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(54) CUSHIONING SYSTEM FOR FOOTWEAR

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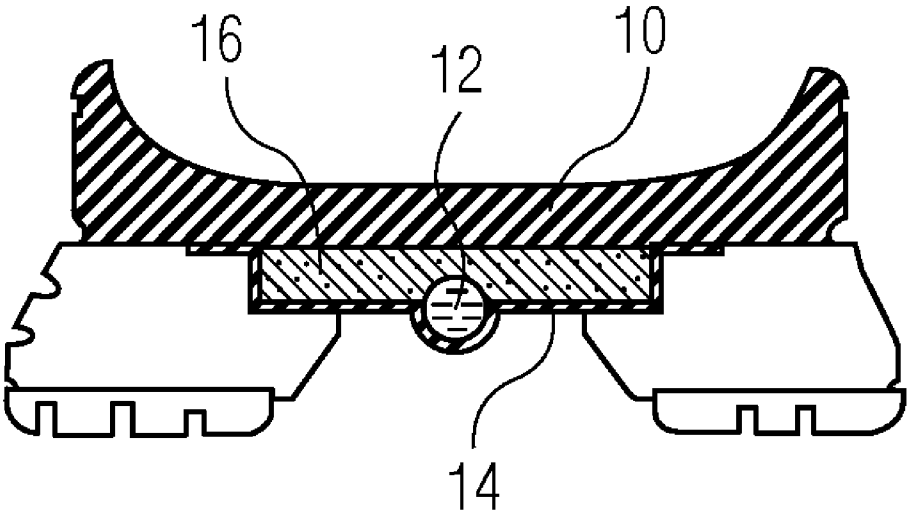
(52) **U.S. Cl.** **36/29**

(57) **ABSTRACT**

A shoe having a shock absorbing bottom comprising one or more compartments filled with gas, for example air or nitrogen and which functions as a spring and one or more dampers which function to control rebound and vibrations. The damper can be viscoelastomeric material.



