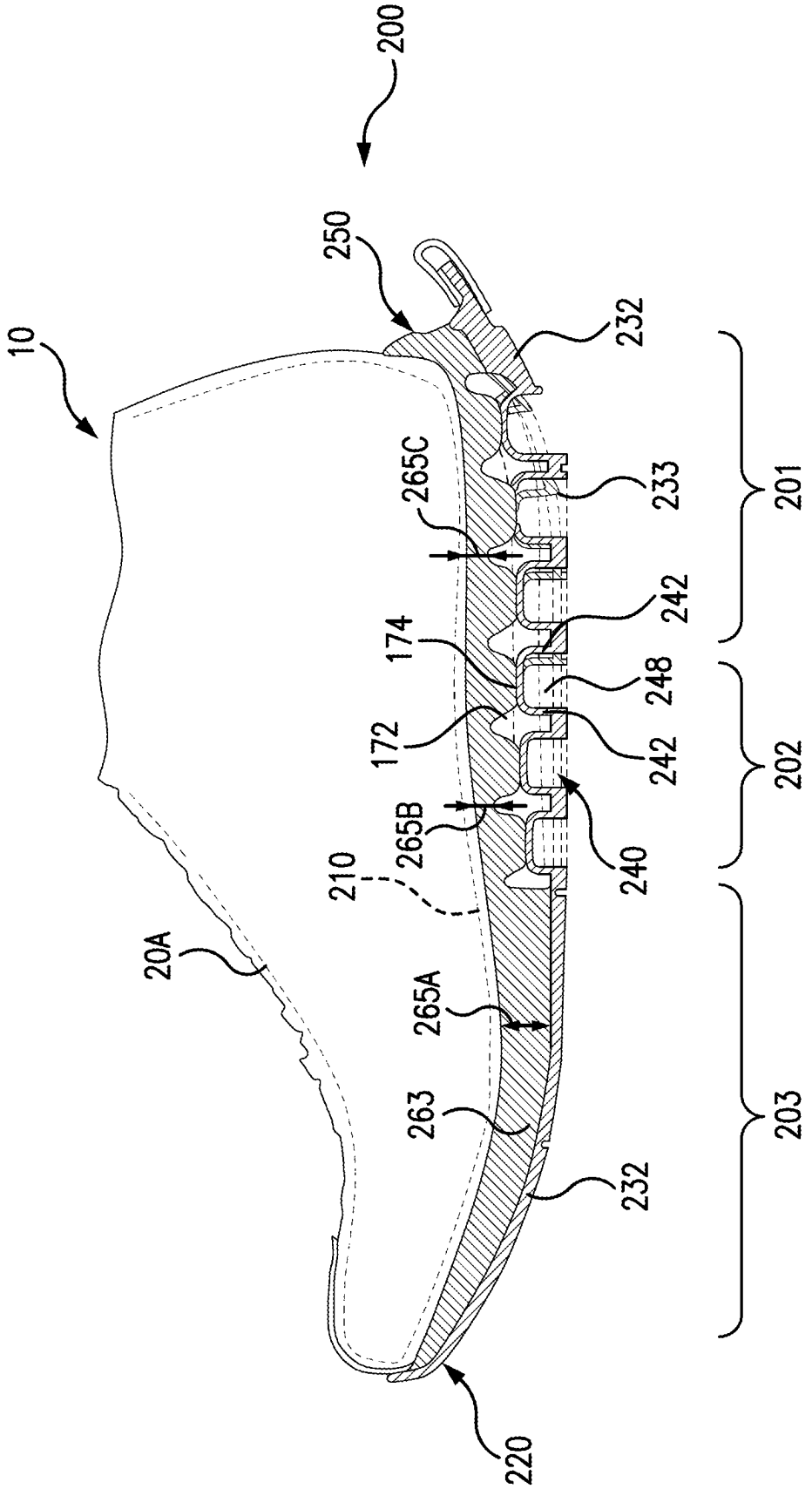
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FIG. 6A

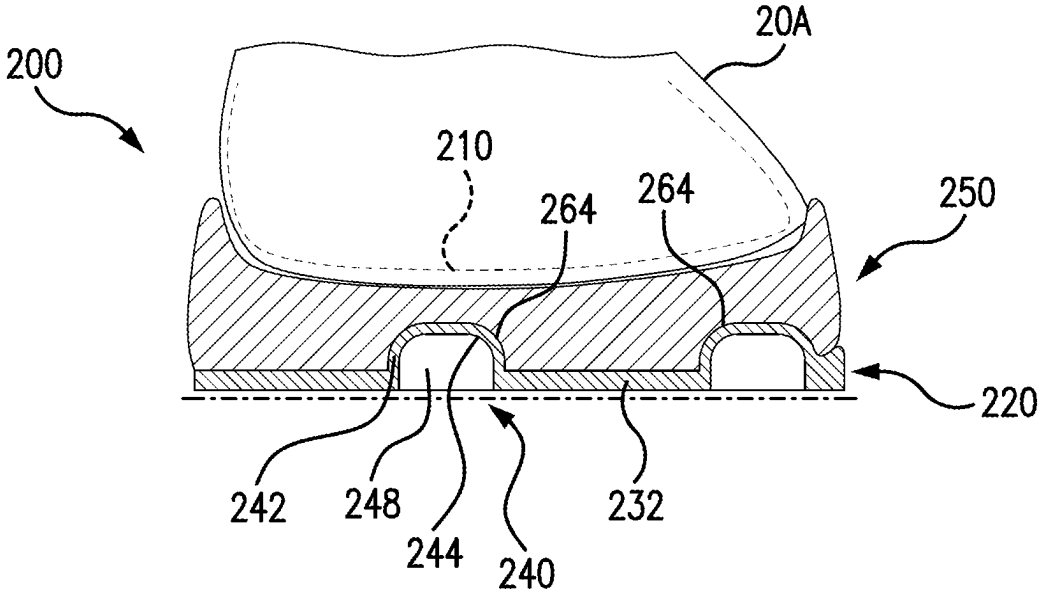
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FIG. 6B

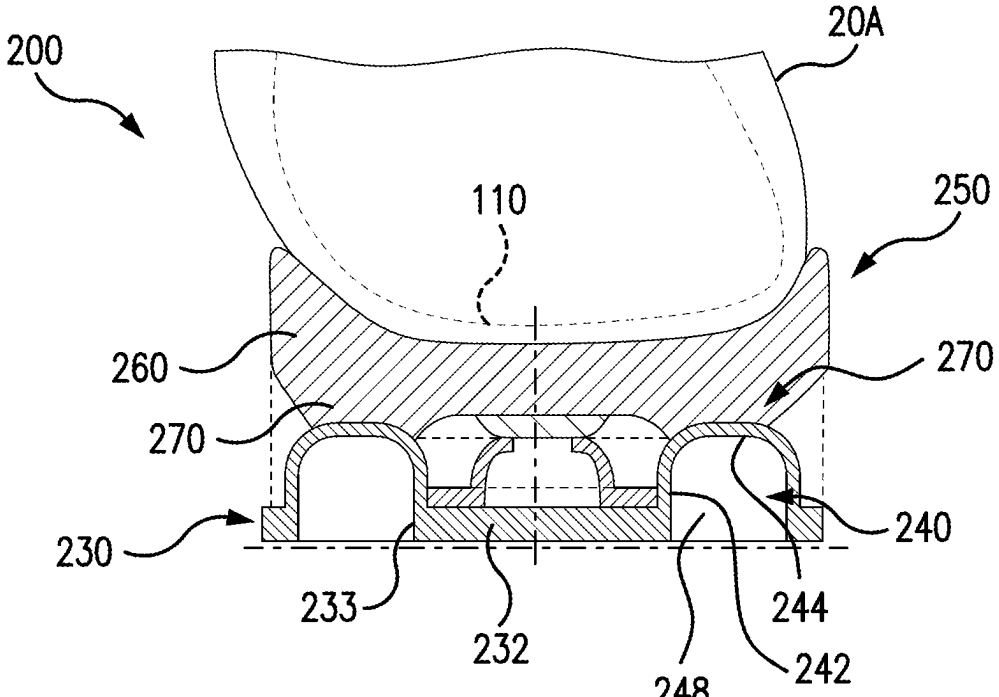
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FIG. 6C

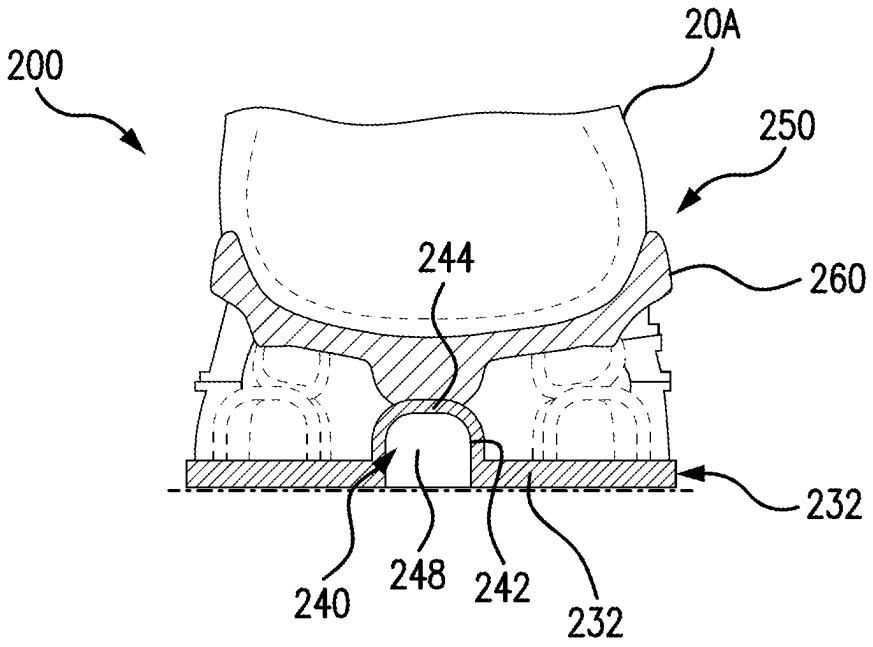
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FIG. 6D

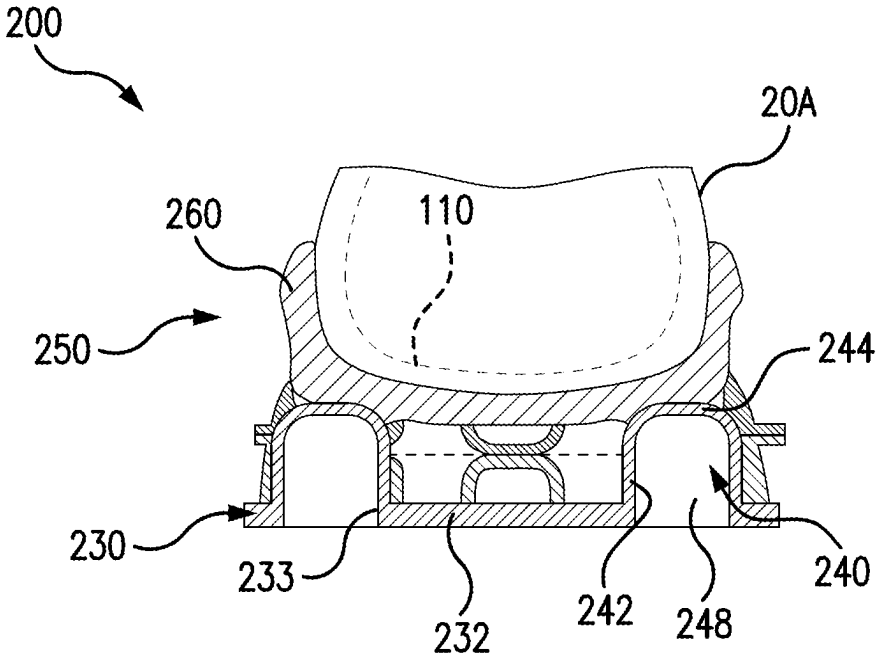
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FIG. 6E

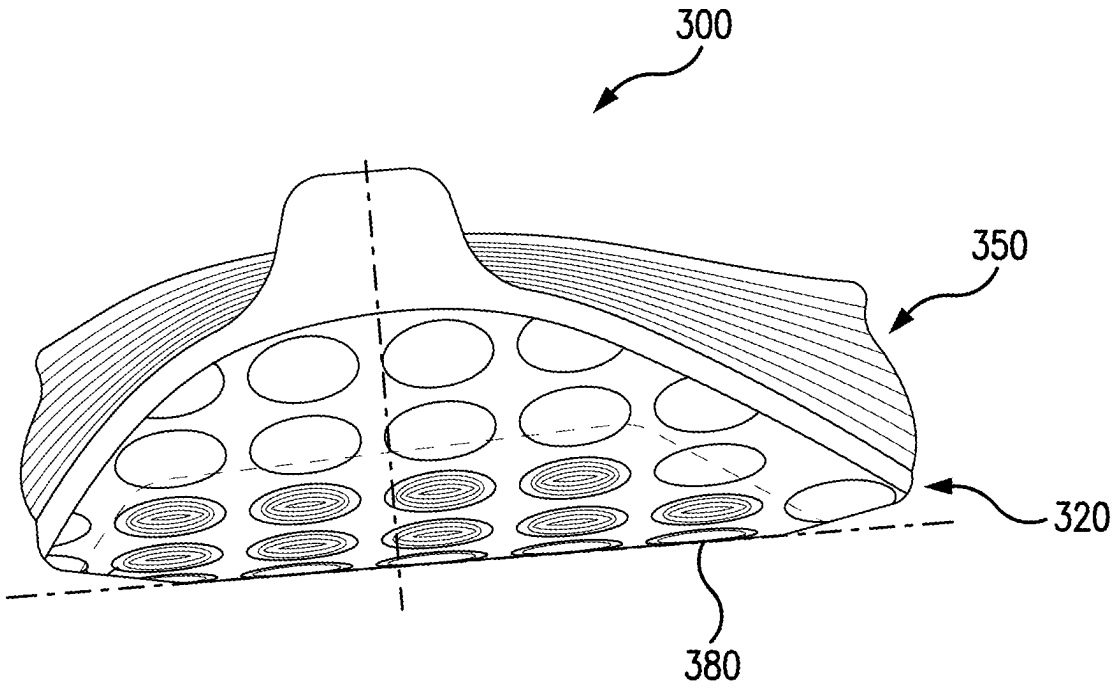
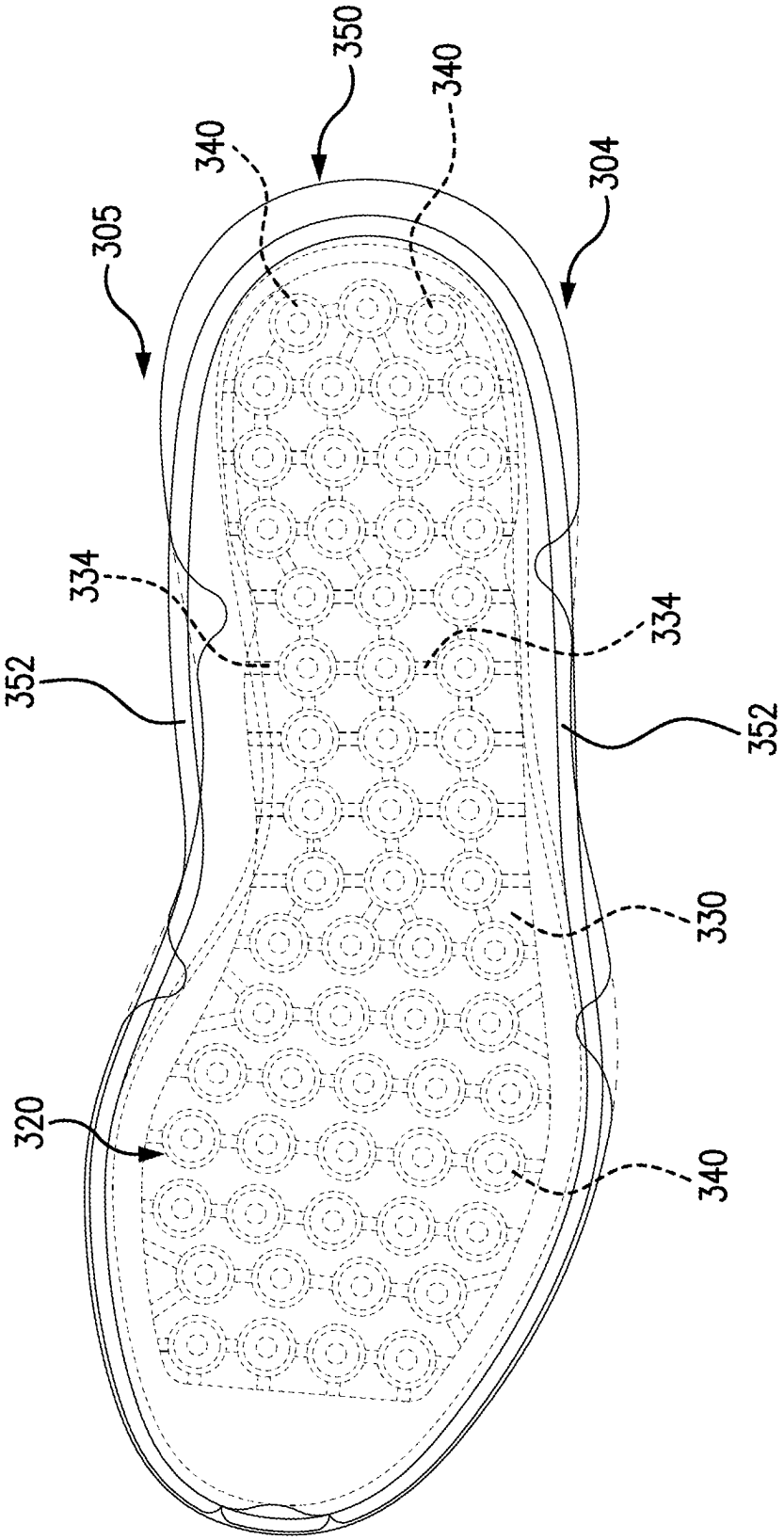


FIG. 7



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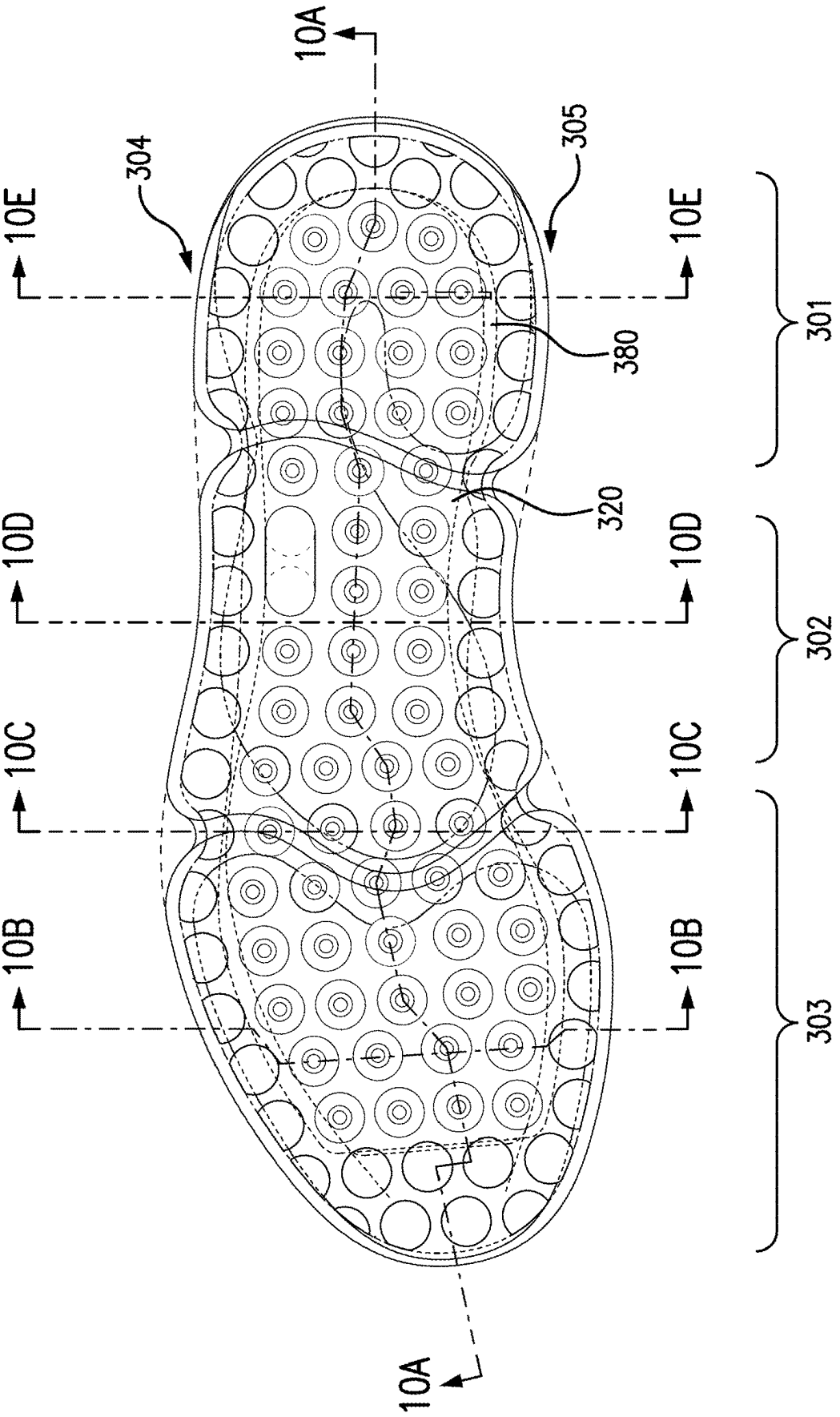
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FIG. 9

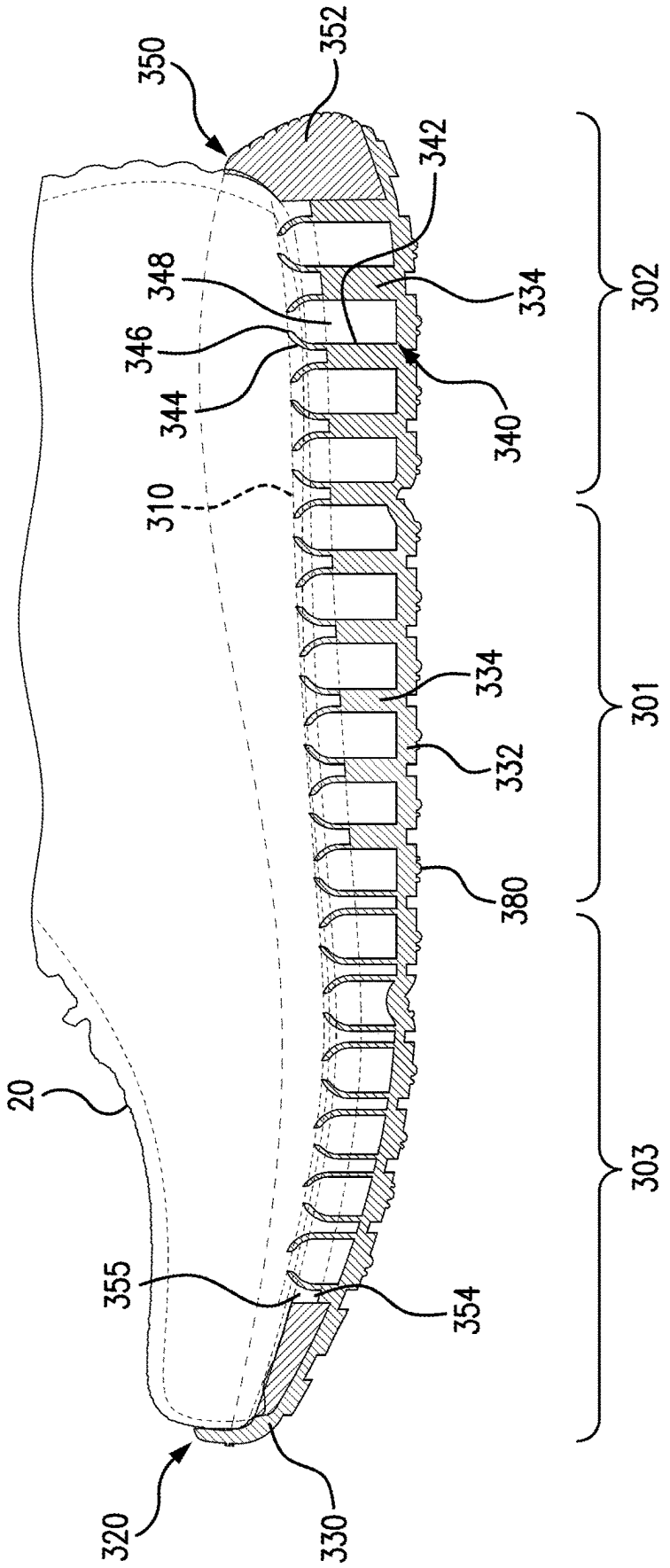
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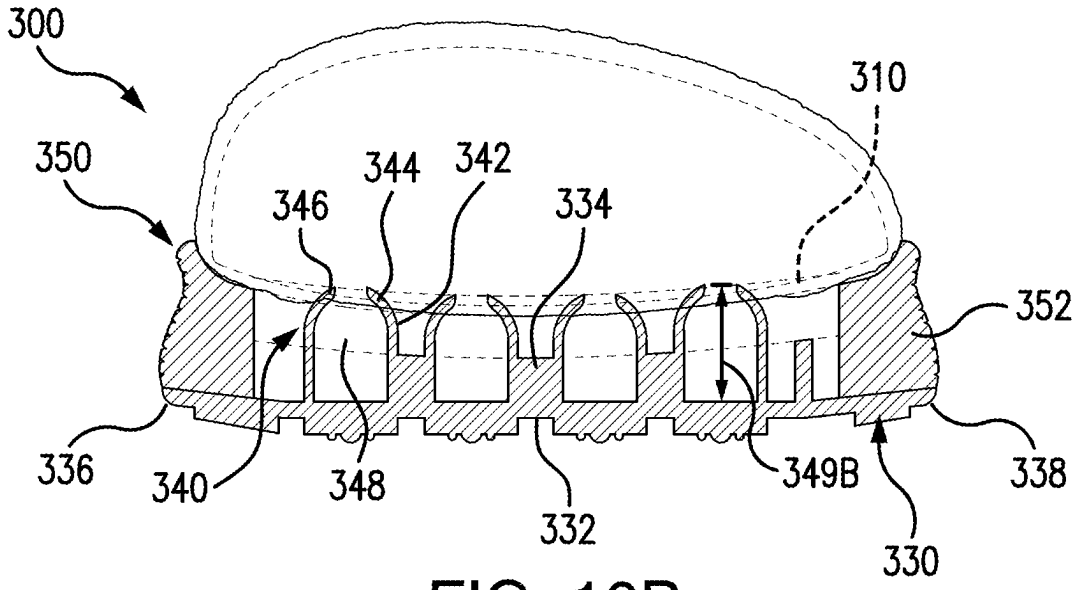
FIG. 10A