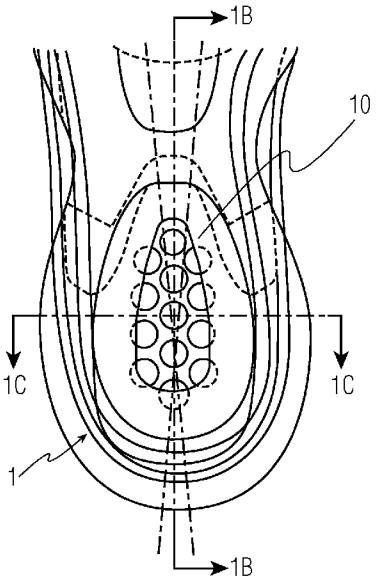


FIG. 1A

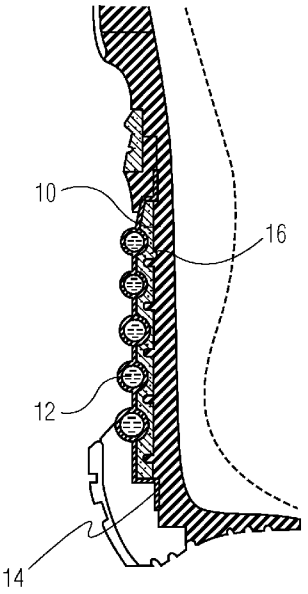


FIG. 1B

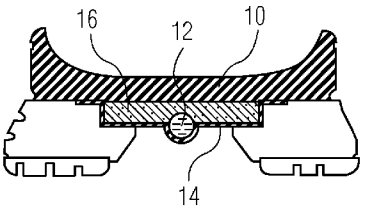


FIG. 1C

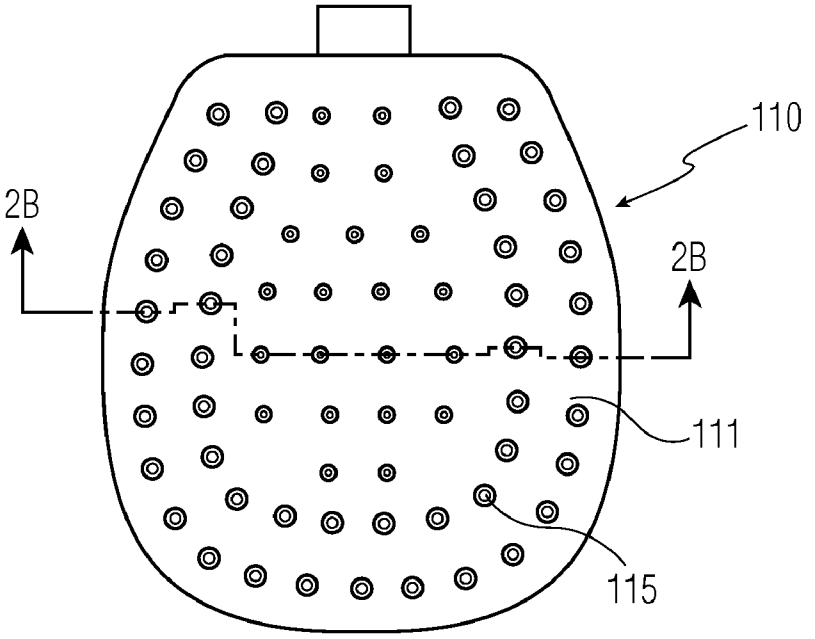

110
2B
2B
111
115

FIG. 2A

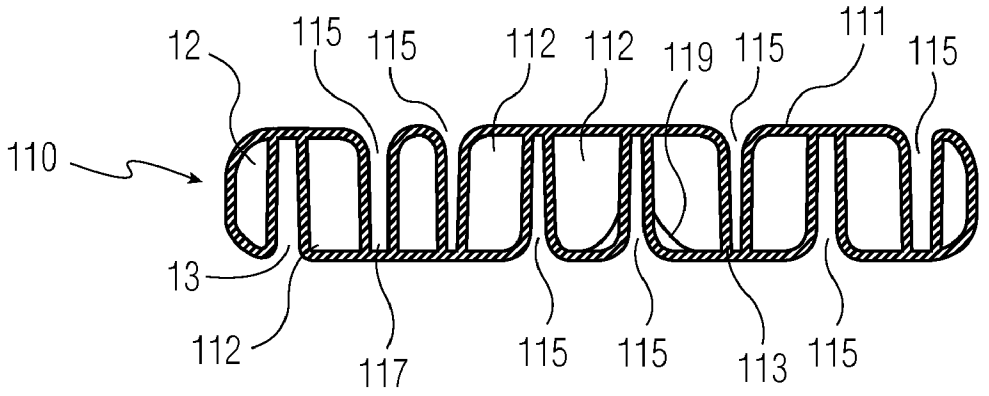

12
115
115
112
112
119
115
111
115
110
13
112
117
115
115
113
115

FIG. 2B

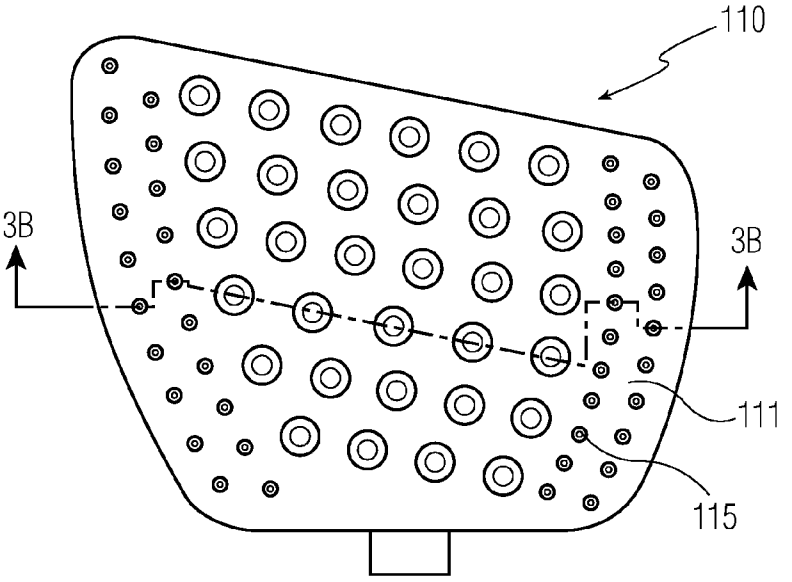


FIG. 3A

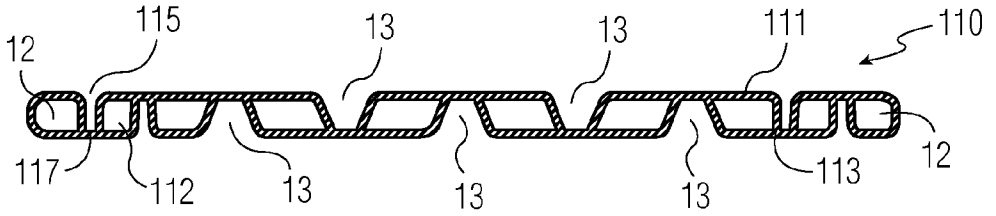


FIG. 3B

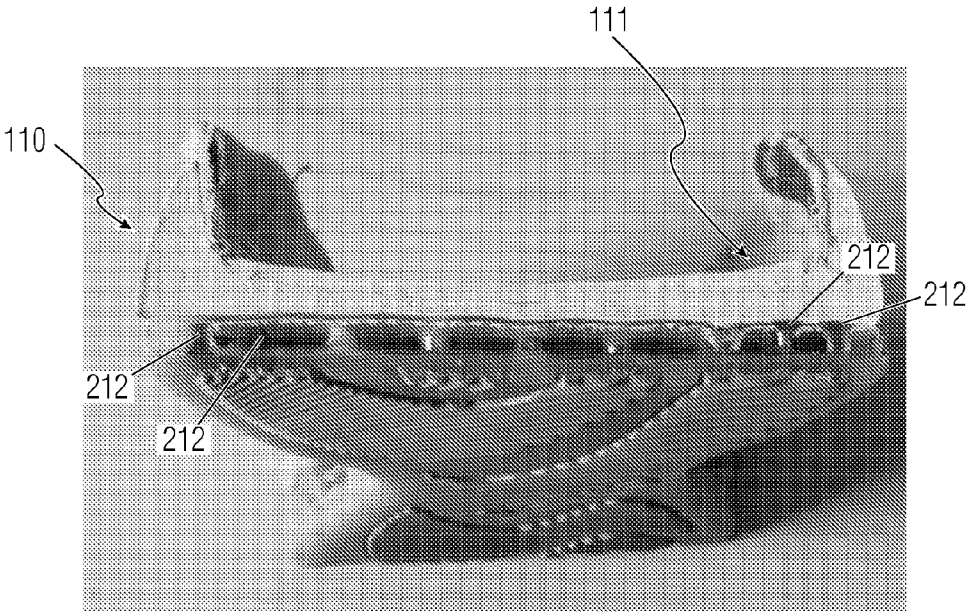


FIG. 4A

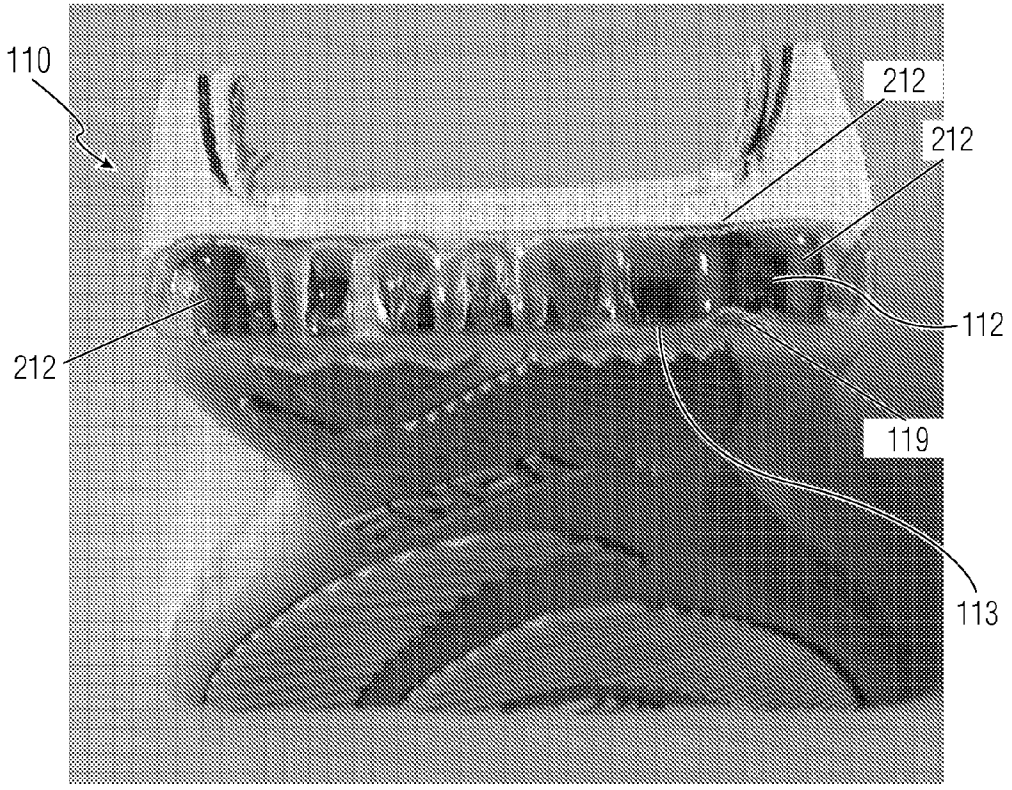


FIG. 4B

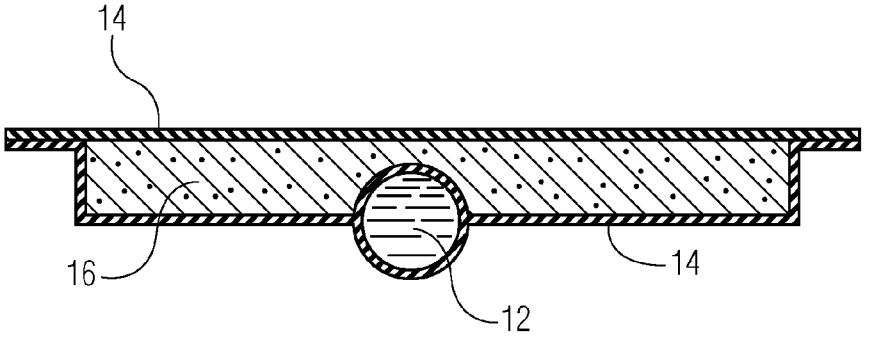


FIG. 5A