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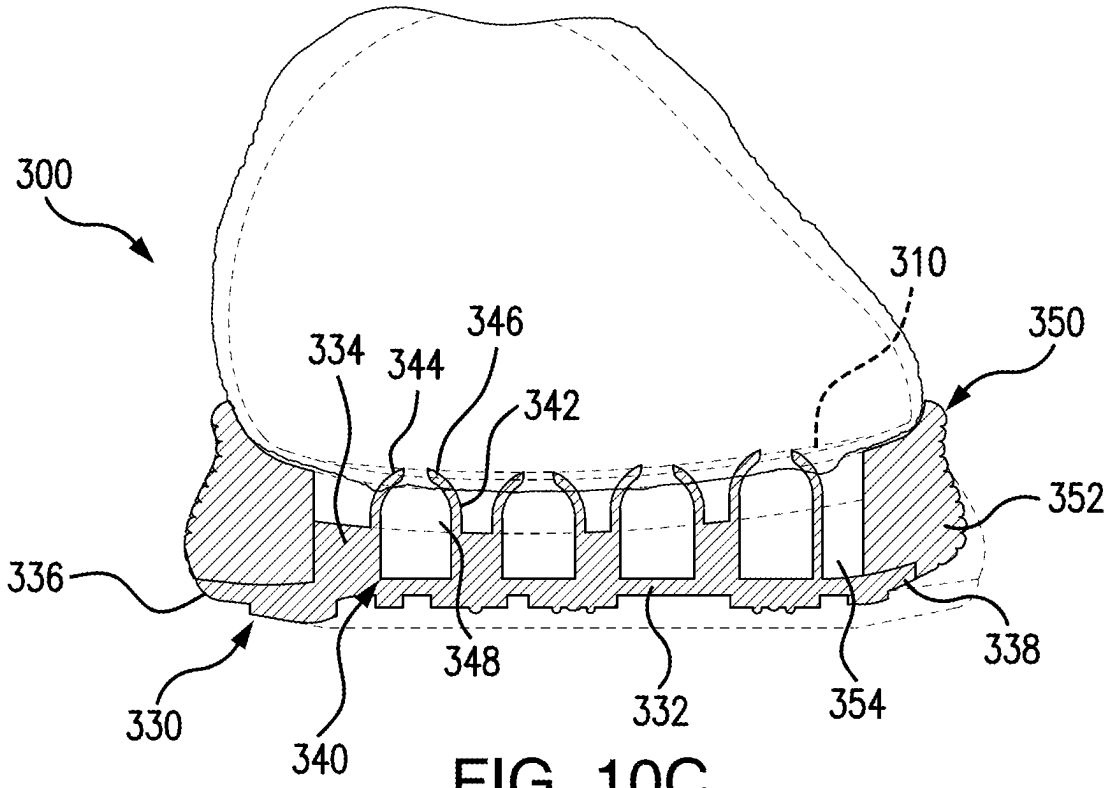

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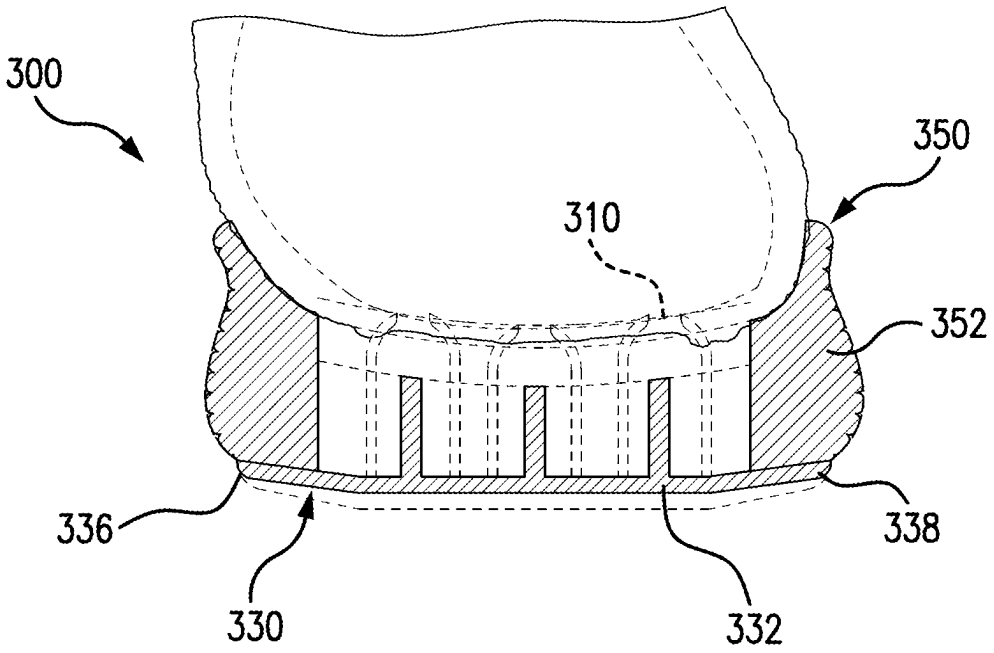

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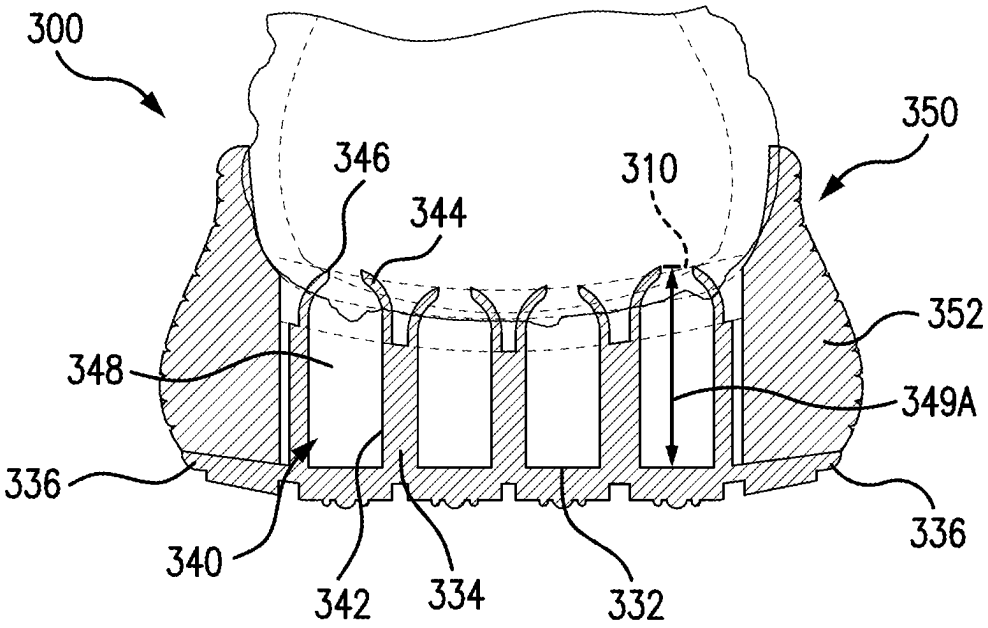

FIG. 10E

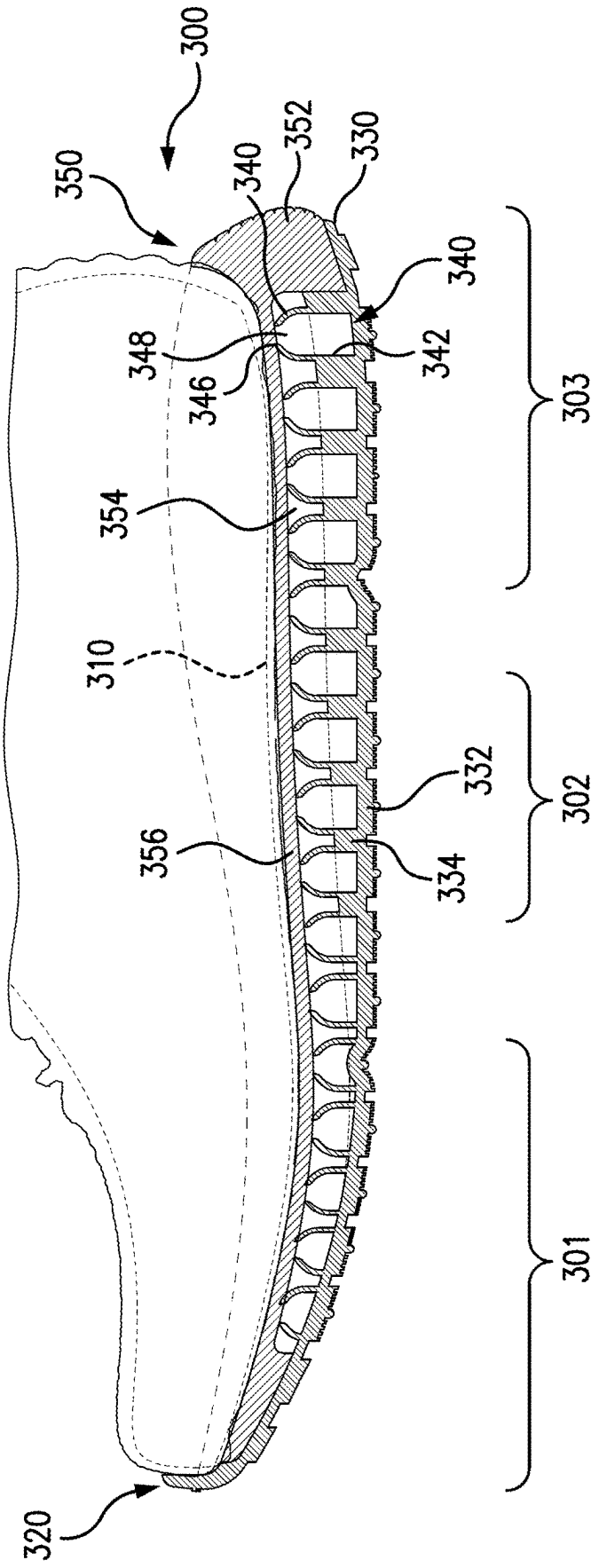
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FIG. 11A

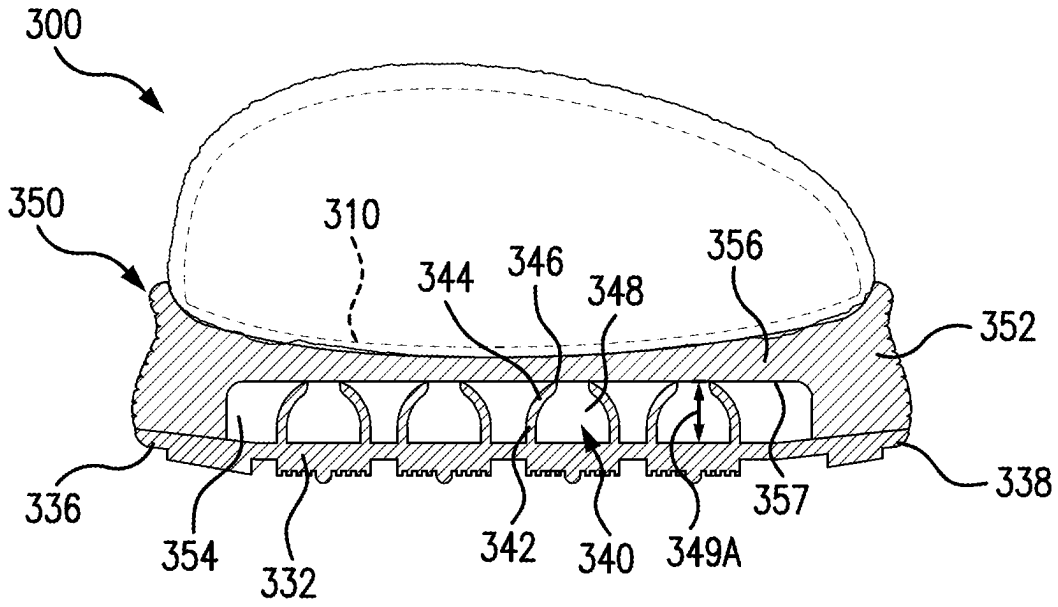
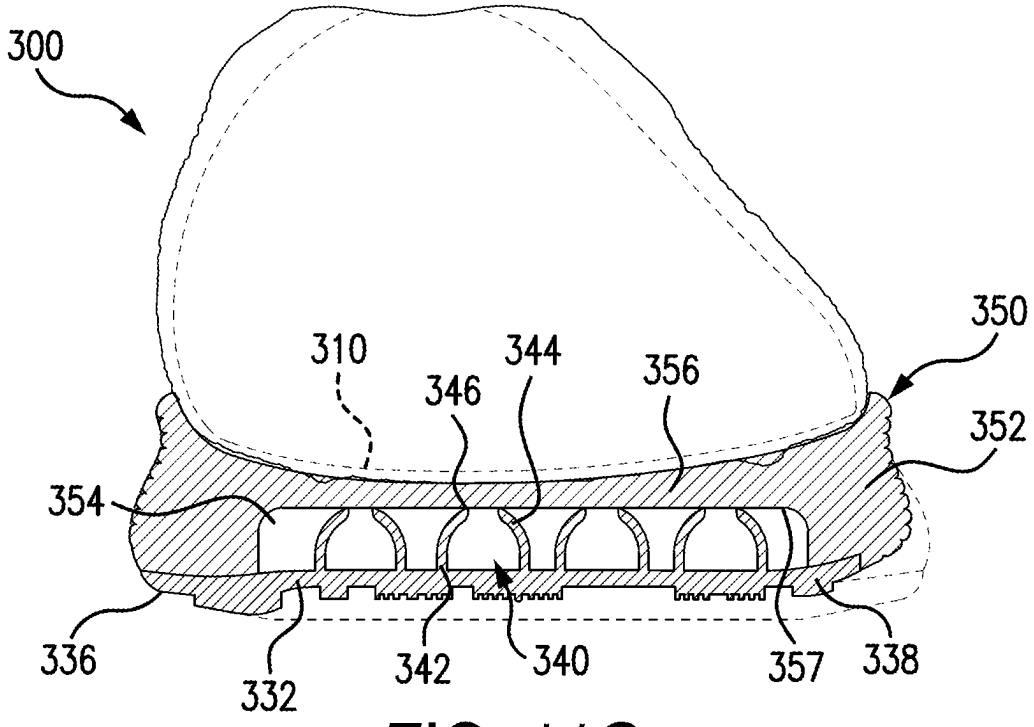


FIG. 11B



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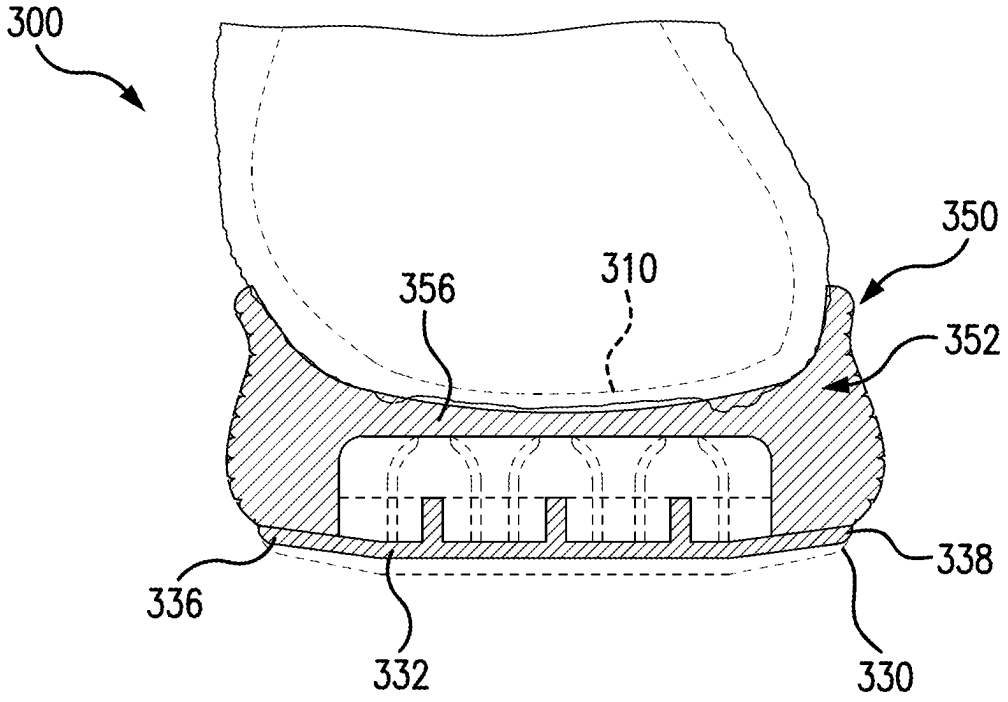
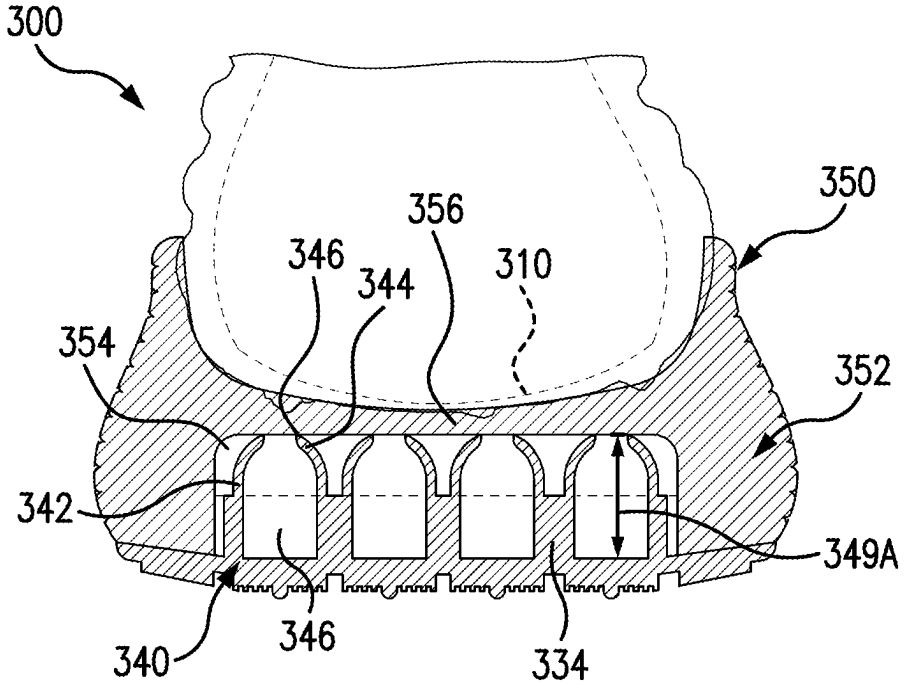


FIG. 11D



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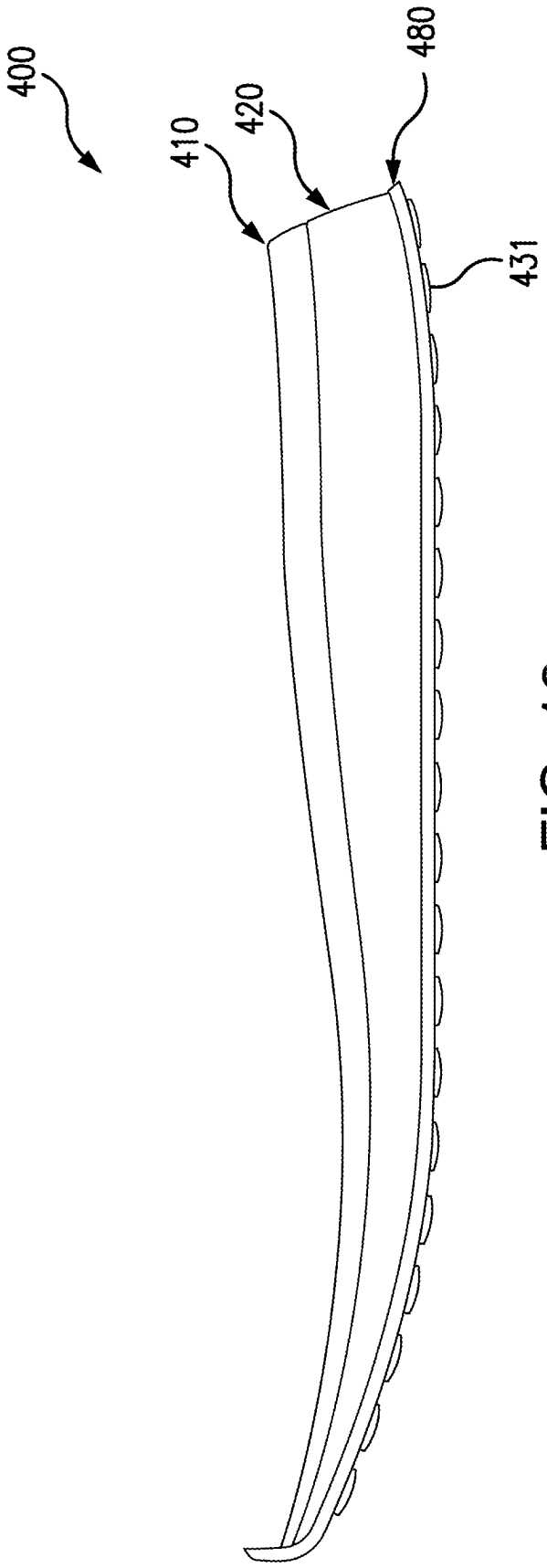

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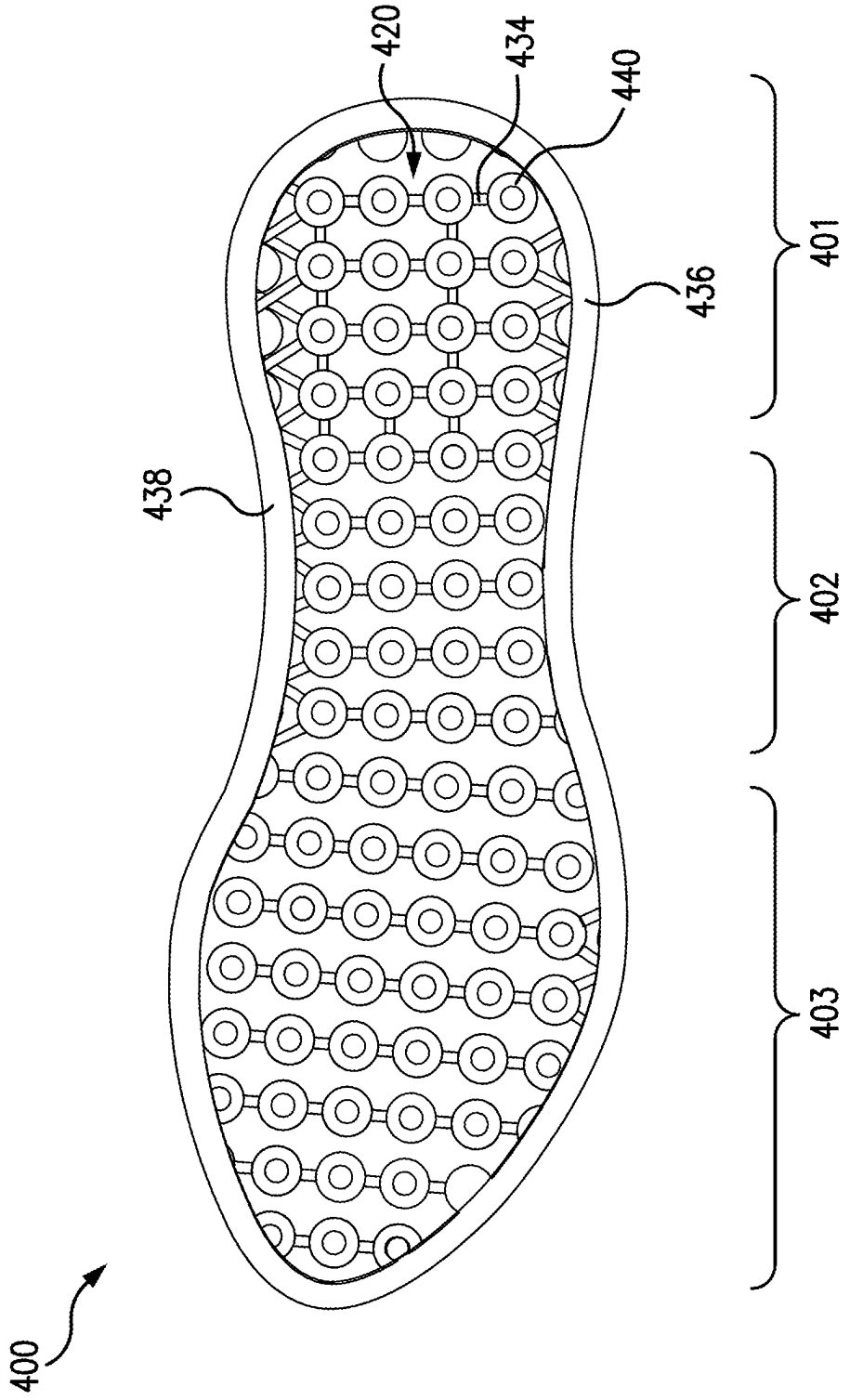
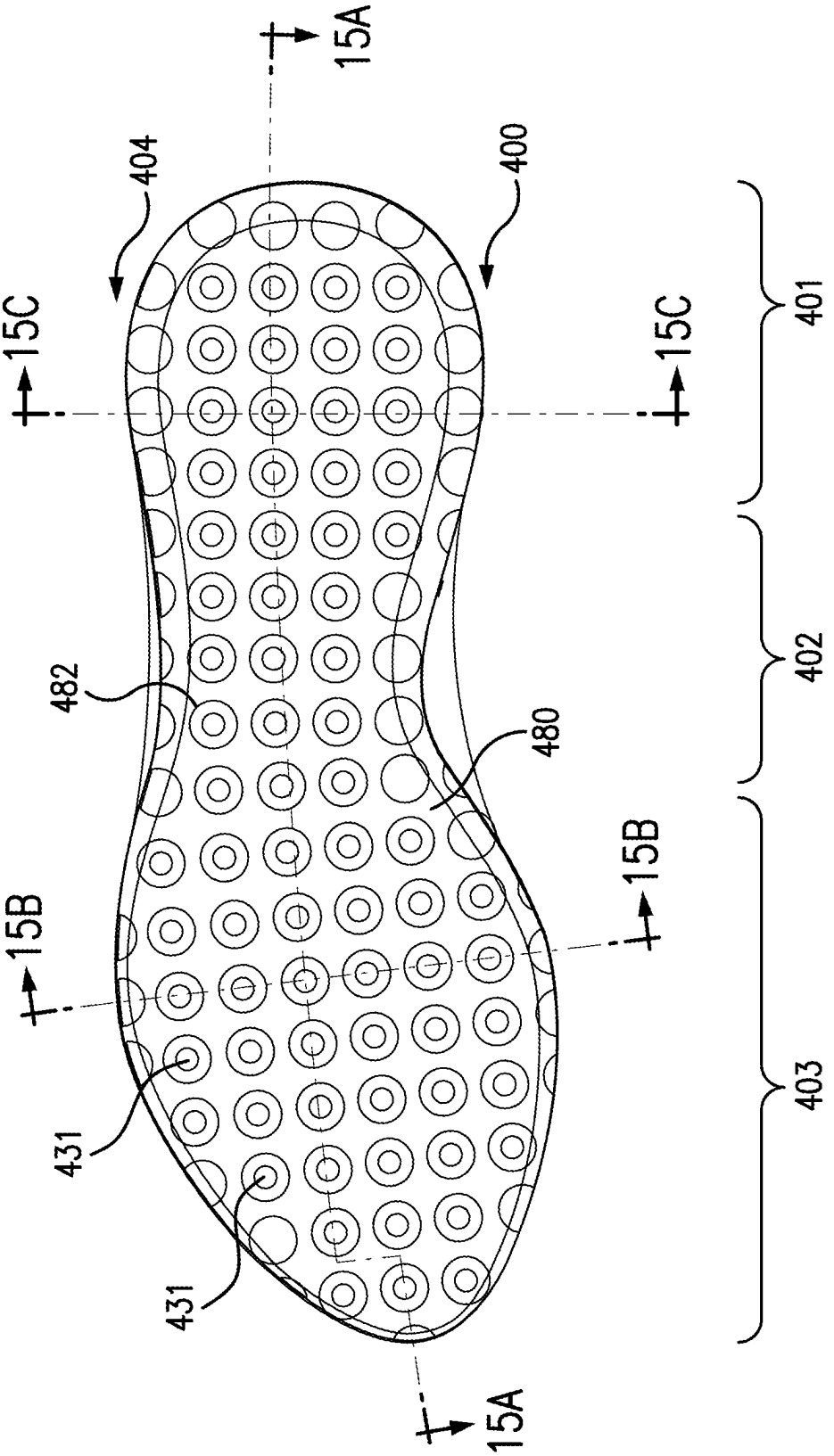