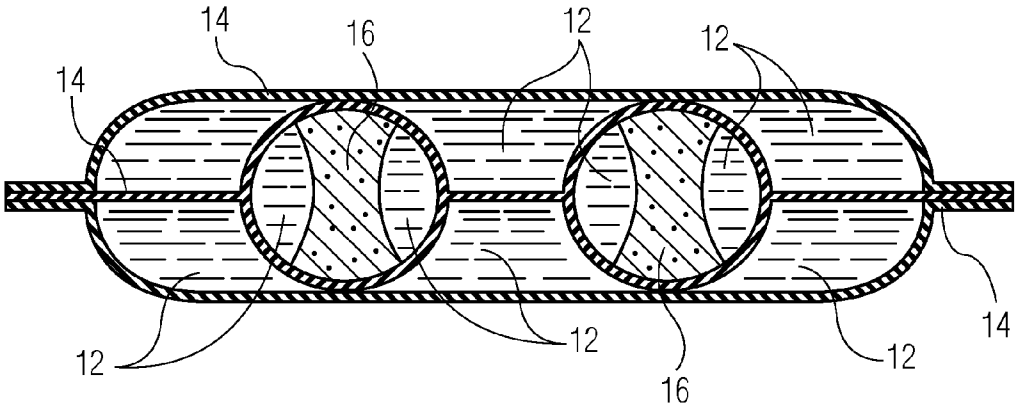


FIG. 5B

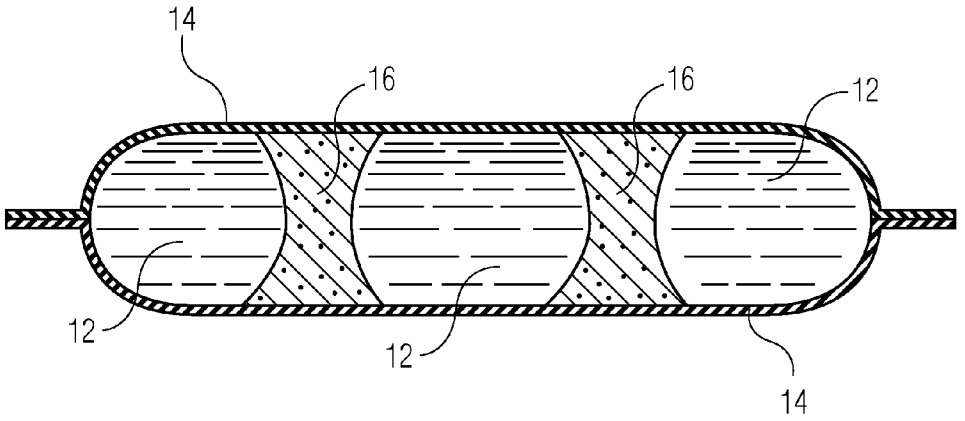


FIG. 5C

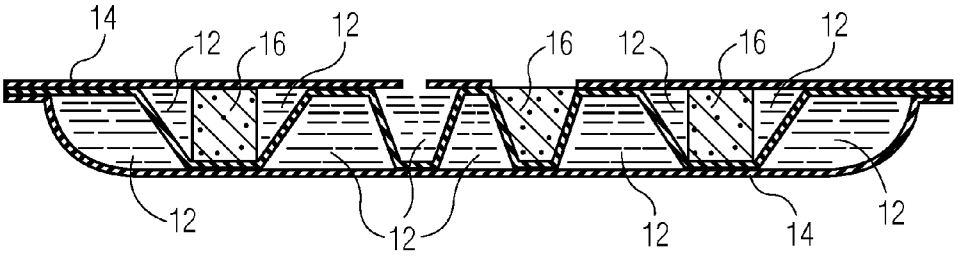


FIG. 5D

CUSHIONING SYSTEM FOR FOOTWEAR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of U.S. Provisional application 60/804,525, filed Jun. 12, 2006.