FIG. 13



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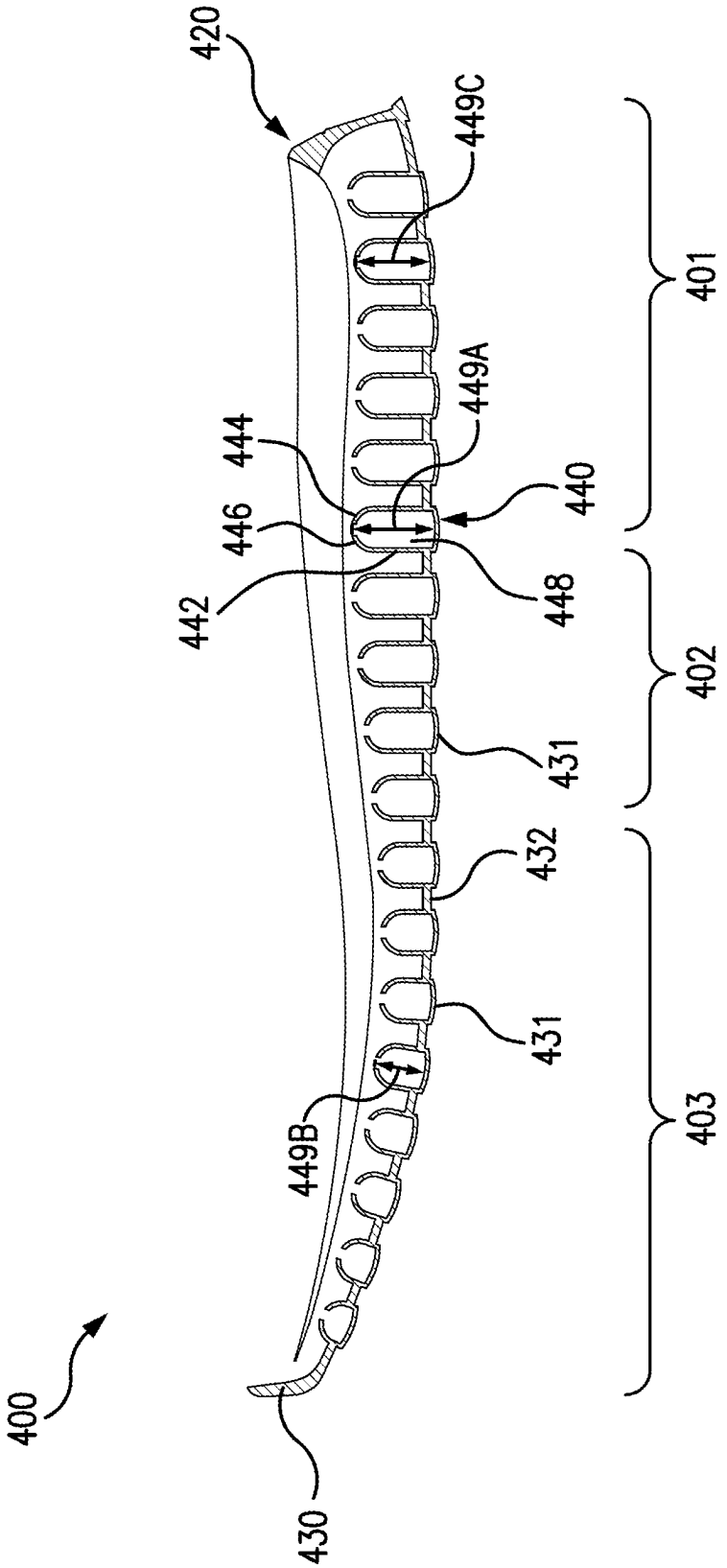
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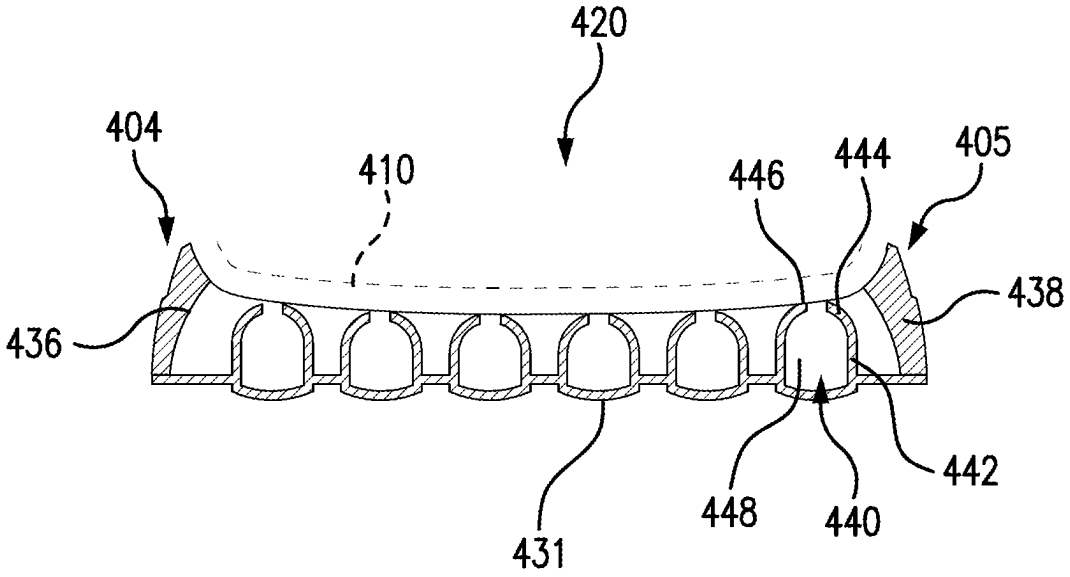


FIG. 15B

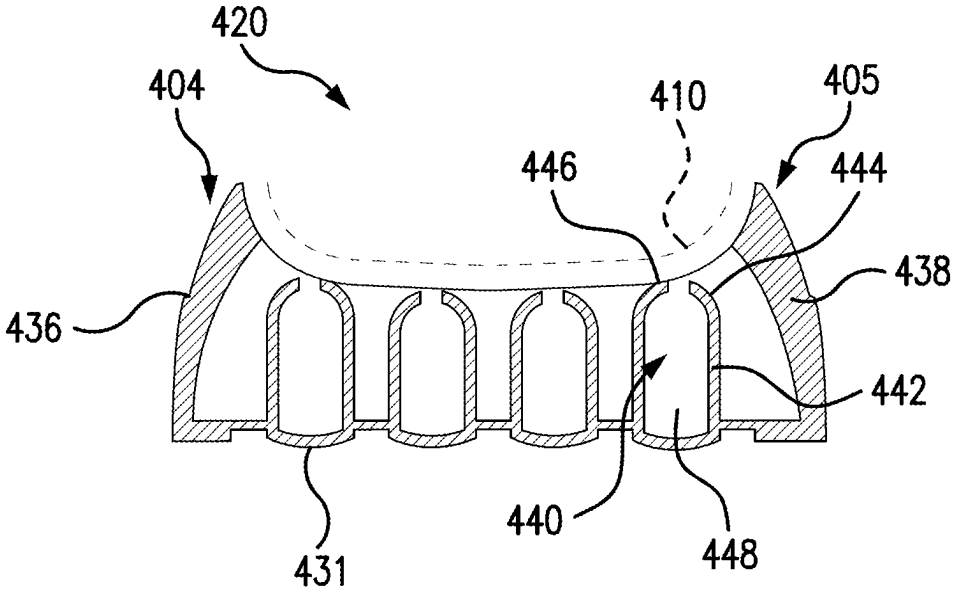
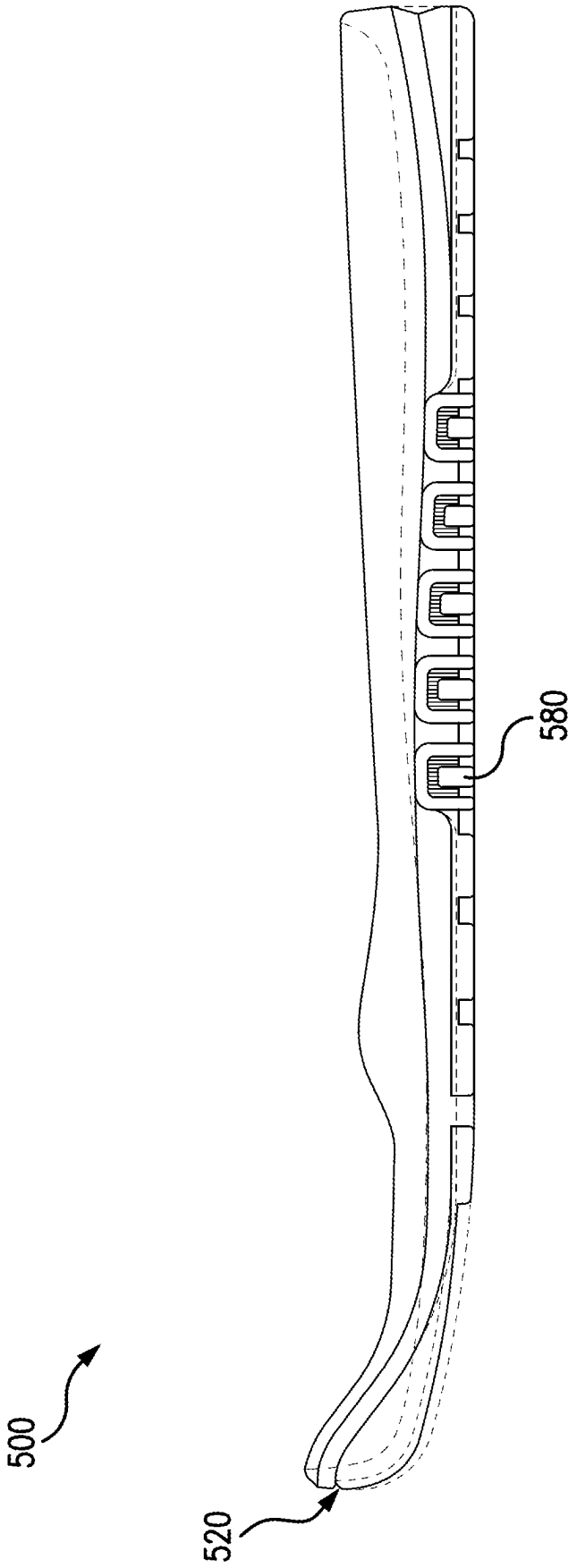


FIG. 15C



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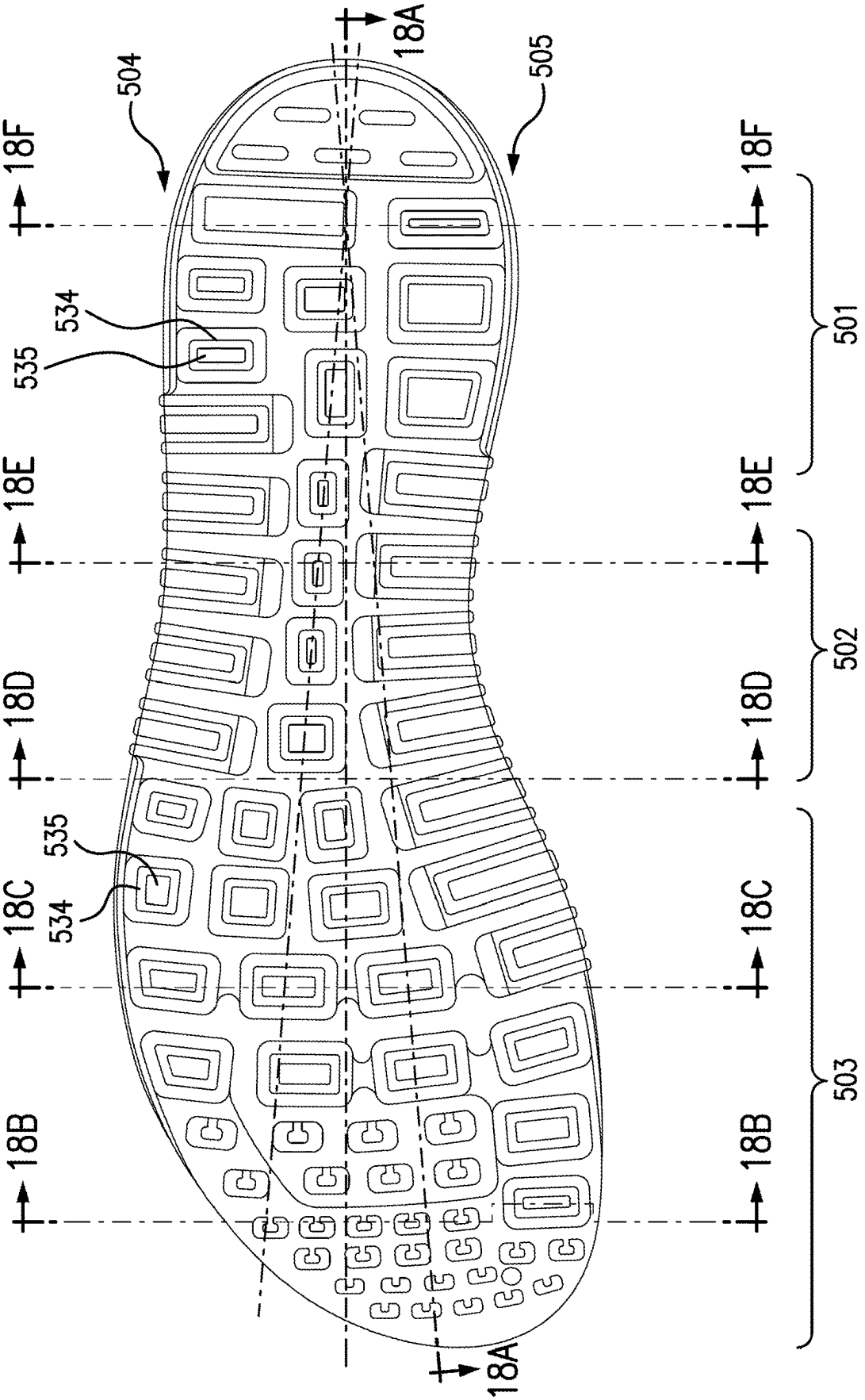
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FIG. 17

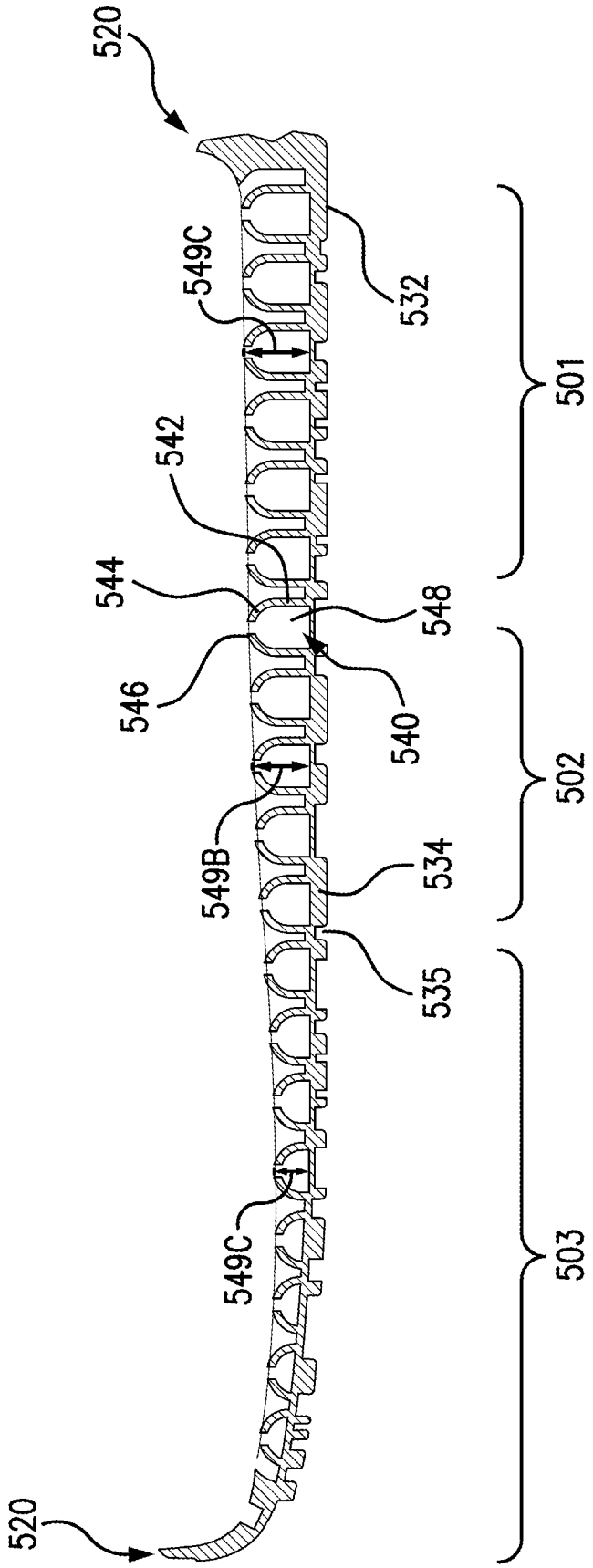
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FIG. 18A

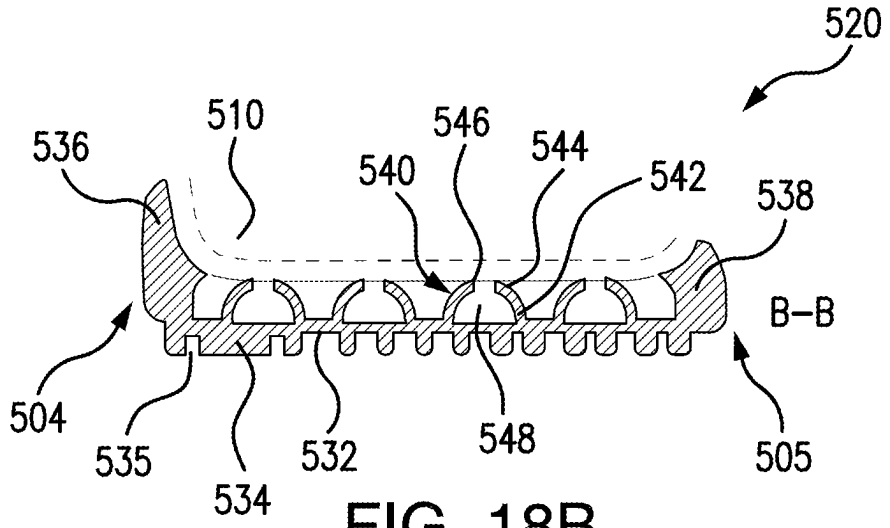
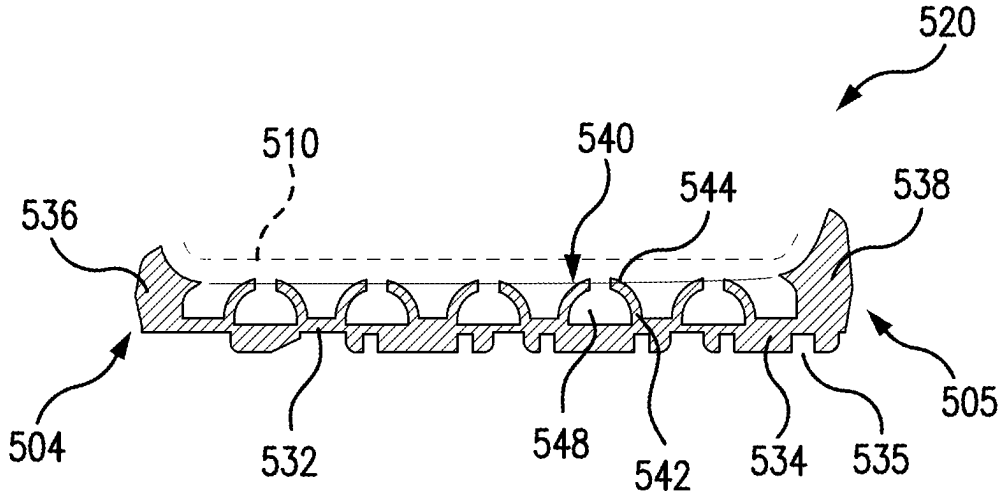


FIG. 18B



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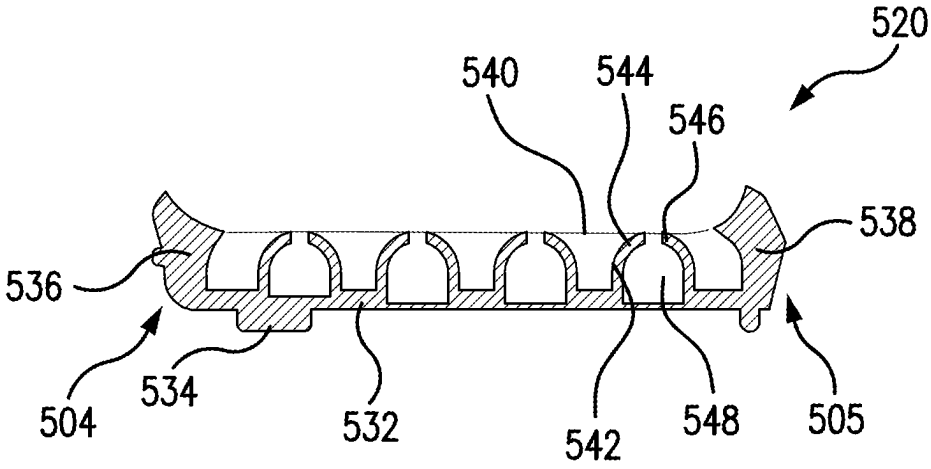

FIG. 18D

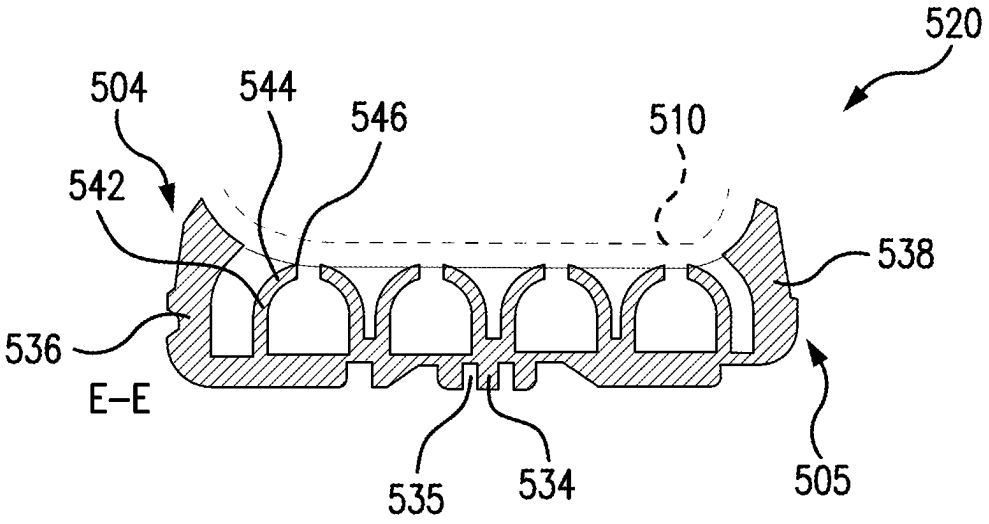

FIG. 18E

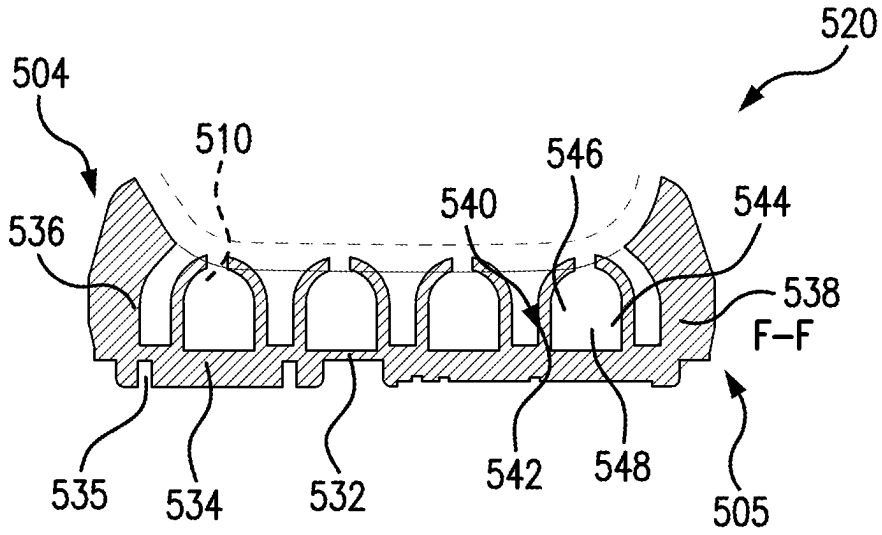

FIG. 18F

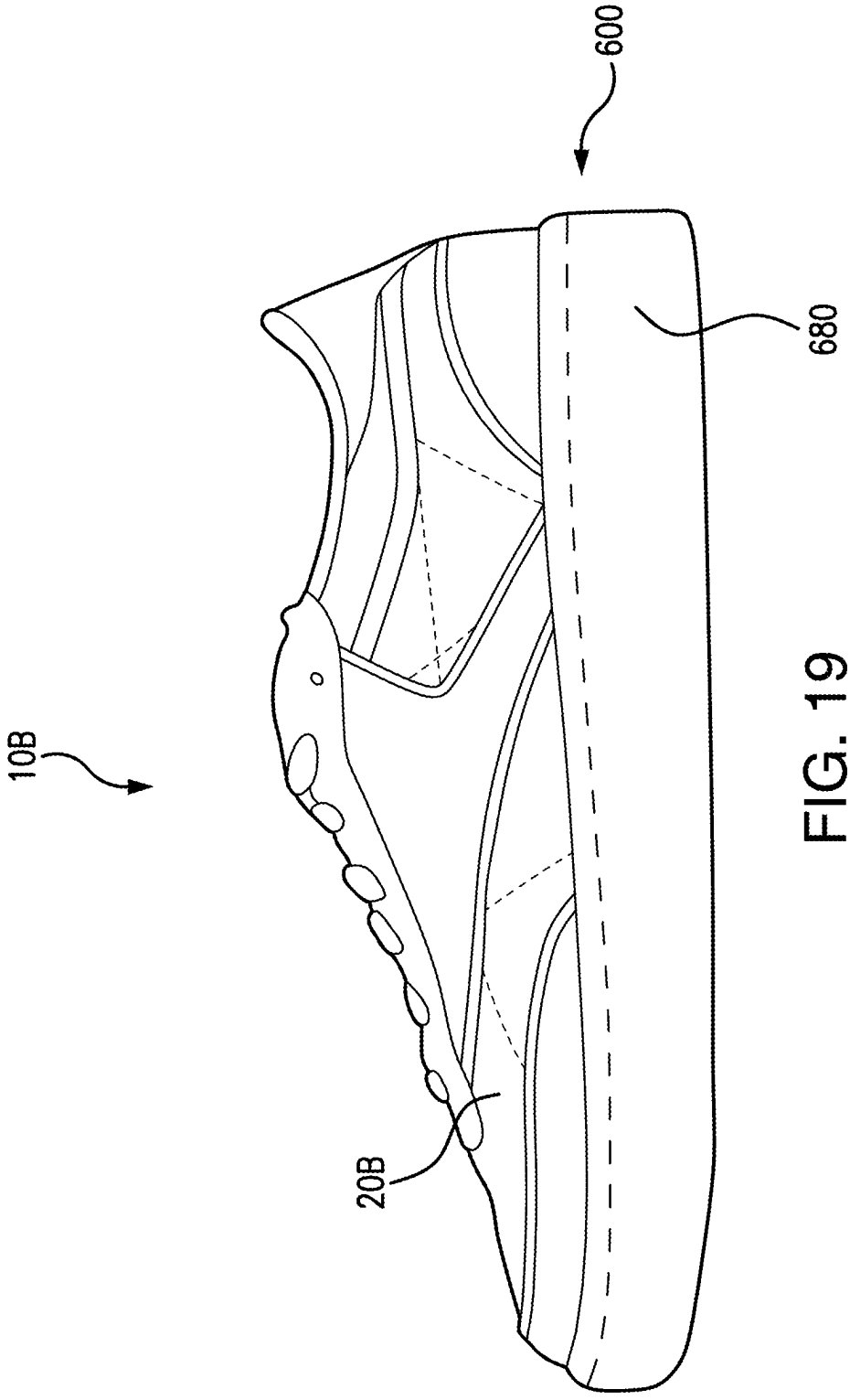

FIG. 19

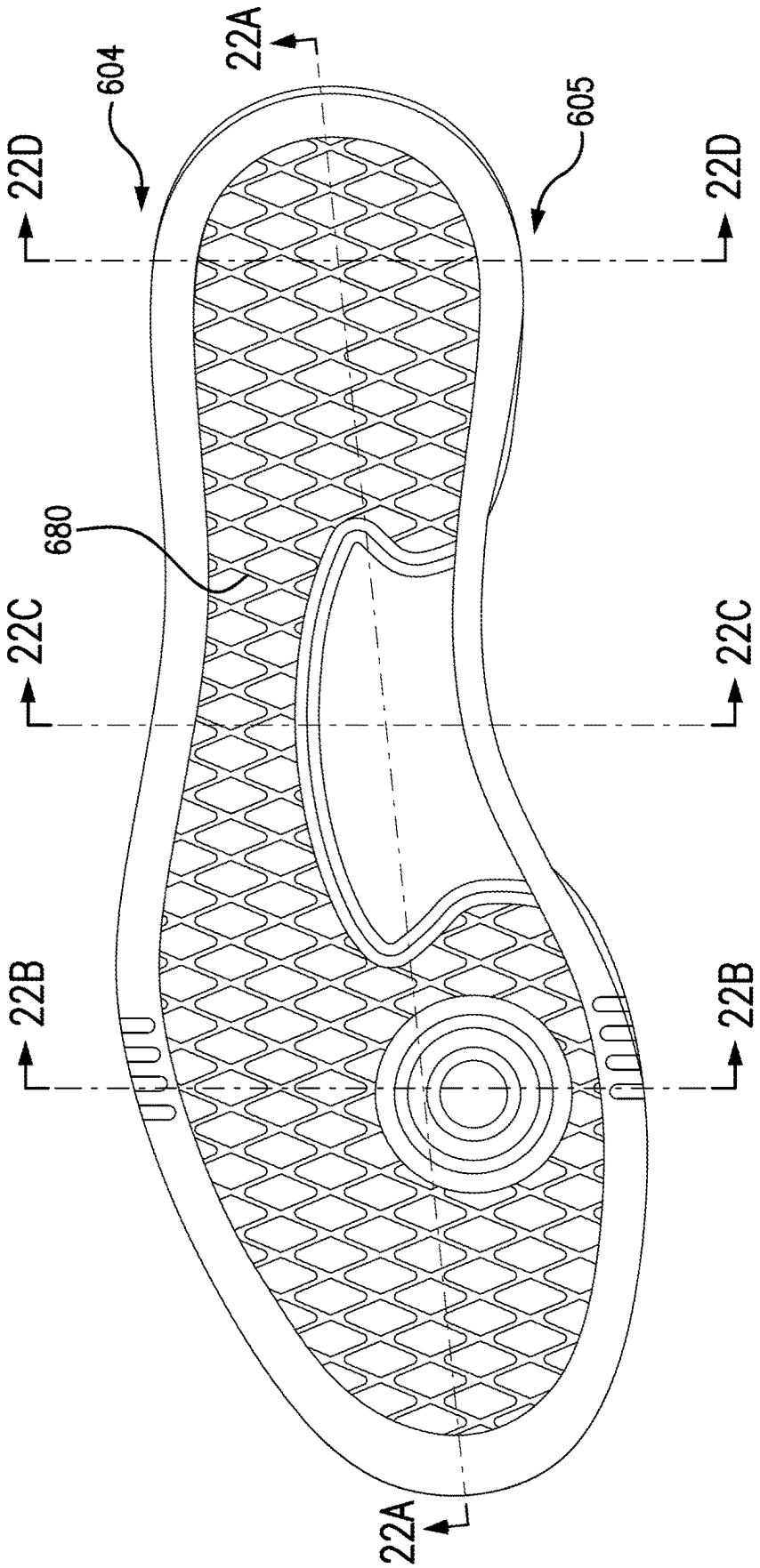

FIG. 20

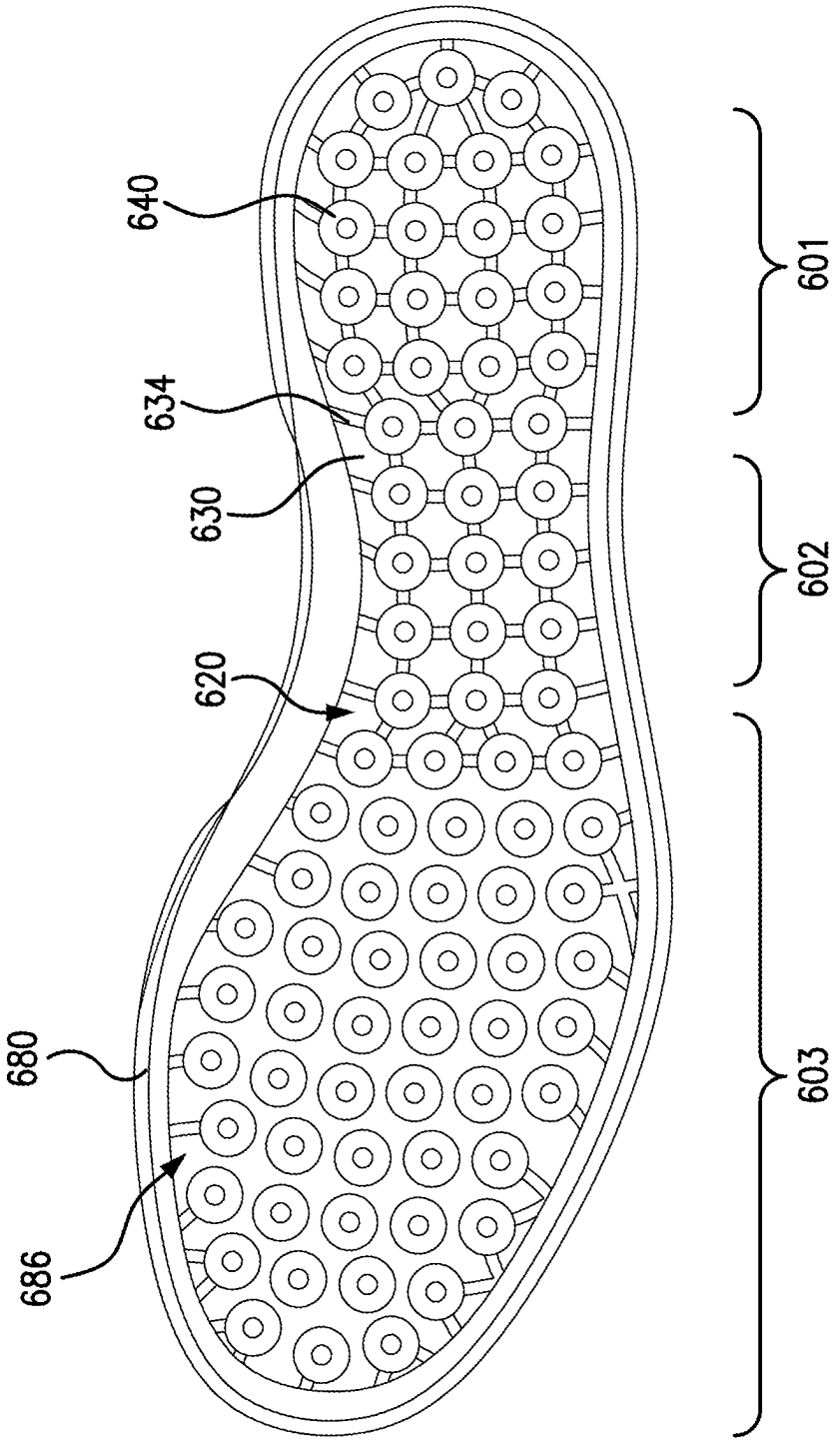

FIG. 21

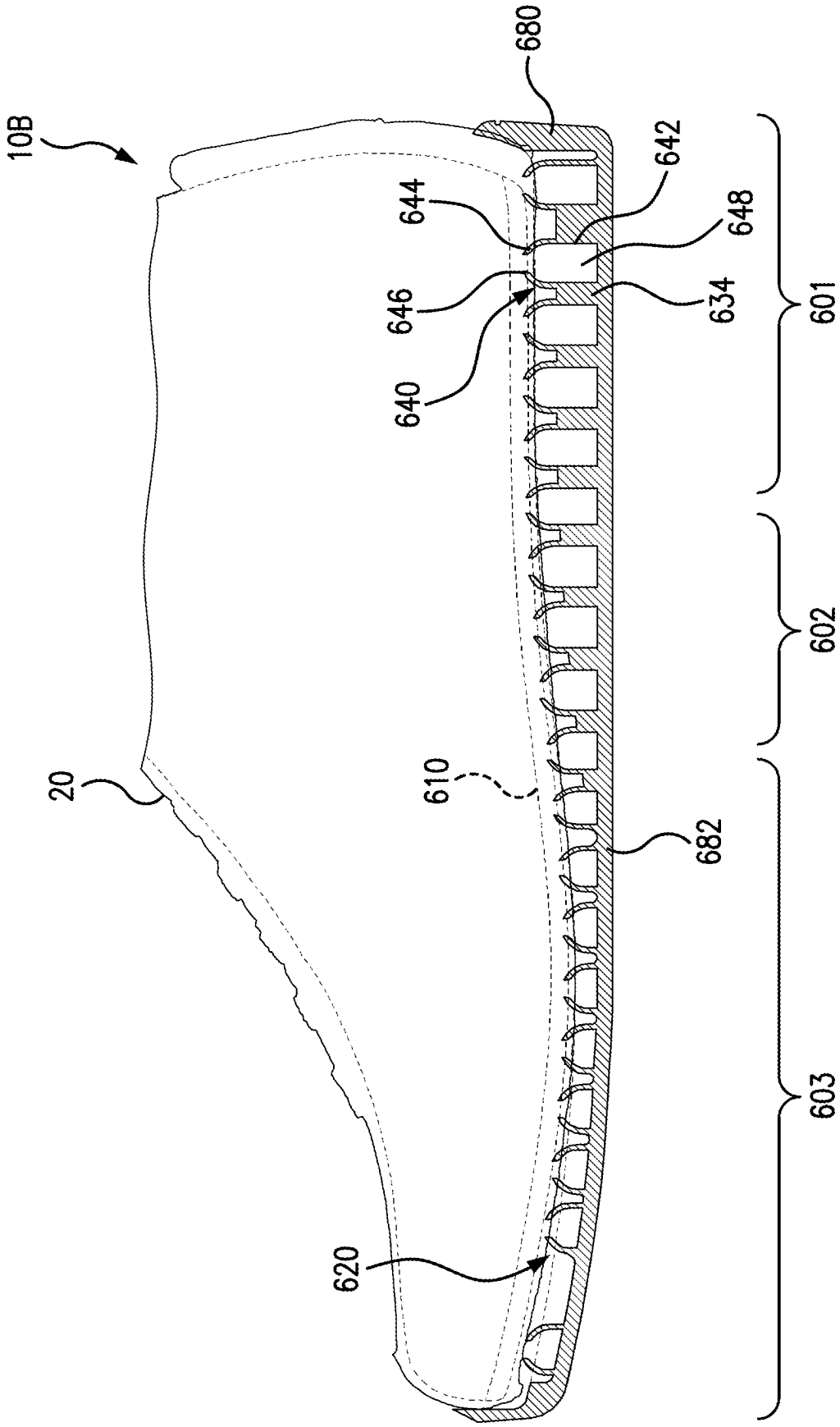

FIG. 22A

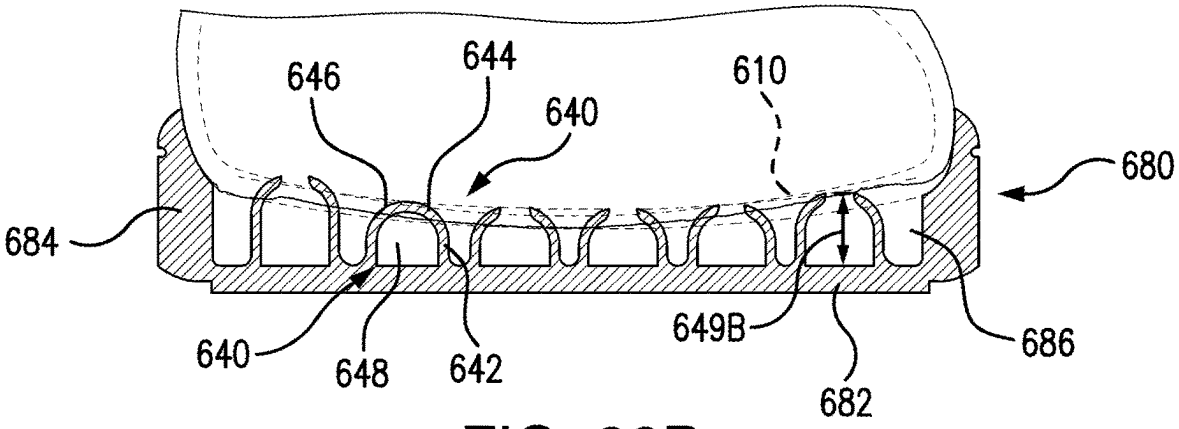

FIG. 22B

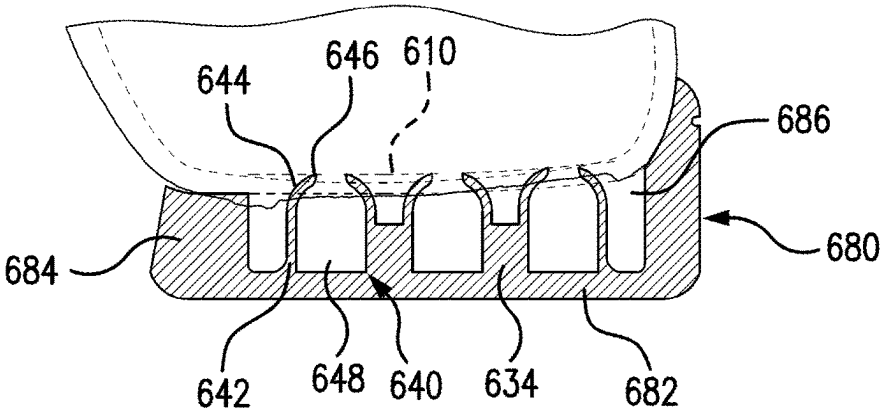

FIG. 22C

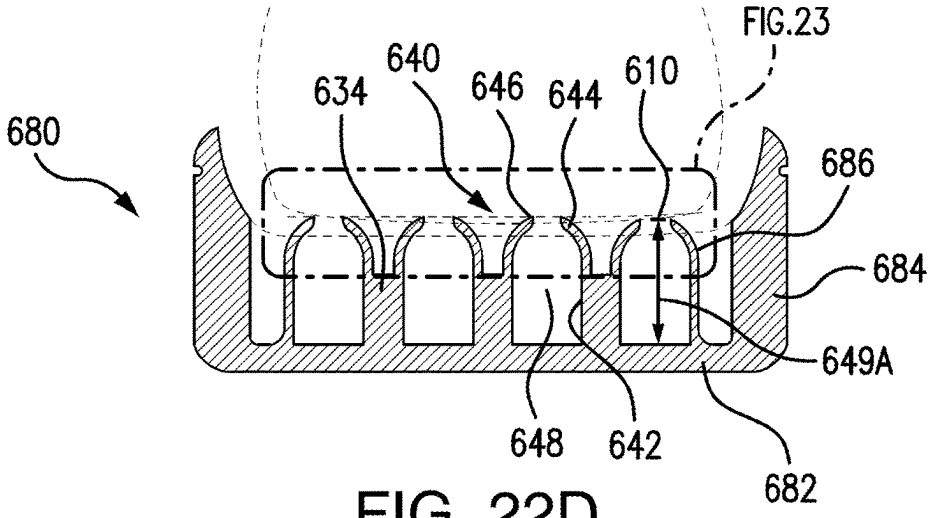

FIG. 22D

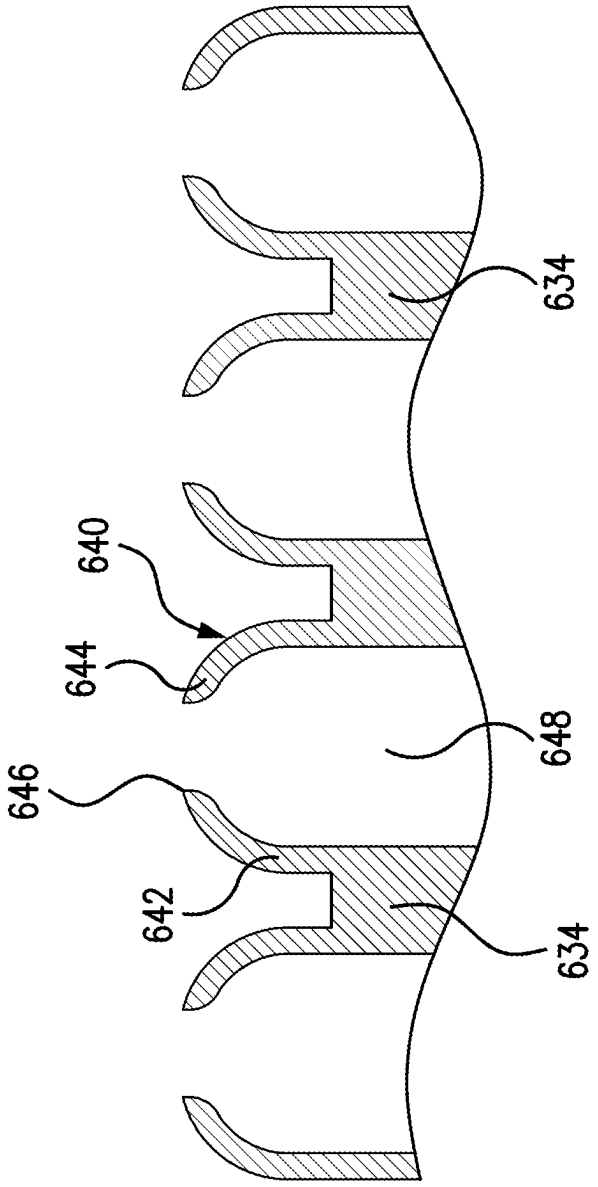

FIG. 23

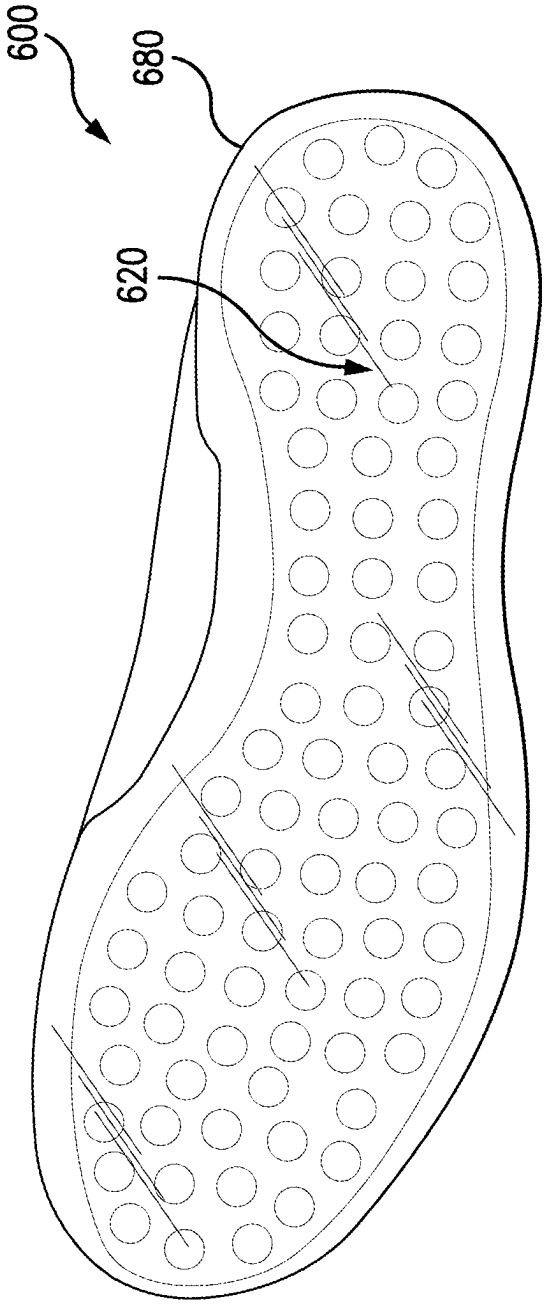

FIG. 24

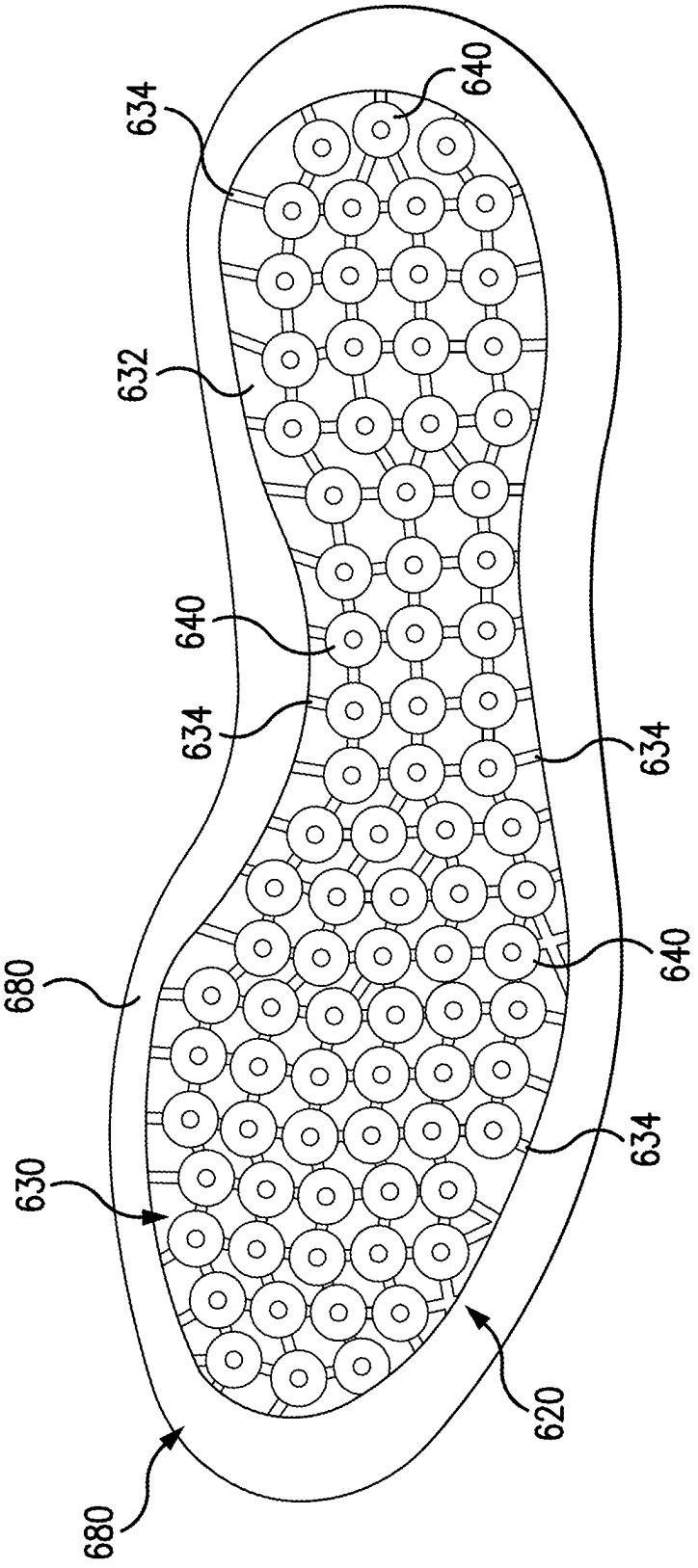

FIG. 25

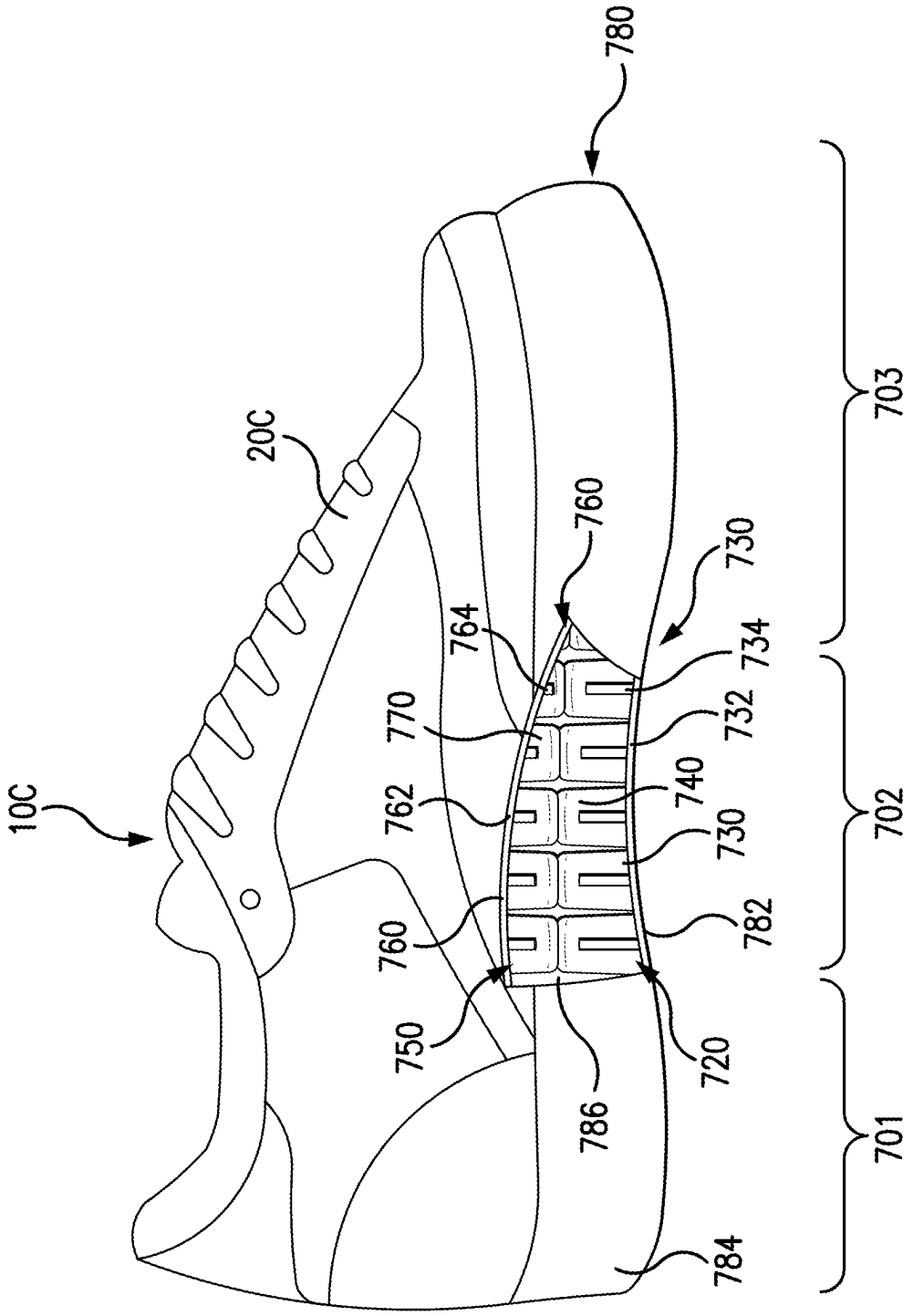
780
20C
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FIG. 26

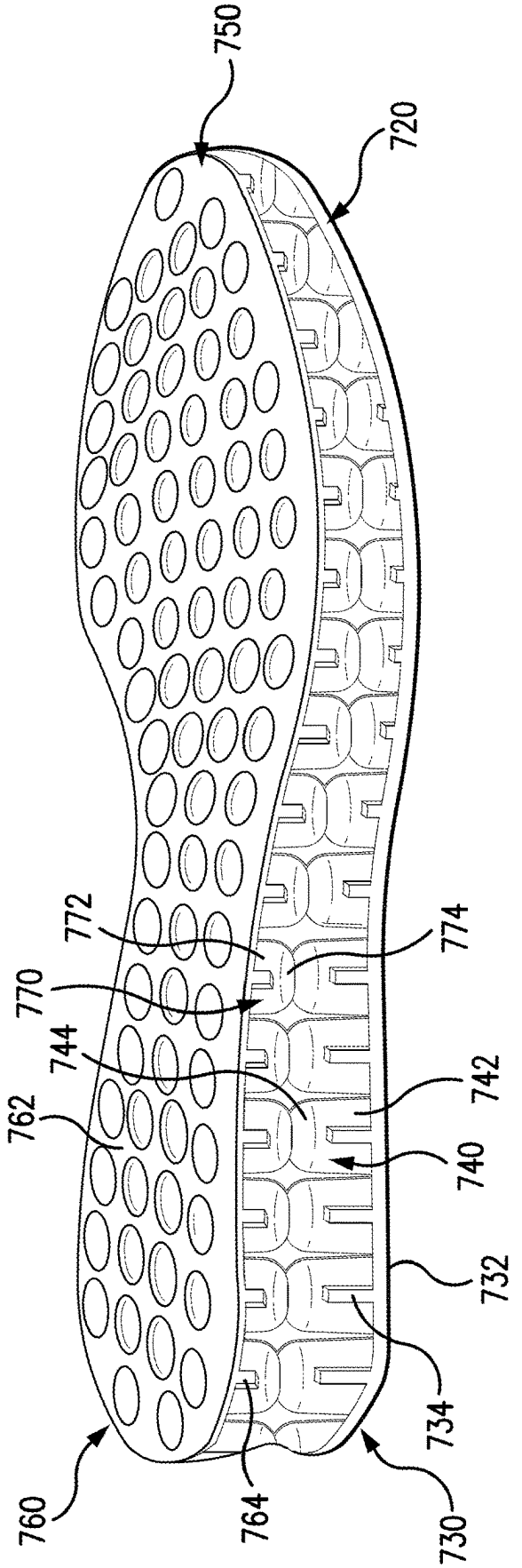

FIG. 27

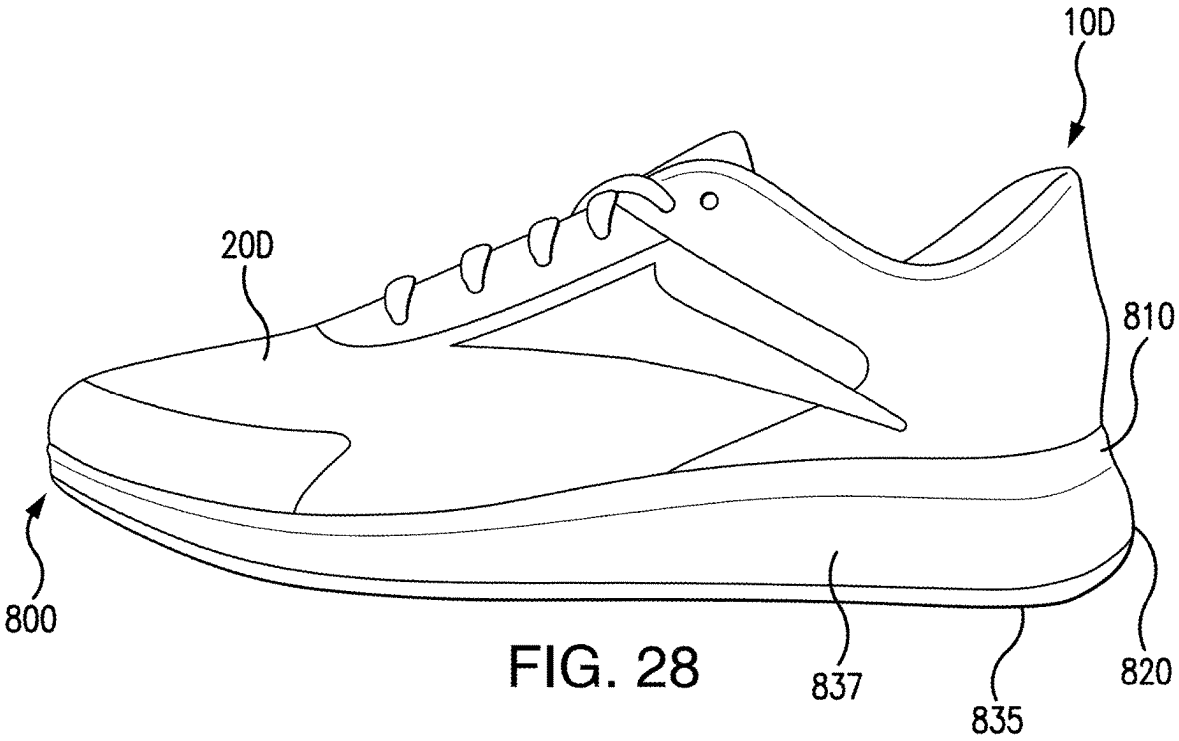

FIG. 28

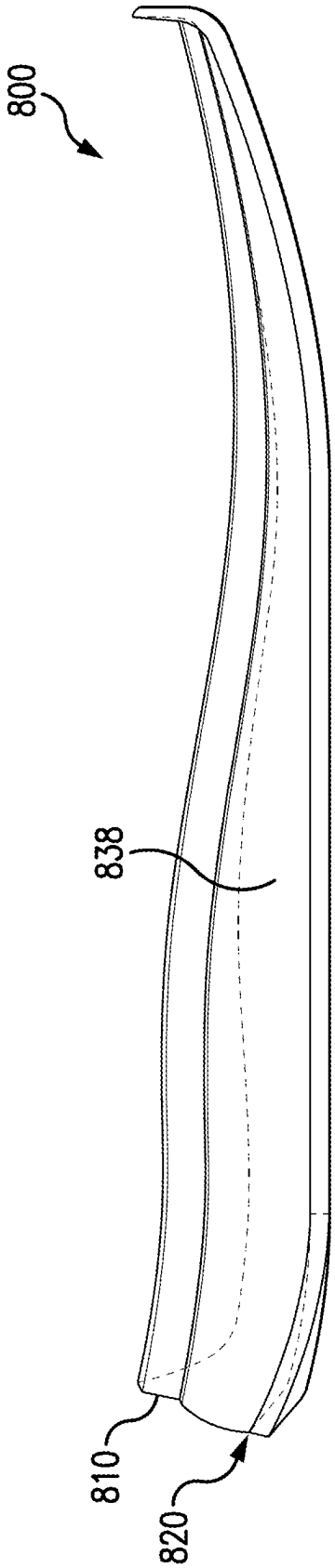

FIG. 29