BACKGROUND

[0002] As used herein, "footwear" refers to any item for supporting the foot and engaging the ground and encompasses shoes, sandals, boots, slippers, over shoes, athletic shoes, and other footwear articles. "Cushioning elements" refers to basic shock absorbing, energy return, and/or protective underfoot materials or structures that are intended to react to the forces of foot strike by providing force attenuation, dissipation, dampening, or energy return (spring), which are typically included on sports and athletic shoes.

[0003] Traditionally, a cushioning element comprised a consistent and uniform layer of shock absorbing and protective material, such as such as EVA or polyurethane, placed in a shoe between the foot and the ground. However, in relatively recent years there has been trend towards customized placements of varying cushioning materials and structures under a foot. Nowadays, common cushioning elements may be based on EVA or polyurethane foam, visco-elastomers of foam or gels, fluid filled bladders, mechanical springs or resiliently collapsible mechanical structures, fluid (e.g., air) springs, or any combination of the foregoing.

[0004] For example polymer spring units have been placed in portions in the sole unit receiver, particularly the heel portion, and in some cases the forefoot portion. Mechanical polymer springs may formed from an injected thermoplastic, such as Hytrel polymer, PEBAX, and TPU, as well as other resilient polymers, thermo-set plastics, and metallic materials known in the art, alone or in combination. See, for example, U.S. Pat. No. 5,461,800, which is hereby incorporated by reference in its entirety. The U.S. Pat. No. 5,461,800 patent discloses a foamless midsole unit, comprising upper and lower plates sandwiching transverse cylindrical units formed of resilient polymer See also, for example, U.S. Pat. Nos. 4,910,884, 6,625,905, and 5,337,492. Other forms of mechanical springs, such as leaf-spring structures, are also contemplated.

[0005] As used herein a "sole unit" generally may comprise a midsole or cushioning element for energy absorption and/or return; or an outsole material for surface contact and abrasion resistance and/or traction; or a single unit providing such midsole or outsole functions. While a sole unit would generally extend the length of the shoe, a sole unit could also comprise a unit that extends for a lesser area, such as, just the forefoot or rearfoot portion, or some other area of lesser length or width.

[0006] A sole unit may include cushioning elements in accordance with any of the foregoing cushioning elements. Contemplated fabrication methods for the sole unit components include molding, injection molding, blow molding, direct-injection molding, one-time molding, composite molding, insert molding, co-molding separate materials, or other techniques known in the art, alone or in combination. Contemplated fabrication or assembly methods include adhesives, bonding agents, welding, mechanical bonding, or interlocking shapes, alone or in combination.

[0007] Dampening elements, which are a form of cushioning element (as defined herein), may also be incorporated into the sole units and/or sole unit receivers disclosed herein. "Dampening" generally refers to the ability of certain materials to reduce the amplitude of oscillations, vibrations, or waves. In footwear, shock from impact may generate compression waves or other vibrations within the sole system. Contemplated dampening materials include visco-elastomers. In some instances, plain elastomer materials may be used as dampers; however, they may not provide as desirable dampening qualities on the spring unit as a visco-elastomer. Example materials for a visco-elastic damper include any number of polymers, including polyurethanes and polyethylenes in foam or gel form, fabricated by conventional molding practices or by film. Other suitable visco-elastomers are known to persons skilled in the art. Contemplated fabrication methods for visco-elastomers include molding, injection molding, blow molding, direct-injection molding, one-time molding, composite molding, insert molding, co-molding separate materials, or other techniques known in the art, alone or in combination. Contemplated fabrication or assembly methods include adhesives, bonding agents, welding, mechanical bonding, or other mechanical or chemical fastening means know to persons in the art, alone or in combination.

[0008] The outsole or traction surface for a sole assembly may include rubber, leather, cleats, spikes, felts, EVA, foam, and other cushioning technologies, and combinations of the foregoing.

SUMMARY

[0009] These objects and needs in the art, and others which will become apparent from the following disclosure and drawings, are provided by the present invention which comprises in one aspect a shoe having a shock absorbing bottom comprising one or more compartments filled with gas, for example air or nitrogen, which functions as a spring, and one or more integrated dampers which functions to control rebound and vibrations. The damper can be viscoelastomeric material, sponge, injection molded material, liquid, or any other material which can function as a damper.