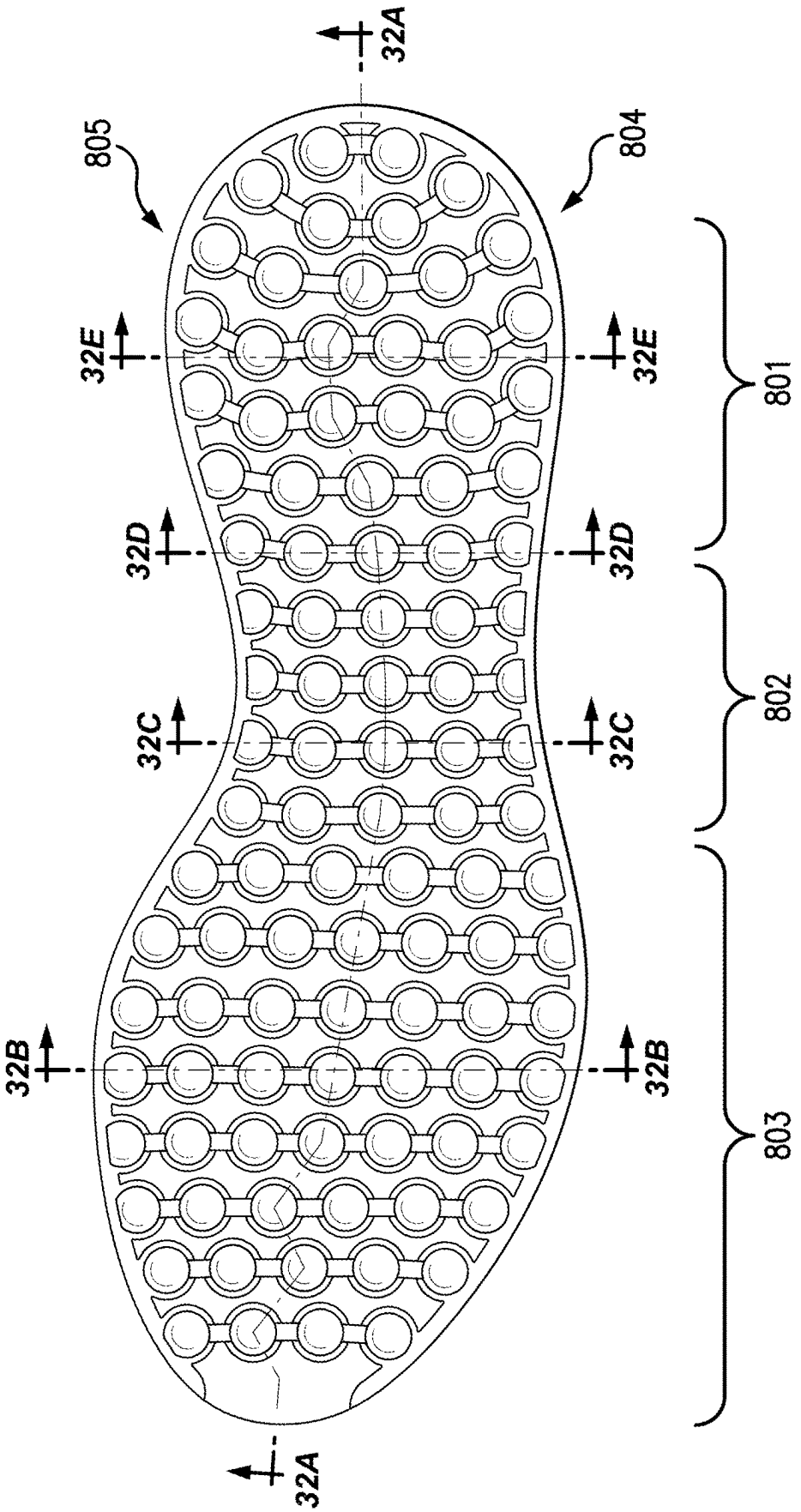

FIG. 30

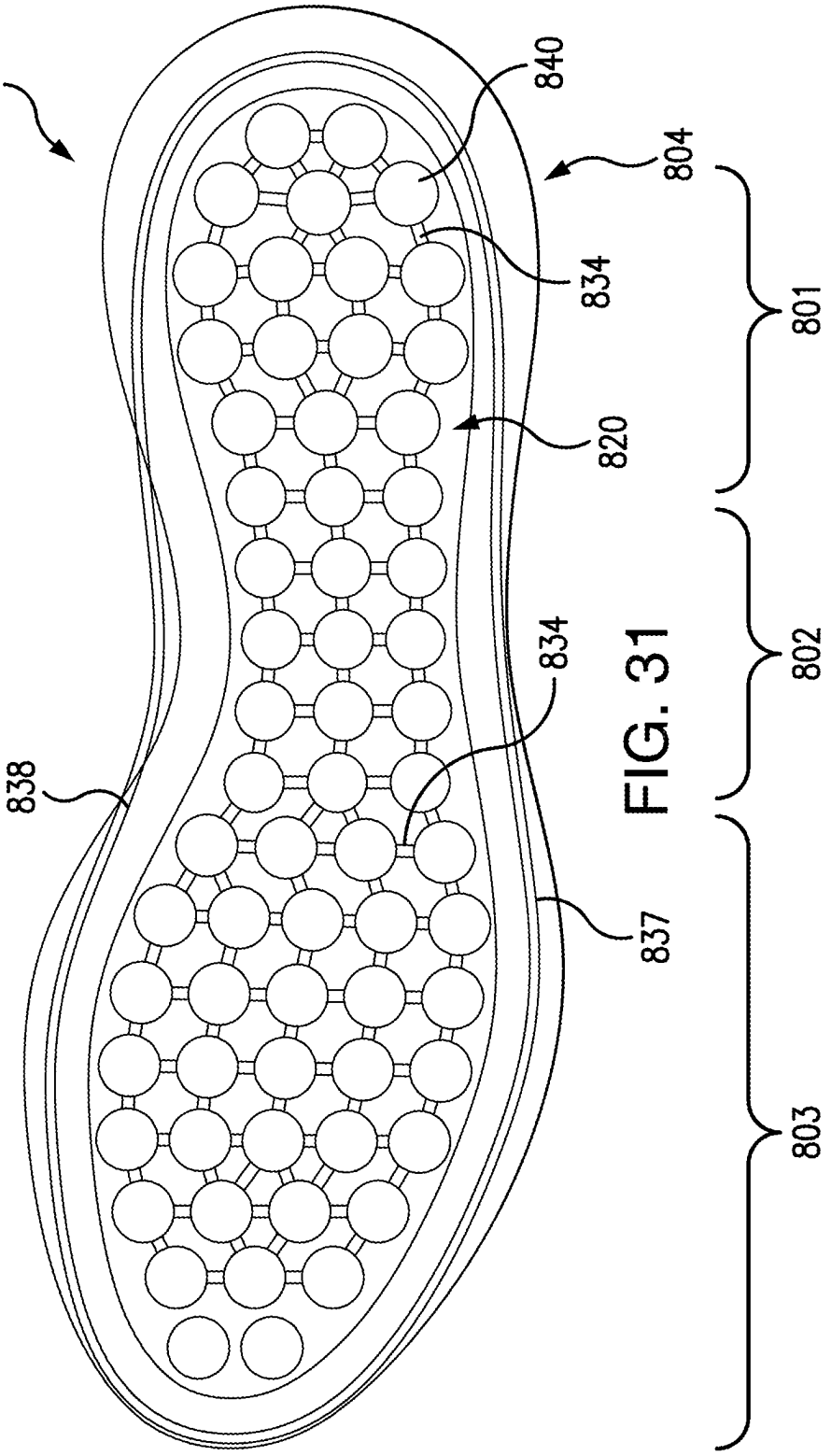

FIG. 31

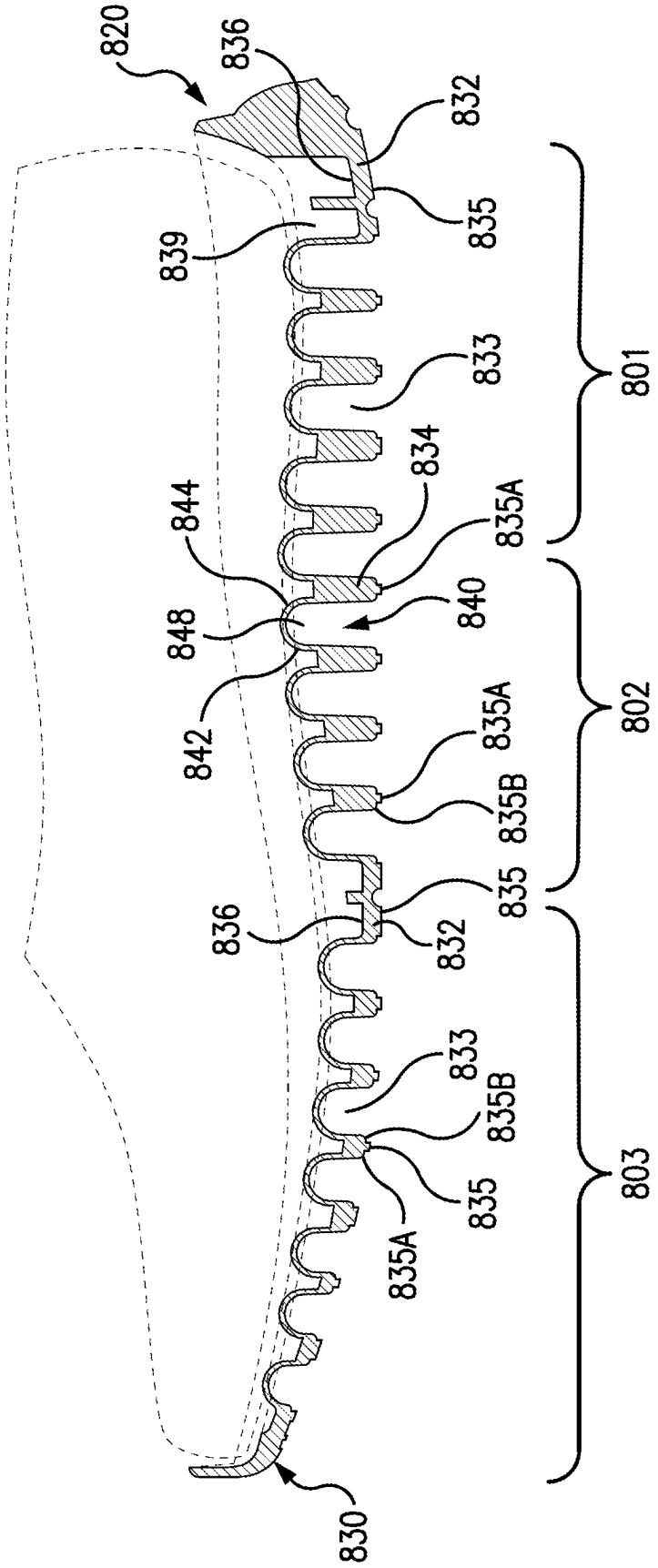
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FIG. 32A

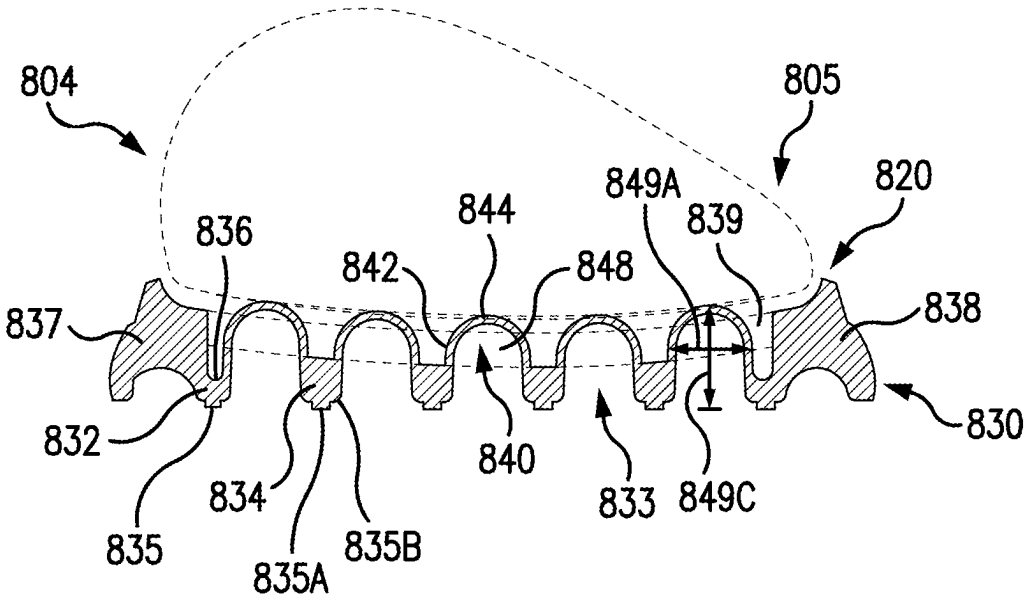
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FIG. 32B

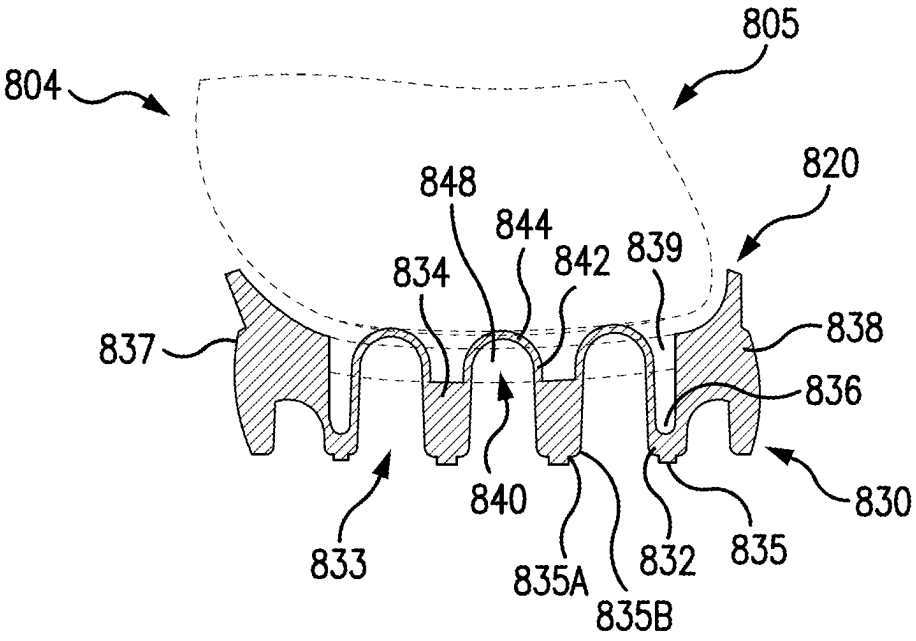
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FIG. 32C

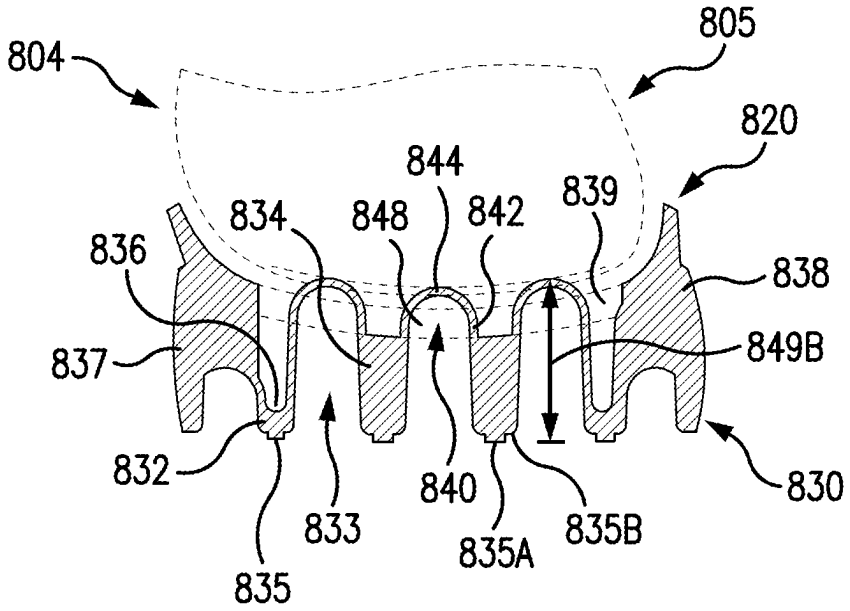
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FIG. 32D

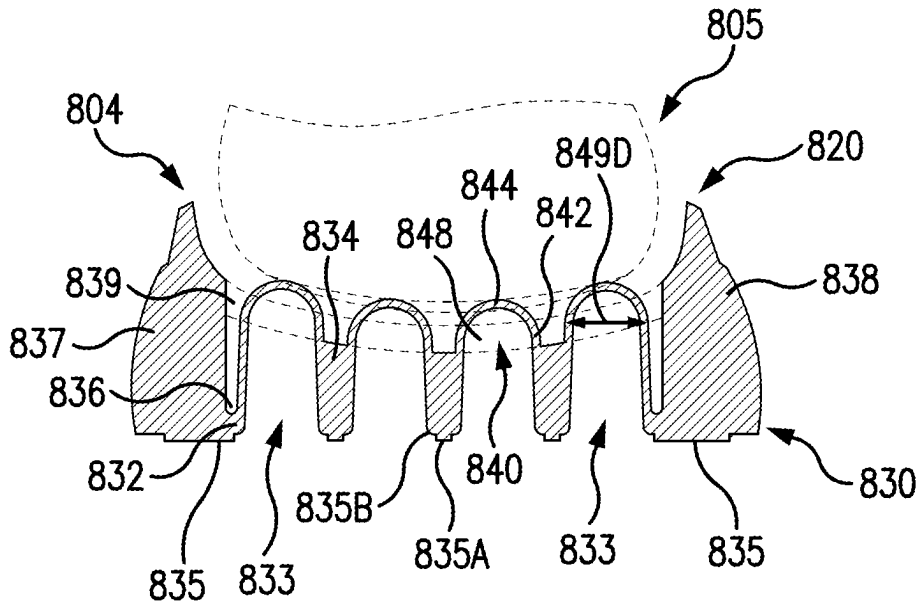
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FIG. 32E

ARTICLE OF FOOTWEAR HAVING A GEOMETRIC CUSHIONING SYSTEM

BACKGROUND

Field of the Invention

The present disclosure relates to footwear, and more particularly relate to a sole and article of footwear having a resilient sole member for supporting a foot of a wearer.