[0010] The one or more compartments can be sealed or unsealed and formed by a sheet or web of material. The compartments can be partially sealed so as to let gas out under pressure and restore gas when pressure is released, somewhat akin to a "whoopee cushion."

[0011] The compartments can be an array resembling a "bubble-pack." The damper elements will be integrated with the spring element, either externally, or completely enclosed by the gas chamber

[0012] The integrated dampers can also be an array and they can be covered by a viscoelastic material disposed over the array of dampers.

[0013] In some embodiments the shock absorbing bottom has a top facing surface and a ground facing surface, and the compartments and integrated damper are interposed between the top and ground facing surfaces.

[0014] The entire structure can be made of a material comprising a thermoplastic.

[0015] In some embodiments gas chamber and/or damper is in the form of projections and the projections can extend from a top or bottom surface, or a combination of top and bottom surfaces, and the projections can extend completely through to the opposite surface, i.e., the top or bottom. The projections can be empty, filled with gas, or filled with damper material.

[0016] In some embodiments the one or more gas compartments and the one or more dampers are tuned to provide selected strength, support, cushioning and/or performance properties. The one or more dampers can be an array and/or the one or more gas compartments can be an array, i.e., a plurality. The there is no limit to the number of integrated dampers or compartments in each array. In some embodiments there are 2 to about 50.

[0017] The one or more compartments filled with gas generally functions as a spring and the damper generally functions to control rebound, oscillations, and or vibration, somewhat akin to an automotive shock absorber system which comprises a spring and a shock absorber damper.

[0018] In some embodiments the one or more compartments and dampers are captured or contained by film.

[0019] Overall, the shock absorbing bottom of the shoe, which can be the sole, heel, both, or a portion of one or the other or both, functions as a cushioning element for that portion of the shoe bottom containing it.

[0020] These and other embodiments are described in more detail in the following detailed descriptions and the figures.

[0021] The foregoing is not intended to be an exhaustive list of embodiments and features of the present inventive concept. Persons skilled in the art are capable of appreciating other embodiments and features from the following detailed description in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1**A is a bottom view of a heel of a shoe comprising the shock absorbing system of the invention.

[0023] FIG. **1**B is a cross-section through **1**B-**1**B of FIG. **1**A.

[0024] FIG. **1**C is a cross-section through **1**C-**1**C of FIG. **1**A.

[0025] FIG. **2**A is a plan view of the foot facing surface of a shock absorbing system in a heel of a shoe.

[0026] FIG. **2**B is a cross section through **2**B-**2**B of FIG. **2**A.

[0027] FIG. **3**A is a plan view of a foot facing surface of a shock absorbing system in a heel of a shoe.

[0028] FIG. **3**B is a cross section through **3**B-**3**B of FIG. **3**A.

[0029] FIG. **4**A is a photograph of a cross section of a shoe according to the invention wherein the foreground section of the heel of the shoe is cut away.

[0030] FIG. **4**B is a photograph of a cross section wherein the foreground section of the heel of a shoe according to the invention is cut away.

[0031] FIG. A**1** is a cross section of a shock absorbing system of the invention having a film/molded component or containment vessel surrounding an integrated damper element and spring element.

[0032] FIG. A**1** is a cross section of a shock absorbing system of the invention having a spring element containing inert gas or ambient, a damper element having visco-elastomer, foam, fluid, fibers, engineered 3d grid, or mechanical structure, the entire array contained in a film/molded component or containment vessel.

[0033] FIG. A**2** shows one embodiment where multiple films, creating multiple gas chambers are used, in unison, and where one contains another, and where the damper element can be integrated in an enclosed, internal or external form, but integral with the spring element formed by the films. The damper elements can be either enclosed inside or integrated with the outside of the film elements containing gas or ambient space"

[0034] FIG. A**3** is a cross section of another embodiment of the shock absorbing system having a film/molded component or containment vessel, damper elements, and spring elements. In this embodiment the damper elements are completely enclosed inside the gas containment vessel.

[0035] FIG. A**4** is a cross section of another embodiment of the shock absorbing system of the invention having a film/molded component or containment vessel, damper elements, and spring elements containing inert gas or ambient.

DETAILED DESCRIPTION

[0036] Representative embodiments of the present inventive concept are shown in the accompanying drawings wherein similar features share common reference numerals.

[0037] Referring first to FIG. **1**A, an embodiment of a sole unit **1** according to the inventive is illustrated with shock absorbing system **10** illustrated in cross sectional view FIG. **1**B illustrating gas filled spring compartments **12** and dampers **16** composed of gel-viscoelastomeric material are enclosed by a flat film web, arranged so as to provide excellent shock absorbing function for the sole **1**.