Background Art

The human foot possesses natural cushioning and rebounding characteristics.

However, the foot alone is incapable of effectively overcoming many of the forces encountered during every day activity. Unless an individual is wearing shoes which provide proper cushioning and support, the soreness and fatigue associated with every day activity is more acute, and its onset accelerated. The discomfort for the wearer that results may diminish the incentive for further activity. Equally important, inadequately cushioned footwear can lead to injuries such as blisters; muscle, tendon and ligament damage; and bone stress fractures. Improper footwear can also lead to other ailments, including back pain.

Proper footwear should complement the natural functionality of the foot, in part, by incorporating a sole, which absorbs shocks. Therefore, a continuing need exists for innovations in providing cushioning to articles of footwear.

BRIEF SUMMARY OF THE INVENTION

The present disclosure includes various embodiments of a sole for an article of footwear that provides a desired cushioning effect to a wearer's foot.

In accordance with one embodiment, an article of footwear comprises an upper and a sole coupled to the upper. In some embodiments, the sole comprises an insole configured to receive a foot of a wearer. In some embodiments, the sole comprises a first sole member disposed below the insole and configured to support the foot of the wearer. In some embodiments, the first sole member comprises a first web extending along a length of the sole. In some embodiments, the first sole member comprises a plurality of first pillars projecting upwardly from the first web toward the insole. In some embodiments, the plurality of first pillars each include a curved sidewall, a lid extending from an upper end of the curved sidewall, wherein the curved sidewall and the lid define a cavity, and an aperture disposed at a center of the lid and opening into the cavity. In some embodiments, the first web and the plurality of first pillars of the first sole member are unitary and made of a first elastomeric material having a first modulus of elasticity configuring the plurality of first pillars to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force.

In some embodiments, the first web comprises a plurality of strips interconnecting the plurality of first pillars.

In some embodiments, the first web comprises a plate, and the sidewall of each first pillar projects upwardly from an upper surface of the plate.

In some embodiments, the lid of each first pillar is dome-shaped, and the aperture of each first pillar is disposed at an apex of the dome-shaped lid.

In some embodiments, the cavity of each first pillar is filled with ambient air.

In some embodiments, the sole further comprises an outsole coupled to the first web of the first sole member, and the outsole is made of a second elastomeric material having a second modulus of elasticity that is greater than the first modulus of elasticity.

In some embodiments, the outsole comprises a base extending along the length of the sole and configured to contact the ground and a sidewall projecting upwardly from the base and extending along a perimeter of the sole. In some embodiments, the base and the sidewall of the outsole define a chamber, and the first sole member is received in the chamber of the outsole.

In some embodiments, a second sole member disposed below the insole and above the first sole member. In some embodiments, the second sole member comprises a second web coupled to the insole and extending along the length of the sole, and a plurality of second pillars projecting downwardly from the second web toward the first sole member. In some embodiments, the plurality of second pillars each include a curved sidewall, and a base extending from a lower end of the curved sidewall. In some embodiments, the second web and the plurality of second pillars of the second sole member are unitary. In some embodiments, the plurality of second pillars are axially aligned with respect to the plurality of first pillars, and the base of each second pillar engages the lid of a respective first pillar. In some embodiments, the plurality of second pillars each include a pin projecting downwardly from a center of the base and received in the aperture of the respective first pillar.

In accordance with one embodiment, a sole for an article of footwear comprises an insole configured to receive a foot of a wearer. In some embodiments, the sole comprises a first sole member disposed below the insole and configured to support the foot of the wearer.

In some embodiments, the first sole member comprises a first web comprising a plate extending along a length of the sole. In some embodiments, the first sole member comprises a plurality of first pillars projecting upward from an upper surface of the plate toward the insole. In some embodiments, the plurality of first pillars each include a curved sidewall and a lid extending from an upper end of the curved sidewall. In some embodiments, the curved sidewall and the lid define a cavity. In some embodiments, the plurality of first pillars each include an aperture disposed at a center of the lid and opening into the cavity. In some embodiments, the first web and the plurality of first pillars of the first sole member are unitary and made of a first elastomeric material having a first modulus of elasticity configuring the plurality of first pillars to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force.

In some embodiments, the first web comprises a plurality of bosses projecting from a bottom surface of the plate, and the plurality of bosses are axially aligned with respect to the plurality of first pillars.

In some embodiments, the plate of the first web comprises a plurality of holes each opening into the cavity of a respective first pillar.

In some embodiments, the first web comprises a first lateral sidewall disposed on a lateral side of the plate of the first web, and a first medial sidewall disposed on a medial side of the plate of the first web.

In some embodiments, the plurality of first pillars are arranged in a series of rows, and at least one of the rows of the first pillars are disposed between the first lateral sidewall and the first medial sidewall of the first web.

In some embodiments, the sole further comprises a midsole made from a foam-based material and coupled to the insole and the first sole member.

In some embodiments, the midsole comprises a sidewall extending along a perimeter of the sole and defining a chamber, and the plurality of first pillars are received in the chamber of the midsole.

In some embodiments, the lid of at least one of the plurality of first pillars engages a bottom surface of the insole.

In some embodiments, the lid of at least one of the plurality of first pillars engages a bottom surface of the midsole.

In some embodiments, the sole further comprises a second sole member disposed below the insole and above the first sole member. In some embodiments, the second sole member comprises a second web coupled to the insole. In some embodiments, the second web comprising a plate extending along the length of the sole and a plurality of second pillars projecting downwardly from a lower surface of the plate of the second web toward the first sole member. In some embodiments, the plurality of second pillars each include a curved sidewall and a base extending from a lower end of the curved sidewall. In some embodiments, the second web and the plurality of second pillars of the second sole member are unitary. In some embodiments, the plurality of second pillars are axially aligned with respect to the plurality of first pillars. In some embodiments, the base of each second pillar is interlocked with the lid of a respective first pillar.

In some embodiments, the second web comprises a second lateral sidewall disposed on a lateral side of the plate of the second web. In some embodiments, the second web comprises a second medial sidewall disposed on a medial side of the plate of the second web. In some embodiments, a bottom surface of the second lateral sidewall engages an upper surface of the first lateral sidewall, and a bottom surface of the second medial sidewall engages an upper surface of the first medial sidewall.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

The accompanying drawings, which are incorporated herein and form a part of the specification, illustrate the present disclosure and, together with the description, further serve to explain the principles thereof and to enable a person skilled in the pertinent art to make and use the same.

FIG. **1** shows a side view of an article of footwear according to embodiments.

FIG. **2** shows a bottom view of the article of footwear shown in FIG. **1** according to embodiments.

FIG. **3**A shows a cross-section view of the article of footwear taken along line **3**A-**3**A in FIG. **2** according to embodiments.

FIG. **3**B shows a cross-section view of the article of footwear taken along line **3**B-**3**B in FIG. **2** according to embodiments.

FIG. **3**C shows a cross-section view of the article of footwear taken along line **3**C-**3**C in FIG. **2** according to embodiments.

FIG. **3**D shows a cross-section view of the article of footwear taken along line **3**D-**3**D in FIG. **2** according to embodiments.

FIG. **3**E shows a cross-section view of the article of footwear taken along line **3**E-**3**E in FIG. **2** according to embodiments.

FIG. **4** shows a side view of an article of footwear according to embodiments.

FIG. **5** shows a bottom view of the article of footwear shown in FIG. **4** according to embodiments.

FIG. **6**A shows a cross-section view of the article of footwear taken along line **6**A-**6**A in FIG. **5** according to embodiments.

FIG. **6**B shows a cross-section view of the article of footwear taken along line **6**B-**6**B in FIG. **5** according to embodiments.

FIG. **6**C shows a cross-section view of the article of footwear taken along line **6**C-**6**C in FIG. **5** according to embodiments.

FIG. **6**D shows a cross-section view of the article of footwear taken along line **6**D-**6**D in FIG. **5** according to embodiments.

FIG. **6**E shows a cross-section view of the article of footwear taken along line **6**E-**6**E in FIG. **5** according to embodiments.

FIG. **7** shows a front perspective view of a sole for an article of footwear according to embodiments.

FIG. **8** shows a top view of the sole shown in FIG. **7** according to embodiments.

FIG. **9** shows a bottom view of the sole shown in FIG. **7** according to embodiments.

FIG. **10**A shows a cross-section view of the sole taken along line **10**A-**10**A in FIG. **9** according to embodiments.

FIG. **10**B shows a cross-section view of the sole taken along line **10**B-**10**B in FIG. **9** according to embodiments.

FIG. **10**C shows a cross-section view of the sole taken along line **10**C-**10**C in FIG. **9** according to embodiments.

FIG. **10**D shows a cross-section view of the sole taken along line **10**D-**10**D in FIG. **9** according to embodiments.

FIG. **10**E shows a cross-section view of the sole taken along line **10**E-**10**E in FIG. **9** according to embodiments.

FIG. **11**A shows a cross-section view of the sole taken along line **10**A-**10**A in FIG. **9** according to embodiments.

FIG. **11**B shows a cross-section view of the sole taken along line **10**B-**10**B in FIG. **9** according to embodiments.

FIG. **11**C shows a cross-section view of the sole taken along line **10**C-**10**C in FIG. **9** according to embodiments.

FIG. **11**D shows a cross-section view of the sole taken along line **10**D-**10**D in FIG. **9** according to embodiments.

FIG. **11**E shows a cross-section view of the sole taken along line **10**E-**10**E in FIG. **9** according to embodiments.

FIG. **12** shows a side view of a sole for an article of footwear according to embodiments.

FIG. **13** shows a top view of the sole shown in FIG. **12** according to embodiments.

FIG. **14** shows a bottom view of the sole shown in FIG. **12** according to embodiments.

FIG. **15**A shows a cross-section view of the sole taken along line **15**A-**15**A in FIG. **14** according to embodiments.

FIG. **15**B shows a cross-section view of the sole taken along line **15**B-**15**B in FIG. **14** according to embodiments.

FIG. **15**C shows a cross-section view of the sole taken along line **15**C-**15**C in FIG. **14** according to embodiments.

FIG. **16** shows a side view of a sole for an article of footwear according to some embodiments.

FIG. **17** shows a bottom view of the sole shown in FIG. **16** according to embodiments.

FIG. **18**A shows a cross-section view of the sole taken along line **18**A-**18**A in FIG. **17** according to embodiments.

FIG. **18**B shows a cross-section view of the sole taken along line **18**B-**18**B in FIG. **17** according to embodiments.

FIG. **18**C shows a cross-section view of the sole taken along line **18**C-**18**C in FIG. **17** according to embodiments.

FIG. **18**D shows a cross-section view of the sole taken along line **18**D-**18**D in FIG. **17** according to embodiments.

FIG. **18**E shows a cross-section view of the sole taken along line **18**E-**18**E in FIG. **17** according to embodiments.

FIG. **18**F shows a cross-section view of the sole taken along line **18**F-**18**F in FIG. **17** according to embodiments.

FIG. **19** shows a side view of an article of footwear according to embodiments.

FIG. **20** shows a bottom view of a sole for the article of footwear shown in FIG. **19** according to embodiments.

FIG. **21** shows a top view of the sole shown in FIG. **20** according to embodiments.

FIG. **22**A shows a cross-section view of the sole taken along line **22**A-**22**A in FIG. **20** according to embodiments.

FIG. **22**B shows a cross-section view of the sole taken along line **22**B-**22**B in FIG. **20** according to embodiments.

FIG. **22**C shows a cross-section view of the sole taken along line **22**C-**22**C in FIG. **20** according to embodiments.

FIG. **22**D shows a cross-section view of the sole taken along line **22**D-**22**D in FIG. **20** according to embodiments.

FIG. **23** shows an enlarged cross-section view of sole taken along line **23**-**23** in FIG. **22**B according to embodiments.

FIG. **24** shows a bottom view of a sole according to embodiments.

FIG. **25** shows a top view of the sole shown in FIG. **24** according to embodiments.

FIG. **26** shows a side view of an article of footwear according to embodiments.

FIG. **27** shows a perspective view of a first sole member and a second sole member according to embodiments.

FIG. **28** shows a side view of an article of footwear according to embodiments.

FIG. **29** shows a side view of a sole for the article of footwear shown in FIG. **28** according to embodiments.

FIG. **30** shows a bottom view of the sole shown in FIG. **29** according to embodiments.

FIG. **31** shows a top of the sole shown in FIG. **29** according to some embodiments.

FIG. **32**A shows a cross-section view of a first sole member taken along line **32**A-**32**A in FIG. **30** according to embodiments.

FIG. **32**B shows a cross-section view of the first sole member taken along line **32**B-**32**B in FIG. **30** according to embodiments.

FIG. **32**C shows a cross-section view of the first sole member taken along line **32**C-**32**C in FIG. **30** according to embodiments.

FIG. **32**D shows a cross-section view of the first sole member taken along line **32**D-**32**D in FIG. **30** according to embodiments.

FIG. **32**E shows a cross-section view of the first sole member taken along line **32**E-**32**E in FIG. **30** according to embodiments.

DETAILED DESCRIPTION OF THE INVENTION

The present inventions will now be described in detail with reference to embodiments thereof as illustrated in the accompanying drawings, in which like reference numerals are used to indicate identical or functionally similar elements. References to "one embodiment", "an embodiment", "an example embodiment", etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

The following examples are illustrative, but not limiting, of the present inventions. Other suitable modifications and adaptations of the variety of conditions and parameters normally encountered in the field, and which would be apparent to those skilled in the art, are within the spirit and scope of the inventions.

One attempt over the years to improve cushioning and resiliency of shoes, particularly athletic shoes, is incorporating a midsole component formed primarily from a polymer foam material due to the polymer foam material's ability to compress resiliently under an applied load, which attenuates forces impacted by the sole striking the ground during the wearer's gait cycle. However, the performance of foam-based midsoles suffers over time due to dynamic fatigue. That is, the polymer foam losses its initial elasticity and firmness as the polymer foam midsole is subjected to stress inhibited by the daily use of the shoe. Furthermore, including foam-based materials in the sole increases the cost of manufacturing.

Accordingly, there is a need for an improved sole that minimizes or eliminates the use of polymer foam, while still providing adequate support and cushioning to the wearer's foot.

According to various embodiments described herein, the sole of the present disclosure may overcome one or more of the deficiencies noted above by comprising a sole member having a web extending along a length of the sole and a plurality of pillars projecting upwardly from the web toward an insole that receives the wearer's foot. In some embodiments, the plurality of pillars may each include a curved sidewall and a lid extending from an upper end of the curved sidewall, where the curved sidewall and the lid define a cavity. In some embodiments, the web and the plurality of pillars of the sole member are unitary and made of a elastomeric material having a modulus of elasticity configuring the plurality of pillars to flex or deform upon an application of a compressive force by the wearer (e.g., a compressed state) and return to their original shape and/or upright position upon a removal of the compressive force (e.g., a relaxed state). The resiliency of the pillars allows the sole member to absorb a significant amount of shock that occurs when the sole strikes the ground, thereby providing a desirable cushioning effect to wearer's foot with minimal use of material.

FIGS. **1**-**3**E illustrate an article of footwear **10** having an upper **20** and a sole **100** coupled to the upper **20** according to one embodiment of the present disclosure. In various embodiments, sole **100** may include a heel region **101**, a midfoot or arch region **102**, and a forefoot region **103** extending between a lateral side **104** and a medial side **105** of sole **100**. In some embodiments, sole **100** may include an insole and/or sockliner **110** configured to receive a wearer's foot. In some embodiments, sole **100** may include a first sole member **120** disposed below insole **110** and configured to support the foot of the wearer. In some embodiments, sole **100** may include a second sole member **150** disposed below insole **110** and above first sole member **120**. In some embodiments, sole **100** may include an outsole **180** coupled to a bottom of first sole member **120**.

In some embodiments, first sole member **120** may include a first web **130** extending along a length of sole **100**. In some embodiments, first web **130** may extend from heel region **101** to forefoot region **103** of sole **100**. In some embodiments, first web **130** may extend from heel region **101** to arch region **102** of sole **100**. In some embodiments, first web **130** may extend from forefoot region **103** to arch region **102** of sole **100**. In some embodiments, first web **130** may be disposed only in heel region **101** of sole **100**. In some embodiments, first web **130** may be disposed only in arch region **102** of sole **100**. In some embodiments, first web **130** may be disposed only in forefoot region **103** of sole **100**.

In some embodiments, first sole member **120** may include a plurality of first pillars **140** projecting upwardly from first web **130** toward insole **110** to provide support for the wearer's foot. The plurality of first pillars **140** are configured to compress, deflect, flex, bend and/or deform upon an application of a compressive force by the wearer's foot (e.g., when sole **100** strikes the ground during a the wearer's gait cycle) and return to their original shape (e.g., stand upright) upon a removal of the compressive force, such that the plurality of first pillars **140** absorb shock imparted from the ground surface during the wearer's gait cycle. For example, in some embodiments, the plurality of first pillars **140** may be configured to compress, deflect, flex, bend, and/or deform at a compressed state (e.g., when sole **100** strikes the ground) and configured to stand upright at a relaxed state (e.g., when sole **100** elevates above the ground). In some embodiments, the plurality of first pillars **140** are configured to return from the compressed state to the relaxed state without incurring permanent buckling or plastic deformation. By demonstrating high resiliency—flexing or bending at a compressed state and returning to stand upright at a relaxed state—the plurality of first pillars **140** absorb a significant amount of shock that provides a desirable cushioning effect to wearer's foot.

The shape of first pillars **140** may be tuned to achieve optimum cushioning and support to the foot of the wearer. For example, in some embodiments, the plurality of first pillars **140** may each include a curved sidewall **142**, such as a cylindrical-shaped sidewall. In some embodiments, the plurality of first pillars **140** may each include a lid **144** extending from an upper end of the curved sidewall **142**. In some embodiments, curved sidewall **142** and lid **144** collectively define a cavity **148**. In some embodiments, the plurality of first pillars **140** may be hollow such that cavity **148** is filled with ambient air. By compressing or flexing at a compressed state, the plurality of first pillars **140** may be configured to pump flow of ambient air held in cavity **148** in a manner complementary to the wearer's stride and to the forces applied to the anatomical structure of the wearer's foot. In some embodiments, cavity **148** may be filled with a pressurized gas having a pressure greater than ambient air (e.g., 4 PSI to 10 PSI above ambient pressure). In some embodiments, cavity **148** may be filled with a fluid containing a gel, a paste, particles (e.g., polymer particles, foam particles, cellulose particles, rock or mineral particles, rubber particles, and the like). In some embodiments, cavity **148** may be filed with a solid material, such as, a foam-based material or elastomeric-based material.

In some embodiments, the plurality of first pillars **140** may each include an aperture **146** disposed at a center of lid **144** and opening into cavity **148**. Locating aperture **146** at the center of lid **144** provides more flexibility to a section of lid **144** surrounding aperture **146**, thereby allowing the plurality of first pillars **140** to be deflect force away more effectively, ultimately increasing the resiliency of first pillars **140**. In some embodiments, lid **144** may have a curved-shaped profile, such as, for example, being dome-shaped. By having a curved-shaped profile, such as a dome shape, lid **144** may dissipate applied forces in a direction tangential to a radius of curvature of lid **144**, thereby increasing the resiliency of first pillars **140**. The radius of curvature defined by the profile of lid **144** may be increased or decreased to adjust the quantity of force dissipated by the plurality of pillars **140** and the quantity of surface area of lid **144**. For example, in some embodiments, the radius of curvature defined by the profile of lid **144** may be reduced to flatten lid **144**, thereby providing a larger surface area on lid **144** to engage an object, such as insole **110** and/or an opposing pillar (e.g., second pillar **170**) of second sole member **150**.

The arrangement and number of first pillars **140** may be tuned to provide a desired cushioning effect to the wearer's foot. In some embodiments, two or more first pillars **140** may be disposed in a linear arrangement extending from lateral side **104** to medial side **105** of sole **100**. In some embodiments, the plurality of first pillars **140** may be arranged in a series of rows arranged from heel region **101** to forefoot region **103** of sole **100**. In some embodiments, two or more first pillars **140** may be disposed in a linear arrangement extending from heel region **101** to forefoot region **103** of sole **100**. The spacing between adjacent pillars **140** may be varied to provide a desired cushioning effect to wearer's foot. For example, in some embodiments, the spacing between adjacent pillars **140** along the length of sole **100** may be uniform. In some embodiments, the spacing between adjacent first pillars **140** located in forefoot region **103** of sole **100** may be less than the spacing between adjacent first pillars **140** located in heel region **101** of sole **100**, such that there is a greater number of first pillars **140** in forefoot region **103** of sole **100** than heel region **101** of sole **100**. In some embodiments, the spacing between adjacent first pillars **140** located in heel region **101** of sole **100** may be less than the spacing between adjacent first pillars **140** located in forefoot region **103** of sole **100**, such that there is a greater number of first pillars **140** in heel region **101** of sole **100** than heel region **103** of sole **100**.

The size (e.g., diameter and height) of first pillars **140** may be varied to provide a desired cushioning effect to the wearer's foot. For example, in some embodiments, the diameter and/or width of first pillars **140** may generally decrease from the heel region **101** to the forefoot region **103**. For example, as shown in FIG. **3**D, first pillars **140** in heel region **101** may include a first width **149**A and a first height **149**B, and as shown in FIG. **3**B, first pillars **140** in forefoot region **103** may include a second width **149**C that is less than the first width **149**A and a second height **149**D that is less than the first height **149**B. In the context of the present disclosure, a width corresponds to the transverse dimension defined between opposing exterior surfaces of the pillar, and a height corresponds to the vertical dimension defined from an exterior surface of the dome of the pillar to a plane defined by the upper surface of the plate of the web. In some embodiments, at least two of first pillars **140** have generally the same diameter and/or width. For example, in some embodiments, at least adjacent two first pillars **140** oriented in a lateral direction along sole **100** from lateral side **104** to medial side **105**, have generally the same diameter and/or width. In some embodiments, the height of first pillars **140** may generally decrease from heel region **101** to forefoot region **103**. In other embodiments, at least two of first pillars **140** have generally the same height. For example, in some embodiments, at least adjacent two first pillars **140**, oriented in a lateral direction along sole **100** from lateral side **104** to

medial side **105**, have generally the same height. In some embodiments, at least two of first pillars **140** define cavities **148** that generally have the same volume. For example, in some embodiments, at least adjacent first pillars **140**, oriented in a lateral direction along sole **100** from lateral side **104** to medial side **105**, define cavities **148** having generally the same volume. In one embodiment, generally larger (e.g., diameter, width, volume, or height) first pillars **140** may be disposed in heel region **101** to provide for increased cushioning at the point of heel strike. In other embodiments, generally larger (e.g., by diameter, width, volume, or height) first pillars **140** may be disposed in forefoot region **103**. In yet other embodiments, generally larger diameter, width, volume, or height) first pillars **140** may be disposed in both heel region **101** and in forefoot region **103**.

In some embodiments, the height of first pillars **140** at a relaxed state (e.g., when no loads are applied to first pillar **140**) may be greater than the height of a chamber defined within a sole, such as the height defined between a bottom surface of an insole and an upper surface of an outsole. By setting the height of first pillars **140** to be greater than the height defined between outsole **180** and insole **110**, first pillars **140** are configured to sink to a profile of the bottom of the wearer's foot at a compressed state (e.g., when a load is applied by the wearer's foot to sole **100**), thereby providing more cushioning to the wearer's foot. The height of first pillars **140** at the compressed state is less than the height of first pillars **140** at the relaxed state.

In some embodiments, the spacing between adjacent first pillars **140** may be varied according to the size of first pillars **140**. For example, in some embodiments, the spacing between adjacent first pillars **140** may be reduced as the size of first pillars **140** (e.g., height or diameter) increases. In some embodiments, first pillars **140** disposed in heel region **101** of sole **100** may be larger (e.g., by height, diameter, or volume) than first pillars **140** disposed in forefoot region **103** of sole **100**, and the spacing between adjacent first pillars **140** in heel region **101** of sole **100** is less than the spacing between adjacent first pillars **140** in forefoot region **103** of sole **100**.

In some embodiments, first web **130** may include a plate **132** interconnecting the plurality of first pillars **140**. For example, in some embodiments, the plurality of first pillars **140** may each extend from an upper surface of plate **132** toward insole **110**. In some embodiments, plate **132** may extend from heel region **101** to forefoot region **103** of sole **100**. In some embodiments, plate **132** may be curved along a length of sole **100** to promote forefoot strike by the wearer and help generate lift as the wearer's foot strikes the ground. For example, as shown in FIGS. **1** and **3**A, plate **132** may be arch-shaped in a longitudinal direction such that plate **132** includes a curved segment disposed along heel region **101** and forefoot region **103** of sole **100** and a flat segment disposed along the arch region **102** of sole **100**. In some embodiments, plate **132** may be curved in a lateral direction of sole **100**. In some embodiments, plate **132** may be generally flat along a length of sole **100**.

In some embodiments, first web **130** may include a plurality of strips **134** interconnecting the plurality of first pillars **140**. For example, in some embodiments, a strip **134** can extend between a pair of adjacent first pillars **140** such that first pillars **140** are supported adequately in an upright position. In some embodiments, a strip **134** can extend from a first pillar **140** to a sidewall of sole **100** to support first pillar **140** in an upright position. The number and placement of strips **134** can be modified to adjust the support of first pillars **140**. For example, in some embodiments, strips **134** may be disposed between every pair of adjacent first pillars **140**. In some embodiments, strips **134** may be disposed between only the sidewall of sole **100** and first pillars **140** located proximate to the sidewall of sole **100**. In some embodiments, strips **134** may be disposed between adjacent first pillars **140** disposed only in heel region **101** of sole **100**. In some embodiments, strips **134** may be disposed between adjacent first pillars **140** disposed only in arch region **102** of sole **100**. In some embodiments, strips **134** may be disposed between adjacent first pillars **140** disposed only in forefoot region **103** of sole **100**. In some embodiments, the height of strips **134** located between a sidewall of sole and a respective first pillar **140** may be greater than the height of strips **134** located between adjacent first pillars **140** to prevent thinning during the molding process.

In some embodiments, first web **130** and the plurality of first pillars **140** of first sole member **120** are unitary (e.g., a single-piece configuration), such that first web **130** and the plurality first pillars **140** are integrally made from the same material. In some embodiments, first sole member **120**, including first web **130** and the plurality of first pillars **140**, is made of a first elastomeric material having a first modulus of elasticity configuring the plurality of first pillars **140** to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force. In some embodiments, the first elastomeric material may include a natural rubber, an ethylene propylene diene monomer (EPDM) rubber, a neoprene rubber, a silicone rubber, a nitrile rubber, a styrene-butadiene rubber, a thermoplastic rubber/elastomer, and/or a combination thereof. For example, in some embodiments, the first elastomeric material may include a high concentration of natural rubber (e.g., greater than 50% by weight) so that first elastomeric material possesses greater resiliency.

In some embodiments, outsole **180** may be coupled to selected portions of a bottom surface of first web **130** of first sole member **120**. In some embodiments, outsole **180** may be coupled to entire bottom surface of first web **130** of first sole member **120**. In some embodiments, all or a portion of outsole **180** may be made of a wear-resistant material, such as, for example, a second elastomeric material having a second modulus of elasticity that is greater than the first modulus of elasticity of first elastomeric material of first sole member **120**. That is, in some embodiments, the second elastomeric material of outsole **180** may possess less flexibility and resiliency compared to the first elastomeric material of first sole member **120**. For example, the second elastomeric material for outsole **180** may include a synthetic or a natural rubber, thermoplastic polyurethane, a wear-resistant foam, or a combination thereof. In some embodiments, the second elastomeric material may include a lower concentration of natural rubber (e.g., less than 50% by weight) than the concentration of natural rubber in the first elastomeric material so that the second elastomeric material is more wear resistant.

In some embodiments, first sole member **120** may be molded using one or more molds. In some embodiments, first sole member **120** may be manufactured and combined with outsole **180** by any suitable process, such as compression molding, injection molding, expansion molding, thermoforming, and/or the combination thereof. For example, in some embodiments, first sole member **120** may be manufactured by compression molding the first elastomeric material with a pressing machine (e.g., a hydraulic press). In some embodiments, first sole member **120** may be molded directly on outsole **180** using a compression molding technique. For example, in some embodiments, a first mold

containing a sole cavity may be used with a pressing machine to press the first elastomeric material for a first time period, and then, a second mold containing a sole cavity may be used with the pressing machine to press the molded first elastomeric material on a blank second elastomeric material for a second time period to combine first sole member **120** with outsole **180**, thereby providing a single integral structure containing two types of elastomeric materials—the first elastomeric material for first sole member **120** and the second elastomeric material for outsole **180**. In some embodiments, additional first elastomeric material may be added to the second mold, such as around the edge of the sole cavity, after the first pressing step, to form a sidewall out of the first elastomeric material. In some embodiments, undercuts may be provided in the molds to yield the shape of first web **130** and/or first pillars **140** of first sole member **120**. In some embodiments, pressing pads may be used to form first pillars **140**. In some embodiments, excess materials from the molding process material may be trimmed from first sole member **120** and/or outsole **180** to yield the final shape of sole **100**. In some embodiments, other techniques may be used to combine first sole member **120** with outsole **180**, such as, for example, adhesive bonding, welding, and/or stitching. In some embodiments, first sole member **120** may be manufactured by any suitable molding process, such as, for example, compression molding, as an insert to be received in sole **100**.

In some embodiments, second sole member **150** may include a second web **160** coupled to a bottom surface of insole **110** and disposed above first sole member **120**. In some embodiments, second web **160** may extend along a length of sole **100** in any way as described above with respect to first web **130**. For example, in some embodiments, second web **160** may extend from heel region **101** to forefoot region **103** of sole **100**. In some embodiments, second web **160** may extend from heel region **101** to arch region **102** of sole **100**. In some embodiments, second web **160** may extend from forefoot region **103** to arch region **102** of sole **100**. In some embodiments, second web **160** may be disposed only in heel region **101** of sole **100**. In some embodiments, second web **160** may be disposed only in arch region **102** of sole **100**. In some embodiments, second web **160** may be disposed only in forefoot region **103** of sole **100**.

In some embodiments, second sole member **150** may include a plurality of second pillars **170** projecting downwardly from second web **160** toward first sole member **120** to provide support for the wearer's foot. Similar to first pillars **140**, the plurality of second pillars **170** are configured to compress, deflect, flex, bend, and/or deform upon an application of a compressive force by the wearer's foot (e.g., when sole **100** strikes the ground during a the wearer's gait cycle) and return to their original shape (e.g., stand upright) upon a removal of the compressive force, such that the plurality of second pillars **170** absorb shock imparted from the ground surface during the wearer's gait cycle. For example, in some embodiments, the plurality of second pillars **170** may be configured to configured to compress, deflect, flex, bend, and/or deform at a compressed state (e.g., when sole **100** strikes the ground) and configured to stand upright at a relaxed state (e.g., when sole **100** elevates above the ground). In some embodiments, the plurality of second pillars **170** are configured to return from the compressed state to the relaxed state without incurring permanent buckling or plastic deformation. By demonstrating high resiliency—flexing or bending at a compressed state and returning to stand upright at a relaxed state—the plurality of second pillars **170** absorb a significant amount of shock that provides a desirable cushioning effect to wearer's foot.

The shape of second pillars **170** may be tuned in any way as described above with respect to first pillar **140** to achieve optimum cushioning and support to the foot of the wearer. For example, in some embodiments, the plurality of second pillars **170** may each include a curved sidewall **172**, such as a cylindrical-shaped sidewall. In some embodiments, the plurality of second pillars **170** may each include a base **174** extending from a lower end of curved sidewall **172**. In some embodiments, curved sidewall **172** and base **174** collectively define a cavity **178**. In some embodiments, cavity **178** may be filled with ambient air. In some embodiments, cavity **178** may be filled with a pressurized gas having a pressure greater than ambient air. In some embodiments, cavity **178** may be filled with a fluid containing a gel, a paste, particles (e.g., polymer particles, foam particles, cellulose particles, rock or mineral particles, rubber particles, and the like). In some embodiments, cavity **178** may be filed with a solid material, such as, a foam-based material or elastomeric-based material. In some embodiments, the shape of second pillars **170** may be the same as the shape of first pillars **140**. In some embodiments, the shape of second pillars **170** may be different than the shape of first pillars **140**.

The arrangement and number of second pillars **170** may be tuned in any way as described above with respect to first pillar **140** to provide a desired cushioning effect to the wearer's foot. For example, in some embodiments, the plurality of second pillars **170** may be axially aligned with respect to the plurality of first pillars **140**. In some embodiments, base **174** of each second pillar **170** may engage lid **144** of a respective first pillar **140** such that each pair of vertically aligned first pillar **140** and second pillar **170** are engaged against each other. In some embodiments, the plurality of second pillars **170** may each be interlocked to a respective first pillar **140**. For example, in some embodiments, the plurality of second pillars **170** may each include a pin **176** projecting downwardly from a center of base **174** and is received in aperture **146** of a respective first pillar **140**. In some embodiments, base **174** of second pillars **170** may be bonded (e.g., using an adhesive) with lid **144** of first pillars **140** to provide an interlock arrangement. The interlock arrangement between first pillars **140** and second pillars **170** provides more stability to sole **100** and allows first pillars **140** and second pillars **170** to flex, bend, deflect, and/or deform in a similar motion, thereby absorbing more shock from sole **100** contacting the ground.

In some embodiments, second web **160** may include a plate **162** interconnecting the plurality of second pillars **170** in any way as described above with respect to plate **132** and first pillars **140**. For example, in some embodiments, the plurality of second pillars **170** may each extend from a lower surface of plate **162** toward insole **110**. In some embodiments, plate **162** may extend from heel region **101** to forefoot region **103** of sole **100**. In some embodiments, plate **162** may be curved along a length of sole **100** to promote forefoot strike by the wearer and help generate lift as the wearer's foot strikes the ground. For example, as shown in FIGS. **1** and **3**A, plate **162** may include a curved segment disposed along forefoot region **103** and arch region **102** of sole **100** and a flat segment disposed along heel region **101** of sole **100** to promote toe drop during the wearer's gait cycle. In some embodiments, plate **162** may be curved in a lateral direction of sole **100** so that plate **162** is configured to receive insole **110**. In some embodiments, plate **162** may be generally flat along a length of sole **100**.

In some embodiments, second web **160** may include a plurality of strips **164** interconnecting the plurality of second pillars **170**. The plurality of strips **164** may be arranged in any way as described above with respect to strips **134** of first web **130**. For example, in some embodiments, a strip **164** can extend between a pair of adjacent second pillars **170** such that second pillars **170** are supported adequately in an upright position. In some embodiments, a strip **164** can extend from a second pillar **170** to a sidewall of sole **100** to support second pillar **170** in an upright position. The number and placement of strips **164** can be modified to adjust the support of second pillars **170**. For example, in some embodiments, strips **164** may be disposed between every pair of adjacent second pillars **170**. In some embodiments, strips **164** may be disposed between only the sidewall of sole **100** and second pillars **170** located proximate to the sidewall of sole **100**. In some embodiments, strips **164** may be disposed between adjacent second pillars **170** disposed only in heel region **101** of sole **100**. In some embodiments, strips **164** may be disposed between adjacent second pillars **170** disposed only in arch region **102** of sole **100**. In some embodiments, strips **164** may be disposed between adjacent second pillars **170** disposed only in forefoot region **103** of sole **100**.

In some embodiments, second web **160** and the plurality of second pillars **170** of second sole member **150** are unitary (e.g., a single-piece configuration), such that second web **160** and the plurality second pillars **170** are integrally made from the same material. In some embodiments, second sole member **150**, including second web **160** and the plurality of second pillars **170**, is made of an elastomeric material, such as, for example, the first elastomeric material described above with respect to first sole member **120**, such that the plurality of second pillars **170** are configured to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force. In some embodiments, second sole member **150** may be made from an elastomeric material that includes a natural rubber, an ethylene propylene diene monomer (EPDM) rubber, a neoprene rubber, a silicone rubber, a nitrile rubber, a styrene-butadiene rubber, a thermoplastic rubber/elastomer, and/or a combination thereof. In some embodiments, second sole member **150** may be made from an elastomeric material that is different than the first elastomeric material. For example, in some embodiments, second sole member **150** may be made from an elastomeric material that includes a modulus of elasticity greater than the first modulus of elasticity so that second sole member **150** possesses less flexibility and resiliency than first sole member **120**. In some embodiments, second sole member **150** may be made from a foam-based material, such as, for example, a foam made from ethyl-vinyl-acetate (EVA) and/or polyurethane.

In some embodiments, second sole member **150** may be manufactured by the same or similar techniques used for making first sole member **120**, as described herein.

Various modifications can be made to first sole member **120**, second sole member **150**, and/or outsole **180** and additional materials, such as a midsole, can be implemented with sole **100** to provide a desirable cushioning effect to wearer's foot, while creating an attractive aesthetic appeal to article of footwear, as shown in the various embodiments described below.

In some embodiments, the sole may include a first sole member and a second sole member to provide two layers of corresponding pillars that eliminate the need for additional cushioning materials. For example, in accordance with the embodiment shown in FIGS. **1**-**3**E, both first sole member **120** and second sole member **150** may be made entirely from an elastomeric-material, such as the first elastomeric-material. In some embodiments, sole **100** shown in FIGS. **1**-**3**E may be devoid of any foam-based materials.

In some embodiments, second web **160** of second sole member **150** may include plate **162** shaped to receive insole **110** and a bottom of the wearer's foot. In some embodiments, second sole member **150** may include the plurality of second pillars **170** projecting downwardly from the bottom surface of plate **162**. As shown in FIG. **3**A, the size (e.g., height and/or diameter) of second pillars **170** in heel region **101** may be larger than the size (e.g., height and/or diameter) of second pillars **170** in forefoot region **103**. For example, as shown in FIG. **3**D, second pillars **170** in heel region **101** may include a first width **179**A and a first height **179**B, and as shown in FIG. **3**B, second pillars **170** in forefoot region **103** may include a second width **179**C that is less than the first width **179**A and a second height **179**D that is less than the first height **179**B. In some embodiments, the plurality of second pillars **170** may include a central second pillar **170**A disposed in a central position in arch region **102** of sole **100**. In some embodiments, the size (e.g., height, length, or width) of central second pillar **170**A may be larger than the size (e.g., height, length, or width) of the remaining second pillars **170**, and the shape of central second pillar **170**A may be different than the shape of the remaining second pillars **170**.

In some embodiments, as shown in FIGS. **1** and **3**A, for example, first web **130** of first sole member **120** may include plate **132** defining an arch-shaped profile along a longitudinal direction of sole **100**. In some embodiments, first sole member **120** may include the plurality of first pillars **140** projecting upwardly from the upper surface of plate **132**. As shown in FIG. **3**A, the size (e.g., height and/or diameter) of first pillars **140** in heel region **101** may be larger than the size of first pillars **140** (e.g., height and/or diameter) in forefoot region **103**. In some embodiments, the plurality of first pillars **140** may include a central first pillar **140**A disposed in a central position in arch region **102** of sole **100**. In some embodiments, the size (e.g., height, length, or width) of central first pillar **140**A may be larger than the size (e.g., height, length, or width) of the remaining first pillars **140**, and the shape of central first pillar **140**A may be different than the shape of the remaining first pillars **140**.

In some embodiments, the plurality of first pillars **140** are axially aligned with respect to the plurality of second pillars **170** in a vertical direction. With reference to FIGS. **3**A-**3**E, lid **144** of each first pillar **140** may engage base **174** of a respective second pillar **170**. In some embodiments, pin **176** of each second pillar **170** may be received in aperture **146** of a respective first pillar **140** so that first pillars **140** are interlocked with second pillars **170**. In some embodiments, a set of first pillars **140** and second pillars **170** disposed adjacent to medial side **105** of sole **100** may aligned with respect to a set of first pillars and second pillars **170** disposed adjacent to lateral side **104** of sole **100**. In some embodiments, a set of first pillars **140** and second pillars **170** disposed adjacent to medial side **105** of sole **100** may be offset with respect to a set of first pillars and second pillars **170** disposed adjacent to lateral side **104** of sole **100**.

In some embodiments, as shown in FIGS. **3**A-**3**E, first web **130** may include a plurality of bosses **131** projecting from a bottom surface of plate **132**. In some embodiments, the plurality of bosses **131** may be axially aligned with respect to the plurality of first pillars **140**. In some embodiments, plate **132** of first web **130** may include a hole **133** axially aligned with central first pillar **140**A, and hole **133**

may open into cavity **148** of central first pillar **140**A. In some embodiments, plate **162** of second web **160** may include a plurality of holes **163** each opening into cavity **178** of a respective second pillar **170**.

In some embodiments, as shown in FIGS. **1**-**3**E, for example, first web **130** may include a first lateral sidewall **136** disposed on a lateral side of plate **132** and a first medial sidewall **138** disposed on a medial side of plate **132**. In some embodiments, the plurality of first pillars **140** are arranged in a series of rows, where each row of first pillars **140** extends in a lateral direction along sole **100**. In some embodiments, at least one of the rows of first pillars **140** are disposed between first lateral sidewall **136** and first medial sidewall **138**. For example, as shown in FIG. **1**, **3**D, **3**E, first lateral sidewall **136** and first medial sidewall **138** may be disposed only in heel region **101** of sole **100**, and only the rows of first pillars **140** disposed in heel region **101** of sole **100** are disposed between first lateral sidewall **136** and first medial sidewall **138**. In some embodiments, first lateral sidewall **136** and first medial sidewall **138** may be only in forefoot region **103** of sole **100**, and only the rows of first pillars **140** disposed in forefoot region **103** of sole **100** are disposed between first lateral sidewall **136** and first medial sidewall **138**. In some embodiments, first lateral sidewall **136** and first medial sidewall **138** may extend along the entire length of sole **100**, and all the rows of first pillars **140** are disposed between first lateral sidewall **136** and first medial sidewall **138**.

In some embodiments, as shown in FIGS. **1**-**3**E, for example, second web **160** may include a second lateral sidewall **166** disposed on a lateral side of plate **162** and a second medial sidewall **168** disposed on a medial side of plate **162**. In some embodiments, the plurality of second pillars **170** are arranged in a series of rows, where each row of second pillars **140** extends in a lateral direction along sole **100**. In some embodiments, at least one of the rows of second pillars **170** are disposed between second lateral sidewall **166** and second medial sidewall **168**. For example, as shown in FIG. **1**, **3**D, **3**E, second lateral sidewall **166** and second medial sidewall **168** may be disposed only in heel region **101** of sole **100**, and only the rows of second pillars **170** disposed in heel region **101** of sole **100** are disposed between second lateral sidewall **166** and second medial sidewall **168**. In some embodiments, second lateral sidewall **166** and second medial sidewall **168** may be only in forefoot region **103** of sole **100**, and only the rows of second pillars **170** disposed in forefoot region **103** of sole **100** are disposed between second lateral sidewall **166** and second medial sidewall **168**. In some embodiments, second lateral sidewall **166** and second medial sidewall **168** may extend along the entire length of sole **100**, and all the rows of second pillars **170** are disposed between second lateral sidewall **166** and second medial sidewall **168**.

In some embodiments, as shown in FIGS. **3**D and **3**E, first lateral sidewall **136** and second lateral sidewall **166** may terminate in a vertical direction approximately at a plane defined by lids **144** of first pillars **140** and/or by bases **174** of second pillars **170** such that a bottom surface of second lateral sidewall **166** engages an upper surface of first lateral sidewall **136**. In some embodiments, first medial sidewall **138** and second medial sidewall **168** may terminate approximately at a plane defined by lids **144** of first pillars **140** and/or bases **174** of second pillars **170** such that a bottom surface of second medial sidewall **168** engages an upper surface of first medial sidewall **138**. In some embodiments, first lateral sidewall **136** and first medial sidewall **138** may extend in a vertical direction from plate **132** of first web **130** to plate **162** of second web **160**. In some embodiments, second lateral sidewall **166** and second medial sidewall **168** may extend in a vertical direction from plate **162** of second web **160** to plate **132** of first web **130**. In some embodiments, the length of first lateral sidewall **136** and first medial sidewall **138** may correspond to the length of second lateral sidewall **166** and second medial sidewall **168**. In some embodiments, the length of first lateral sidewall **136** and first medial sidewall **138** may be different than (e.g., shorter or longer) than the length of second lateral sidewall **166** and second medial sidewall **168**. In some embodiments, first lateral and medial sidewalls **136**, **138** and second lateral and medial sidewalls **166**, **168** may terminate in a longitudinal direction at a space defined between adjacent first and/or second pillars **140**, **1470**.

In some embodiments, the second sole member may be made of a different material than the first elastomeric material of the first sole member and may include a different geometric configuration than the shape of the first sole member. For example, FIGS. **4**-**6**E illustrate an article of footwear **10**A having an upper **20**A and a sole **200** coupled to the upper **20** according to one embodiment of the present disclosure. In some embodiments, sole **200** may include an insole **210**, a first sole member **220**, and a second sole member **250** disposed below insole **210** and above first sole member **220**.

In some embodiments, first sole member **220** may include the same and/or similar features of first sole member **120** described herein. For example, in some embodiments, first sole member **220** may include a first web **230** having a plate **232** extending from a heel region **201** to a forefoot region **203** of sole **200**, and first sole member **220** may include a plurality of first pillars **240** projecting upwardly from an upper surface of plate **232** to support the wearer's foot. In some embodiments, as shown in FIGS. **6**A-**6**E, the plurality of first pillars **240** may each include a curved sidewall **242** and a dome-shaped lid **244** extending from an upper end of curved sidewall **242**, in which sidewall **242** and lid **244** define a void cavity **248**. In some embodiments, lid **244** may include a solid surface without including any apertures opening into cavity **248**. In some embodiments, plate **232** of first web **230** may include a plurality of holes **233** that are axially aligned with the plurality of first pillars **240** and open into cavity **248**. In some embodiments, first web **230** and the plurality of first pillars **240** of first sole member **220** are unitary (e.g., a single-piece configuration), such that first web **230** and the plurality first pillars **240** are integrally made from the same material, such as, for example, the first elastomeric-based material described herein.

In some embodiments, second sole member **250** may include the same and/or similar features of second sole member **150** described herein. For example, in some embodiments, second sole member **250** may include a second web **260** having a plate **262** extending from a heel region **201** to a forefoot region **203** of sole **200**, and second sole member **250** may include a plurality of second pillars **270** projecting downwardly from a lower surface of plate **262** to support the wearer's foot. In some embodiments, as shown in FIGS. **4**-**6**A, for example, the plurality of second pillars **270** are disposed only in heel region **201** and arch region **202** of sole **200** and not disposed in forefoot region **203** of sole **200**. In some embodiments, second sole member **250**, including second web **260** and second pillars **270**, may be solid formed from a material (e.g., an EVA foam material) different than the first elastomeric material of first sole member **220**. For example, as shown in FIGS. **6**A-**6**E, the plurality of second pillars **270** may be filled with a solid

material, such as a foam-based material (e.g., EVA foam) and/or an elastomer-based material. In some embodiments, the height of plate **262** increases at a transition from arch region **202** to forefoot region **203** of sole **200** such that a forefoot section **263** of plate **262** includes a height **265**A that is greater than a height **265**B of plate **262** along arch region **202** and a height **265**C of plate **262** along heel region **201** of sole **200**. In some embodiments, as shown in FIG. **6**B, forefoot section **263** of plate **262** may include a plurality of recesses **264** axially aligned with respect to the plurality of first pillars **240** disposed in forefoot region **203** of sole **200**, and the plurality of recesses **264** each receive a respective first pillar **240** of first sole member **220**.

In some embodiments, additional materials, such as a midsole made of a foam-based material, may be added to the sole with the first sole member to achieve a particular cushioning effect. For example, FIGS. **7-11**E illustrate a sole **300** according to some embodiments of the present disclosure. In some embodiments, sole **300** may include an insole **310**, a midsole **350** coupled to insole **310**, a first sole member **320** coupled to midsole **350**, and an outsole **380** coupled to first sole member **320** and midsole **350**.

In some embodiments, first sole member **320** may include the same and/or similar features of first sole member **120** and **220** described herein. For example, in some embodiments, first sole member **320** may include a first web **330** having a plate **332** extending from a heel region **301** to a forefoot region **303** of sole **300**, and first sole member **220** may include a plurality of first pillars **340** projecting upwardly from an upper surface of plate **332** to support the wearer's foot. In some embodiments, as shown in FIGS. **10**A-**10**E and **11**A-**11**E, the plurality of first pillars **340** may each include a curved sidewall **342** and a dome-shaped lid **344** extending from an upper end of curved sidewall **342**, in which sidewall **342** and lid **344** define a void cavity **348**. In some embodiments, lid **344** may include an aperture **346** opening into cavity **348**. As shown in FIGS. **11**A and **10**A, the size (e.g., height and/or diameter) of first pillars **340** decreases from heel region **301** to forefoot region **303**. For example, as shown in FIGS. **10**E and **11**E, first pillars **340** in heel region **301** may include a first height **349**A, and as shown in FIGS. **10**B and **11**B, first pillars **340** in forefoot region **303** may include a second height **349**B that is less than the first height **349**A. In some embodiments, plate **332** of first web **330** may include a solid bottom surface **333** that does not include any holes. In some embodiments, first web **330** can include a plurality of strips **334** interconnecting the plurality of first pillars **340**. In some embodiments, first web **330** and the plurality of first pillars **340** of first sole member **320** are unitary (e.g., a single-piece configuration), such that first web **330** and the plurality first pillars **340** are integrally made from the same material, such as, for example, the first elastomeric-based material described herein.

In some embodiments, as shown in FIGS. **10**A-**10**E and **11**A-**11**E, midsole **350** may include a sidewall **352** extending along a perimeter of sole **300**, including along both lateral side **304** and medial side **305** of sole **300**. In some embodiments, sidewall **352** of midsole **350** defines a chamber **354** extending along a length of sole **300**. In some embodiments, the plurality of first pillars **340** of first sole member **320** are received in chamber **354** of midsole **350**. In some embodiments, plate **332** of first web **330** is disposed underneath midsole **350**. In some embodiments, a lateral end **336** of plate **332** may be coupled to a bottom surface of sidewall **352** along lateral side **304** of sole **300**, and a medial end **338** of plate **332** may be coupled to a bottom surface of sidewall **352** along medial side **305** of sole **300**.

In some embodiments, as shown in FIGS. **10**A-**10**E, midsole **350** has an open top section **355** such that chamber **354** extends through the entire thickness of midsole **350** and the upper boundary of chamber **354** is bounded by insole **310**. Accordingly, lids **344** of the plurality of first pillars **340** received in chamber **354** may engage the bottom surface of insole **310**. In some embodiments, the height of first pillars **340** at a relaxed state (e.g., when no loads are applied to first pillar **140**) may be greater than the height chamber **354** such that the plurality of first pillars **340** slightly sink to the profile of wearer's foot when the wearer is standing, thereby providing better cushioning to the wearer's foot.