[0038] FIG. **1**C is a cross-section through **1**C-**1**C of FIG. **1**A showing gas filled spring compartments **12**, cushioning element **10**, damper **16**, and film **14**.

[0039] FIG. **2**A is a plan view of the foot facing surface of a shock absorbing system **110** in a heel of a shoe, the heel having a top or foot facing surface **111**. Open ends of cones **115** containing damping material are shown.

[0040] FIG. **2**B is a cross section through **2**B-**2**B of FIG. **2**A showing areas **115** of damping material having generally flat tips **117**, the bottom or ground facing surface **113** and top facing surface **111** at opposing sides of the heel cushioning element **110**.

[0041] FIG. **3**A is a plan view of another embodiment of a foot facing surface of a shock absorbing system in a heel of a shoe wherein top or foot facing surface **111** and dampers **115** are shown.

[0042] FIG. **3**B is a cross section through **3**B-**3**B of FIG. **3**A illustrating dampers **115**, end gas filled compartments **12** and medial gas filled compartments **112**.

[0043] FIG. **4**A is a photograph of a cross section of a shoe according to the invention wherein the foreground section of the heel of the shoe is cut away, illustrating dampers **112** filled with viscoelastomeric material, gas filled compartments **12**.

[0044] FIG. **4**B is a photograph of a cross section wherein the foreground section of the heel of a shoe according to the invention is cut away.

[0045] FIG. A**1** is a cross section of a shock absorbing system of the invention having a film/molded component or containment vessel surrounding an integrated damper element and spring element.

[0046] FIG. A**1** is a cross section of a shock absorbing system of the invention having a spring element containing inert gas or ambient, a damper element having visco-elastomer, foam, fluid, fibers, engineered 3d grid, or mechanical structure, the entire array contained in a film/molded component or containment vessel.

[0047] FIG. A**3** is a cross section of another embodiment of the shock absorbing system having a film/molded component or containment vessel, damper elements, and spring elements.

[0048] FIG. A**4** is a cross section of another embodiment of the shock absorbing system of the invention having a film/molded component or containment vessel, damper elements, and spring elements containing inert gas or ambient.

[0049] In some of the embodiments the sole unit includes a cushioning unit that relates to a combination of fluid filled compartments wherein one or more compartments are associated with a solid or gel material that provides energy return (spring) and/or dampening. In certain embodiments, the compartments are sealed and include within a fluid such as air, another gas, or a liquid. In certain embodiments the material associated with the compartments provides dampening properties. Suitable dampers include visco-elastic dampers, particularly gel elastomers.

[0050] Gel elastomers are highly viscoelastic polymer gels that have excellent shock absorption and damping characteristics. They are available in a variety of material types and grades. Examples include thermoplastics, thermoset plastics, resins, binders, base polymers, monomers, composite materials, and silicone compounds. Example materials that have been used in footwear include polyurethanes and polyethylenes in foam or gel form, fabricated by conventional molding practices or by film.

[0051] The sole unit has a set or array of fluid filled compartments **12** that are generally arranged in a plane under a foot and function as a spring. In this embodiment, the cushioning element **10** is intended for a rearfoot portion of an item of footwear, but analogous cushioning elements could be made for any other portion of a foot. In this embodiment, the fluid filled compartments are shaped as spheres—like bubble pack—connected at their equators by a flat film web **14**.

[0052] Element **16** is a gel visco-elastomeric material that functions as a damper. The damper is generally arranged in a plane above the fluid filled compartments. A set of recesses are formed in the damper and they are sized and spaced so that they closely couple with corresponding tops of the compartments **12**.

[0053] Another embodiment of a hybrid cushioning system is shown in FIGS. **2**A-**2**B. This embodiment is intended for a heel of a shoe. In this embodiment, a heel cushioning element **110** that has a top or foot facing surface **111** and a bottom or ground facing surface **113**. An array of resilient structural elements **112** are interposed between the surfaces. In the embodiment shown the elements in the array are conical projections that may be referred to as "pins" that extend from a top or bottom surface of the cushioning element completely through to an opposite surface. The cushioning element may have side walls connecting the top and bottom surfaces so as to seal the structural elements within the cushioning element. Alternatively, the sidewalls can be omitted. The top and bottom surfaces and optional sidewalls may be made from thermoplastics.

[0054] The cones may have open ends **115** at their base and abut the opposite surface at generally flat tips **117**. The pins alternate in terms of which of the opposing surfaces the open base is formed. Together the opposing top surfaces and interposed and connected provide a functional cushioning unit for use in a shoe sole. The bag may include a fluid, such as air, that in combination with the structural support of the pins provides controlled cushioning and spring. The pins may also have buttresses **119** at their bases that strengthen the system. The buttresses are formed when the polymer material that is stretched over the cammed male mold pins in the mold wrinkles based on the anisotropic stretching of the material over the male form of the pin in the mold. (This is analogous to the stretching a nylon stocking over a traffic cone.) Controlling the timing of the camming of the mold pins in a parison molding process can determine the degree of buttressing and/or the effectiveness of the abutments.

[0055] The structural elements in an array may be hollow or solid. They may have one or both ends left open or closed at the point where an end of the structural element joins a top or bottom surface. In the case of hollow elements, they may be partially or completely filled with another material or structure. For example, one or more elements in an array may be filled with a visco-elastomer, a damper, or an energy return (spring) material or structure.

[0056] Some structural elements in the array may be sized and shaped differently from other structural elements in the array to create areas of desired properties, such as strength and compressibility, and performance (e.g., anti-pronation or supination). Similarly, hollow structural elements can contain different materials or structures and be arranged in different patterns. For example, FIGS. **4**A-**4**B show a cushioning element where a set of hollow structural elements disposed along a perimeter of a rear foot are filled with a resilient solid material, such as a polyurethane based material. that help strengthen the cushioning unit. In this case the pattern is a generally horse-shoe shaped pattern. An adjacent set of filled structural elements **212** could provide even further strength, for example. The sole units include highly tunable cushioning elements to address, support, cushioning and performance needs. Although the cushioning elements are shown as generally planar structures, they can have three dimensional shapes that extend up the sides of a foot.

[0057] FIGS. **3**A and **3**B show an embodiment, similar to that of FIGS. **2**A and **2**B, for a forefoot **210** shoe. FIGS. **4**A and **4**B show a cross-section of a cushioning system assembled in a sole unit. The outer elements are filled with a material.

[0058] U.S. Pat. Nos. 7,020,988, 4,999,931, 6,098,313, 6,029,962, 5,976,451, 5,092,060, 5,369,896, 5,918,383, 6,763,612, 6,589,614, and PCT/US01/25693 are hereby incorporated by reference in their entireties for all they disclose.

[0059] Persons skilled in the art will recognize that many modifications and variations are possible in the details, materials, and arrangements of the parts and actions which have been described and illustrated in order to explain the nature of this inventive concept and that such modifications and variations do not depart from the spirit and scope of the teachings and claims contained therein.

What is claimed is:

1. A shoe having a shock absorbing bottom comprising a compartment filled with gas and an integrated damper.

2. The shoe of claim 1 wherein the compartment is sealed or unsealed and formed by a sheet or web of material.

3. The shoe of claim 1 comprising an array of compartments, the array resembling a "bubble-pack."

4. The shoe of claim 1 wherein the integrated damper comprises a viscoelastic material.

5. The shoe of claim 1 wherein comprising an array of integrated dampers and a viscoelastic material disposed over the integrated dampers.

6. The shoe of claim 1 wherein the shock absorbing bottom has a top facing surface and a ground facing surface, and the compartments and integrated damper are interposed between the top and ground facing surfaces.

7. The shoe of claim 1 wherein the entire structure is made of a material comprising a thermoplastic.

8. The shoe of claim 1 comprising gas chamber and/or damper projections from a top or bottom surface completely through to an opposite surface.

9. The shoe of claim 1 comprising gas chamber and/or damper projections from a top or bottom surface completely through to an opposite surface wherein one or more of the projections is empty, filled with gas, or filled with damper material.

10. The shoe of claim 1 wherein the gas chamber and damper are tuned to provide selected strength, support, cushioning and/or performance properties.

11. The shoe of claim 1 having an array of compartments that contain gas and/or damper material.

12. The shoe of claim 1 wherein the integrated damper comprises a visco-elastomer.

13. The shoe of claim 1 wherein the compartment filled with gas functions as a spring and the damper functions to control rebound, oscillations, and or vibration.

14. The shoe of claim 1 wherein the compartment and damper are contained by film.

15. The shoe of claim 1 having an array of compartments and dampers, the array captured or contained by film.

16. The shoe of claim 1 wherein the damper comprises a gel of viscoelastomeric material, sponge, injection molded material, or liquid.

17. The shoe of claim 1 wherein the shock absorbing bottom functions as a cushioning element.

18. The shoe of claim 1 wherein the bottom is either a heel section, sole section, or a combination heel and sole.

19. The shoe of claim 1 wherein the compartments are filled with a gas selected from air and nitrogen.

* * * * *