In some embodiments, as shown in FIGS. **11**A-**11**E, midsole **350** has a closed top section **356** such that the upper boundary of chamber **354** is bounded by a bottom surface **357** of closed top section **356** of midsole **350**. Accordingly, lids **244** of the plurality of first pillars **240** received in chamber **354** may engage bottom surface **357** of midsole **350**.

In some embodiments, midsole **350** may be made of a material different than the first elastomeric-based material of first sole member **320**. For example, midsole **350** may be made of a foam-based material, such as, for example, an EVA foam material and/or a polyurethane foam material.

In some embodiments, outsole **380** may be coupled to selected portions of a bottom surface of web **330** of first sole member **320** and/or sidewall **352** of midsole **350**. In some embodiments, outsole **380** may be made of a wear-resistant material, such as, for example, a second elastomeric material having a second modulus of elasticity that is greater than the first modulus of elasticity of first elastomeric material of first sole member **120**. For example, the second elastomeric material for outsole **380** may include a synthetic or a natural rubber, thermoplastic polyurethane, a wear-resistant foam, or a combination thereof.

In some embodiments, the first sole member may form the sidewall of the sole and bosses for engaging the ground, without the use of additional cushioning materials. For example, FIGS. **12-15**C illustrate a sole **400** according to one embodiment of the present disclosure. In some embodiments, sole **400** may include an insole **410**, a first sole member **420** disposed below insole **410**, and an outsole **480** disposed below first sole member **420**.

In some embodiments, first sole member **420** may include the same and/or similar features of first sole member **120**, **220**, and **320** described herein. For example, in some embodiments, first sole member **420** may include a first web **430** having a plate **432** extending from a heel region **401** to a forefoot region **403** of sole **400**, and first sole member **420** may include a plurality of first pillars **440** projecting upwardly from an upper surface of plate **432** to support the wearer's foot. In some embodiments, as shown in FIGS. **15**A-**15**C, the plurality of first pillars **440** may each include a curved sidewall **442** and a dome-shaped lid **444** extending from an upper end of curved sidewall **442**, in which sidewall **442** and lid **444** define a void cavity **448**. In some embodiments, lid **444** may include an aperture **446** opening into cavity **448**. As shown in FIG. **15**A, the size (e.g., height and/or diameter) of first pillars **440** varies from heel region **401** to forefoot region **403**. For example, a height **449**A of first pillars **440** located at a transition between arch region **402** and heel region **401** may be larger than the height of remaining first pillars **440**, such as a height **449**B of first pillars **440** in forefoot region **403** and a height **449**C of first pillars **440** in heel region **401**, to provide adequate support for the wearer's hear. In some embodiments, the size (e.g., height and/or diameter) of first pillars **440** disposed in

forefoot region **403** may be smaller than the size (e.g., height and/or diameter) of the remaining first pillars **440**. In some embodiments, lids **444** of the plurality of first pillars **440** engage a bottom surface of insole **410**.

In some embodiments, first web **430** may include a plurality of strips **434** interconnecting the plurality of first pillars **440**. In some embodiments, a strip **434** can extend between a pair of adjacent first pillars **440** such that first pillars **440** are supported adequately in an upright position. In some embodiments, a strip **434** can extend from a first pillar **440** to a sidewall of sole **400** to support first pillar **440** in an upright position. In some embodiments, plate **432** of first web **330** may include a solid bottom surface **433** that does not include any holes. In some embodiments, first web **430** may include a plurality of bosses **431** projecting from a bottom surface of plate **432**. In some embodiments, the plurality of bosses **431** may be axially aligned with respect to the plurality of first pillars **440**. In some embodiments, the plurality of bosses **431** may be dome-shaped to promote more lift when sole **400** strikes the ground during the wearer's gait cycle. In some embodiments, outsole **480** may include a plurality of apertures **482** corresponding to the location of the plurality of bosses **431** such that each of the bosses **431** projects through a respective aperture **482** of outsole **480**.

In some embodiments, as shown in FIGS. **15**B and **15**C, for example, first web **430** may include a lateral sidewall **436** disposed on a lateral side **404** of plate **432** and a medial sidewall **438** disposed on a medial side **405** of plate **432**. In some embodiments, lateral sidewall **436** and medial sidewall **438** are coupled to outer edge of insole **410**. In some embodiments, lateral sidewall **436** and medial sidewall **438** extend along the entire length of sole **400**. In some embodiments, the height of lateral sidewall **436** may correspond to the height of medial sidewall **438** (e.g., same height) along the length of sole **400**. In some embodiments, lateral sidewall **436** and medial sidewall **438** merge at heel region **401** and at forefoot region **403** of sole **400**, such that lateral sidewall **436** and medial sidewall **438** define a chamber **439** bounded by insole **410** and plate **432** of first web **430**. In some embodiments, the plurality of first pillars **440** are arranged in a series of rows, where each row of first pillars **440** extends in a lateral direction along sole **400**. In some embodiments, as shown in FIGS. **15**B and **15**C, the rows of first pillars **440** are disposed between lateral sidewall **436** and medial sidewall **438** of first web **430**.

In some embodiments, first web **430** and the plurality of first pillars **440** of first sole member **420** are unitary (e.g., a single-piece configuration), such that first web **430** and the plurality first pillars **440** are integrally made from the same material, such as, for example, the first elastomeric-based material described herein. In some embodiments, outsole **480** may be coupled to selected portions of a bottom surface of first web **430** and may be made of a wear-resistant material, such as, for example, a second elastomeric material described herein. In some embodiments, the height of lateral sidewall **436** may be different than the height of medial sidewall **438** along the length of sole **400**.

FIGS. **16**-**18**F illustrate a sole **500** according to one embodiment of the present disclosure. In some embodiments, sole **500** may include an insole **510**, a first sole member **520** disposed below insole **510**, and an outsole **580** disposed below first sole member **520**.

In some embodiments, first sole member **520** may include the same and/or similar features of first sole member **120**, **220**, **320**, and **420** described herein. For example, in some embodiments, first sole member **520** may include a first web **530** having a plate **532** extending from a heel region **501** to a forefoot region **503** of sole **500**, and first sole member **520** may include a plurality of first pillars **540** projecting upwardly from an upper surface of plate **532** to support the wearer's foot. In some embodiments, as shown in FIGS. **18**A-**18**F, the plurality of first pillars **540** may each include a curved sidewall **542** and a dome-shaped lid **544** extending from an upper end of curved sidewall **542**, in which sidewall **542** and lid **544** define a void cavity **548**. In some embodiments, lid **544** may include an aperture **546** opening into cavity **548**. As shown in FIG. **18**A, the size (e.g., height and/or diameter) of first pillars **540** may decrease from heel region **501** to forefoot region **503**. For example, a height **549**A of first pillars **540** in heel region **501** may be greater than a height **549**B of first pillars **540** in arch region **502** and a height **549**C of first pillars **540** in forefoot region **503**. In some embodiments, plate **532** of first web **530** may include a solid bottom surface having a plurality of protuberances **534** and a plurality of recesses **535** defined between the plurality of protuberances **534**. In some embodiments, one or more of recesses **535** may extend around a respective protuberance **534**. In some embodiments, the plurality of protuberances **534** are configured to engage the ground during foot strike of the wearer's gait cycle.

In some embodiments, as shown in FIGS. **18**B-**18**F, for example, first web **530** may include a lateral sidewall **536** disposed on a lateral side **504** of plate **532** and a medial sidewall **538** disposed on a medial side **505** of plate **532**. In some embodiments, lateral sidewall **536** and medial sidewall **538** are coupled to outer edge of insole **510**. In some embodiments, lateral sidewall **536** and medial sidewall **538** extend along the entire length of sole **500**. In some embodiments, the height of lateral sidewall **536** may be different than the height of medial sidewall **538** along the length of sole **500**. For example, as shown in FIG. **18**B, the height of lateral sidewall **536** is greater than the height of medial sidewall **538** at a first location in forefoot region **503** of sole **500**. In some embodiments, as shown in FIG. **18**C, the height of lateral sidewall **536** is less than the height of medial sidewall **538** at a second location in forefoot region **503** of sole **500**. In some embodiments, as shown in FIGS. **18**E and **18**F, the height of lateral sidewall **536** may correspond to the height of medial sidewall **538** (e.g., the same height) along arch region **502** and heel region **501** of sole **500**.

In some embodiments, lateral sidewall **536** and medial sidewall **538** merge at heel region **501** and at forefoot region **503** of sole **500**, such that lateral sidewall **536** and medial sidewall **538** define a chamber **539** bounded by insole **510** and plate **532** of first web **530**. In some embodiments, the plurality of first pillars **540** are arranged in a series of rows, where each row of first pillars **540** extends in a lateral direction along sole **500**. In some embodiments, as shown in FIGS. **18**B-**18**F, the rows of first pillars **540** are disposed between lateral sidewall **536** and medial sidewall **538** of first web **530**.

In some embodiments, first web **530** and the plurality of first pillars **540** of first sole member **520** are unitary (e.g., a single-piece configuration), such that first web **530** and the plurality first pillars **540** are integrally made from the same material, such as, for example, the first elastomeric-based material described herein. In some embodiments, outsole **580** may be coupled to selected portions of a bottom surface of first web **530** and may be made of a wear-resistant material, such as, for example, a second elastomeric material described herein.

In some embodiments, the outsole of the sole may define a wear-resistant cupsole for encapsulating the first sole member and engaging the ground, and the first sole member may be molded directly on the bottom cupsole or received on the bottom cupsole as an insert. For example, FIG. **19** illustrates an article of footwear **10**B having an upper **20**B and a sole **600** coupled to the upper **20**B according to some embodiments of the present disclosure. FIGS. **20-25** illustrate sole **600** according to some embodiments of the present disclosure. In some embodiments, sole **600** may include an insole **610**, a first sole member **620** disposed below insole **610**, and an outsole **680** disposed below first sole member **620**.

In some embodiments, first sole member **620** may include the same and/or similar features of first sole member **120**, **220**, **320**, **420**, and **520** described herein. For example, in some embodiments, first sole member **620** may include a plurality of first pillars **640** and a first web **630** having a plurality of strips **634** interconnection first pillars **640**. In some embodiments, as shown in FIGS. **22**A-**22**D, the plurality of first pillars **640** may each include a curved sidewall **642** and a dome-shaped lid **644** extending from an upper end of curved sidewall **642**, in which sidewall **642** and lid **644** define a void cavity **648**. In some embodiments, lid **644** may include an aperture **646** opening into cavity **648**. As shown in FIG. **22**A, the size (e.g., height and/or diameter) of first pillars **640** may decrease from heel region **601** to forefoot region **603**. For example, as shown in FIG. **22**D, first pillars **640** in heel region **603** may include a first height **649**A, and as shown in FIG. **22**B, first pillars **640** in forefoot region **603** may include a second height **649**B that is less than the first height.

In some embodiments, outsole **680** may include a base **682** extending along the length of sole **600**. In some embodiments, outsole **680** may include a sidewall **684** projecting upwardly from base **682** and extending along a perimeter of sole **600**. In some embodiments, sidewall **684** may be coupled to insole **610** and an upper of the article of footwear. In some embodiments, base **682** and sidewall **684** collectively define a chamber **686** that is bounded by insole **610**.

In some embodiments, first sole member **620** may be disposed in chamber **686** of outsole **680**. In accordance with the embodiment shown in FIGS. **21-23**, first sole member **620** may be coupled directly to upper surface of base **682**. For example, the plurality of strips **634** and the plurality of first pillars **640** may be molded directly into an upper surface of base **682**, such that first sole member **620** and outsole **680** are unitary (e.g., configured as a single piece). Any molding technique suitable for molding first sole member **620** to outsole **680** may be used, such as, for example, compression molding, thermoforming, and/or injection molding. In some embodiments, first sole member **620** may be made of the highly-resilient first elastomeric-based material, as described herein, and outsole **680** may be made of the wear-resistant second elastomeric-based material, as described herein.

In accordance with the embodiment shown in FIGS. **24** and **25**, first sole member **620** may be configured as an insert received in chamber **686** of outsole **680**. For example, in some embodiments, first web **630** may include a sheet **632** extending from heel region **601** to forefoot region **603** of sole **600**. In some embodiments, the plurality of first pillars **640** may project upwardly from sheet **632** toward insole **610**. In some embodiments, a bottom surface of sheet **632** may be bonded to upper surface of base **682** of outsole **680** to secure first sole member **620** to outsole **680**.

Whether molded directly into outsole **680** or received as an insert in chamber **686** of outsole **680**, first sole member **620** provides support to the wearer's foot and absorbs shock imparted from sole **600** striking the ground, similar to the other embodiments described herein. By providing adequate cushion and support for the wearer's foot, first sole member **620** allows sole **600** to be void of any additional cushioning materials, such as foam, to reduce the cost of sole **600**.

In some embodiments, a first sole member and a second sole member may be encapsulated by a bottom wear-resistant cupsole such that two layers of pillars are received in the cupsole. For example, FIG. **26** illustrates an article of footwear **10**C having an upper **20**C and a sole **700** coupled to the upper **20**C according to some embodiments of the present disclosure. In some embodiments, sole **700** may include an insole **710**, a first sole member **720** disposed below insole **710**, a second sole member **750** disposed above first sole member **720** and below insole **710**, and an outsole **780** disposed below first sole member **720**.

In some embodiments, first sole member **720** may include the same and/or similar features of first sole member **120**, **220**, **320**, **420**, **520**, and **720** described herein. For example, as shown in FIGS. **26** and **27**, first sole member **720** may include a first web **730** having a plate **732** extending from heel region **701** to forefoot region **703** of sole **700** and a plurality of first pillars **740** projecting from an upper surface of plate **732**. In some embodiments, first web **730** may include a plurality of strips **734** interconnecting first pillars **740**. In some embodiments, the plurality of first pillars **740** may each include a curved sidewall **742** and a dome-shaped lid **744** extending from an upper end of curved sidewall **742**, in which sidewall **742** and lid **744** define a void cavity. In some embodiments, lid **744** may include an aperture opening into cavity.

In some embodiments, second sole member **750** may include the same or similar features of second sole member **150** and **250** as described herein. For example, as shown in FIGS. **26** and **27**, second sole member **750** may include a second web **760** having a plate **762** and a plurality of second pillars **770** projecting downwardly from a bottom surface of plate **762**. In some embodiments, second web **760** may include a plurality of strips **764** interconnecting second pillars **770**. In some embodiments, the plurality of second pillars **770** may each include a curved sidewall **772** and a base **774** extending from a lower end of sidewall **772**. In some embodiments, second sole member **750** may be stacked on first sole member **720**, such that the plurality of second pillars **770** are axially aligned with respect to the plurality of first pillars **740**. In some embodiments, lids **744** of first pillars **740** may be interlocked and/or bonded to bases **774** of second pillars **770** so that second sole member **750** is secured to first sole member **720** as single piece insert.

In some embodiments, outsole **780** may include the same or similar features of outsole **180** and **680** described herein. For example, in some embodiments, outsole **780** may include a base **782** extending along the length of sole **700**. In some embodiments, outsole **780** may include a sidewall **784** projecting upwardly from base **782** and extending along a perimeter of sole **700**. In some embodiments, sidewall **784** may be coupled to insole **710** and upper **20**C of the article of footwear **10**C. In some embodiments, base **782** and sidewall **784** collectively define a chamber **786** that is bounded by insole **710**.

In some embodiments, first sole member **720** and second sole member **750** may be received in chamber **786** of outsole **780**. First sole member **720** and second sole member **750** collectively function as a cushion insert for sole **700** by

providing support to the wearer's foot and absorbing shock imparted from sole **700** striking the ground, similar to the other embodiments described herein. By providing adequate cushion and support for the wearer's foot, first sole member **720** and second sole member **750** allow sole **700** to be void of any additional cushioning materials, such as foam, to reduce the cost of sole **700**.

In some embodiments, the sole may include a single sole member defining the bottom surface of the sole and having a web interconnecting a plurality of hollow pillars that are engaged against a bottom surface of an insole such that the plurality of hollow pillars can sink to the profile of wearer's foot when the wearer is standing, thereby providing better cushioning to the wearer's foot. In some embodiments, the web of the sole member may include a plurality of through holes axially aligned with respect to the plurality of hollow pillars such that the cavities of the pillars are exposed at the bottom of the sole via the through holes. For example, FIG. **28** illustrates an article of footwear **10**D having an upper **20**D and a sole **800** coupled to the upper **20**D according to some embodiments of the present disclosure. In some embodiments, sole **800** may include an insole **810** and a first sole member **820** disposed below insole **810**. In some embodiments, first sole member **820** may define both the sidewalls (e.g., lateral sidewall **837** and medial sidewall **838**) and a bottom surface **835** of sole **800**.

In some embodiments, first sole member **820** may include the same and/or similar features of first sole member **120**, **220**, **320**, **420**, **520**, **620**, and **720** described herein. For example, in some embodiments, first sole member **820** may include a first web **830** having a plate **832** extending from a heel region **801** to a forefoot region **803** of sole **800**, and first sole member **820** may include a plurality of hollow first pillars **840** projecting upwardly from an upper surface **836** of plate **832** to support the wearer's foot. In some embodiments, the plurality of first pillars **840** are arranged in a series of rows, where each row of first pillars **840** extends in a lateral direction along sole **800**.

In some embodiments, as shown in FIGS. **32**A-E, the plurality of first pillars **840** may each include a curved (e.g., cylindrical) sidewall **842** and a dome-shaped lid **844** extending from an upper end of curved sidewall **842**, in which sidewall **842** and lid **844** define a void cavity **848**. In some embodiments, lids **844** of the plurality of first pillars **840** may engage a bottom surface of insole **810**. In some embodiments, plate **832** of first web **830** may include a plurality of holes **833** that are axially aligned with the plurality of first pillars **840** and open into cavity **848**. In some embodiments, the plurality of holes **833** extend through plate **832** from upper surface **836** to bottom surface **835** such that cavities **848** of first pillars **840** are exposed at the bottom of sole **800**. In some embodiments, the shape of bottom surface **835** may be tuned to maintain the structural integrity of first pillars **840** during foot strike. For example, as shown in FIGS. **32**A-**32**E, plate **832** may include a plurality of posts **835**A disposed along bottom surface **835** and a plurality of curved edges **835**B, where each curved edge **835**B extends from an edge of a respective hole **833** to the top of a respective post **835**A. The plurality of posts **835**A and the plurality of curved edges **835**B displace the opening of hole **833** from lying flush against a ground surface during foot strike, thereby avoiding a seal from forming within cavities **848** of first pillars **840**, ultimately preventing first pillars **840** from significantly collapsing during foot strike and potentially creating a vacuum within cavities **848** (e.g., a suction-cup-like effect).

In some embodiments, first web **830** may include a plurality of strips **834** disposed along portions of plate **832** interconnecting the plurality of first pillars **840**. In some embodiments, a strip **834** can extend from an upper surface **836** of plate **832** between a pair of adjacent first pillars **840** such that first pillars **840** are supported adequately in an upright position. In some embodiments, a strip **834** can extend from a first pillar **840** to a sidewall of sole **800** to support first pillar **840** in an upright position.

In some embodiments, as shown in FIGS. **32**A-D, for example, first web **830** may include a lateral sidewall **837** disposed on a lateral side **804** of plate **832** and a medial sidewall **838** disposed on a medial side **805** of plate **832**. In some embodiments, lateral sidewall **837** and medial sidewall **838** are coupled to outer edge of insole **810**. In some embodiments, lateral sidewall **837** and medial sidewall **838** extend along the entire length of sole **800**. In some embodiments, the height of lateral sidewall **837** may correspond to the height of medial sidewall **838** (e.g., same height) along the length of sole **800**. In some embodiments, lateral sidewall **837** and medial sidewall **838** merge at heel region **801** and at forefoot region **803** of sole **800**, such that lateral sidewall **837** and medial sidewall **838** define a chamber **839** bounded by insole **810** and plate **832** of first web **830**. In some embodiments, as shown in FIGS. **32**A-D, the rows of first pillars **840** are disposed between lateral sidewall **837** and medial sidewall **838** of first web **830**.

As shown in FIGS. **32**A-E, the size (e.g., height and/or diameter) of first pillars **840** varies from heel region **801** to forefoot region **803**. For example, as shown in FIG. **32**B, first pillars **840** in forefoot region **803** may include a first height **849**C, and as shown in FIG. **32**D, first pillars **840** in arch region **802** may include a second height **849**B that is greater than the first height **849**C to provide more support against the arch of the wearer's foot. In some embodiments, as shown in FIG. **32**B, first pillars in forefoot region **803** may include a first width **849**A, and as shown in FIG. **32**E, first pillars **840** in heel region **801** may include a second width **849**D greater than the first width **849**A to provide more cushioning for the wearer's heel. In some embodiments, the size of first pillars **840** disposed in forefoot region **803** may include a smaller height and/or diameter than the height and/or diameter of the remaining first pillars **840**.

In some embodiments, first web **830** and the plurality of first pillars **840** of first sole member **820** are unitary (e.g., a single-piece configuration), such that first web **830**, including plate **832**, strips **834**, lateral sidewall **837**, and medial sidewall **838** of first web **830**, and the plurality of first pillars **840** are integrally made from the same material, such as, for example, the first elastomeric-based material described herein. In some embodiments, sole **800** may include a second material, such as a foam-based material, to form lateral sidewall **837** and medial sidewall **838** of sole **800**, in which the plurality of first pillars **840** of the first elastomeric-based material and the medial and lateral sidewalls of the second material are molded together to form first sole member **820**. In some embodiments, sole **800** may include an outsole coupled to selected portions of bottom surface **835** and may be made of a wear-resistant material, such as, for example, the second elastomeric material described herein.

The foregoing description of the specific embodiments will so fully reveal the general nature of the invention(s) that others can, by applying knowledge within the skill of the art, readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present

invention(s). Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed embodiments, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the teachings and guidance.

The breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. An article of footwear, comprising:

an upper; and

a sole coupled to the upper, the sole comprising:

an insole configured to receive a foot of a wearer, and

a first sole member disposed below the insole and configured to support the foot of the wearer, the first sole member comprising:

a first web including a plate extending along a length of the sole,

a plurality of first pillars projecting upwardly from the first web toward the insole, the plurality of first pillars each include:

a curved sidewall projecting upwardly from an upper surface of the plate;

a lid extending from an upper end of the curved sidewall, wherein the curved sidewall and the lid define a cavity; and

an aperture disposed at a center of the lid and opening into the cavity;

a plurality of dome-shaped walls, each axially aligned with one of the plurality of first pillars, and each including:

a concave interior surface bounding the cavity of its respective first pillar, and

a convex exterior surface surrounded by a rim recessed from a ground-contacting surface of the plate; and

strips projecting upwardly from the upper surface of the plate, each of the strips extending from a curved sidewall of a respective first pillar to a curved sidewall of an adjacent first pillar,

wherein the first web and the plurality of first pillars of the first sole member are unitary and made of a first elastomeric material having a first modulus of elasticity configuring the plurality of first pillars to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force.

2. The article of footwear of claim **1**, wherein the lid of each first pillar is dome-shaped, and the aperture of each first pillar is disposed at an apex of the dome-shaped lid.

3. The article of footwear of claim **1**, wherein the cavity of each first pillar is filled with ambient air.

4. The article of footwear of claim **1**, wherein the sole further comprises an outsole coupled to the first web of the first sole member, and the outsole is made of a second elastomeric material having a second modulus of elasticity that is greater than the first modulus of elasticity.

5. The article of footwear of claim **1**, further comprising:

a second sole member disposed below the insole and above the first sole member, the second sole member comprising:

a second web coupled to the insole and extending along the length of the sole, and

a plurality of second pillars projecting downwardly from the second web toward the first sole member, the plurality of second pillars each include:

a curved sidewall, and

a base extending from a lower end of the curved sidewall,

wherein the second web and the plurality of second pillars of the second sole member are unitary,

wherein the plurality of second pillars are axially aligned with respect to the plurality of first pillars, and the base of each second pillar engages the lid of a respective first pillar.

6. The article of footwear of claim **5**, wherein the plurality of second pillars each include a pin projecting downwardly from a center of the base and received in the aperture of the respective first pillar.

7. The article of footwear of claim **1**, wherein the first sole member includes a central pillar projecting upwardly from the upper surface of the plate in a central portion of an arch region of the sole, and the plate of the first sole member includes a hole opening into a cavity of the central pillar.

8. The article of footwear of claim **7**, wherein a length of the central pillar defined in a longitudinal direction of the sole is larger than a length of each of the first pillars defined in the longitudinal direction of the sole.

9. A sole for an article of footwear, comprising:

an insole configured to receive a foot of a wearer, and

a first sole member disposed below the insole and configured to support the foot of the wearer, the first sole member comprising:

a first web comprising a plate extending along a length of the sole, and

a plurality of first pillars projecting upwardly from the first web toward the insole, the plurality of first pillars each include:

a curved sidewall projecting upwardly from an upper surface of the plate,

a lid extending from an upper end of the curved sidewall, wherein the curved sidewall and lid define a cavity;

a plurality of dome-shaped walls, each axially aligned with one of the plurality of first pillars, and each including:

a concave interior surface bounding the cavity of its respective first pillar, and

a convex exterior surface surrounded by a rim recessed from a ground-contacting surface of the plate; and

strips projecting upwardly from the upper surface of the plate, each of the strips extending from a curved sidewall of a respective first pillar to a curved sidewall of an adjacent first pillar, wherein one or more of the strips includes an upper surface defining an arch-shaped contour.

10. The sole of claim **9**, wherein the plate of the first web comprises a hole opening into the cavity of one of the first pillars.

11. The sole of claim **9**, wherein the first web comprises:

a first lateral sidewall disposed on a lateral side of the plate of the first web, and

a first medial sidewall disposed on a medial side of the plate of the first web.

12. The sole of claim **11**, wherein the plurality of first pillars are arranged in a series of rows, and at least one of

the rows of the first pillars are disposed between the first lateral sidewall and the first medial sidewall of the first web.

13. The sole of claim **11**, further comprising:

a second sole member disposed below the insole and above the first sole member, the second sole member comprising:

a second web coupled to the insole, the second web comprising a plate extending along the length of the sole, and

a plurality of second pillars projecting downwardly from a lower surface of the plate of the second web toward the first sole member, the second pillars each include:

a curved sidewall, and

a base extending from a lower end of the curved sidewall,

wherein the second web and the plurality of second pillars of the second sole member are unitary,

wherein the plurality of second pillars are axially aligned with respect to the plurality of first pillars, and the base of each second pillar is interlocked with the lid of a respective first pillar.

14. The sole of claim **13**, wherein the second web comprises:

a second lateral sidewall disposed on a lateral side of the plate of the second web, and

a second medial sidewall disposed on a medial side of the plate of the second web,

wherein a bottom surface of the second lateral sidewall engages an upper surface of the first lateral sidewall, and a bottom surface of the second medial sidewall engages an upper surface of the first medial sidewall.

15. The sole of claim **9**, wherein the first web and the plurality of first pillars of the first sole member are unitary and made of a first elastomeric material having a first modulus of elasticity configuring the plurality of first pillars to flex or deform upon an application of a compressive force by the wearer and return to their original shape upon a removal of the compressive force.

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