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(54) PROTECTIVE HELMET WITH ENERGY STORAGE MECHANISM

(57) A protective helmet (200) having multiple protective zones, including an inner shell (204) having a first inner surface (201) and a first outer surface (205), an outer shell (202) having a second inner surface (206), a second outer surface (207), and at least one window (210) defined by said outer shell (202), said outer shell (202) functionally attached to said inner shell (204), an elastomeric zone (203) between said first outer surface (205) and said second inner surface (206), a plurality of sinusoidal springs (208) positioned in said elastomeric zone (203), each of the plurality of sinusoidal springs (208) including a first end (264), and a second end (260), a force indicator tab (216) in operative contact with said second end (260) of at least one of said plurality of sinusoidal springs (208), wherein said force indicator tab (216) is displaced in said at least one window (210) by said second end (260) when said helmet is impacted with sufficient force, and a transmission device (250).

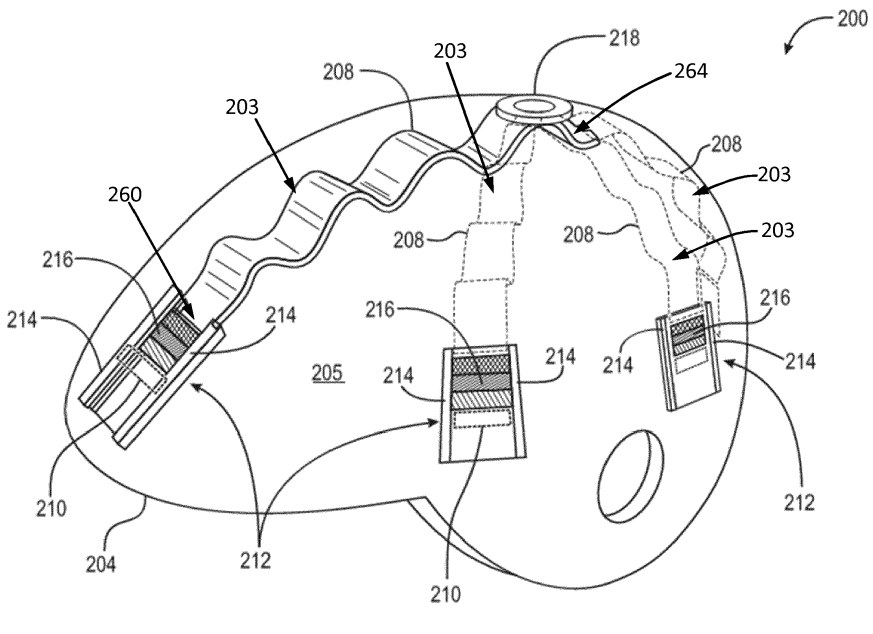

Fig. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is filed under 35 U.S.C. § 120 as a continuation-in-part of U.S. Patent Application No. 15/401,257, filed on January 9, 2017, which application is a continuation-in-part of U.S. Patent Application No. 14/615,011, filed February 5, 2015, which application is a continuation-in-part of U.S. Patent Application No. 13/841,076, filed March 15, 2013, now U.S. Patent No. 9,795,178, issued October 24, 2017, which application is a continuation-in-part of U.S. Patent Application No. 13/412,782, filed March 6, 2012, which applications are hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

[0002] The invention relates generally to a protective helmet, and, more particularly, to a protective helmet having an energy storage mechanism which absorbs linear and rotational forces and slowly releases such forces.

BACKGROUND

[0003] The human brain is an exceedingly delicate structure protected by a series of envelopes to protect it from injury. The innermost layer, the pia mater, covers the surface of the brain. The arachnoid layer, adjacent to the pia mater, is a spidery web-like membrane that acts like a waterproof membrane. Finally, the dura mater, a tough leather-like layer, covers the arachnoid layer and adheres to the bones of the skull.

[0004] While this structure protects against penetrating trauma, the softer inner layers absorb only a small amount of energy before linear forces applied to the head are transmitted to the brain. When an object strikes a human head, both the object and the human head are moving independently and often in different angles thus, angular forces, as well as linear forces, are almost always involved in head injuries. Many surgeons in the field believe the angular or rotational forces applied to the brain are more hazardous than direct linear forces due to the twisting or shear forces they apply to the white matter tracts and the brain stem.

[0005] One type of brain injury that occurs frequently is the mild traumatic brain injury (MTBI), more commonly known as a concussion. Such injury occurs in many settings, such as, construction worksites, manufacturing sites, and athletic endeavors and is particularly problematic in contact sports. While at one time a concussion was viewed as a trivial and reversible brain injury, it has become apparent that repetitive concussions, even without loss of consciousness, are serious deleterious events that contribute to debilitating irreversible diseases, such as dementia and neuro-degenerative diseases including Parkinson's disease, chronic traumatic encephalopathy (CTE), and dementia pugilistica.

[0006] Thus, there is a long-felt need for a protective helmet having an energy storage mechanism that absorbs linear and rotational forces and slowly releases such forces.

SUMMARY

[0007] According to aspects illustrated herein, there is provided a protective helmet having multiple protective zones, comprising an inner shell having a first inner surface and a first outer surface, an outer shell having a second inner surface, a second outer surface, and at least one window defined by said outer shell, said outer shell functionally attached to said inner shell, an elastomeric zone between said first outer surface and said second inner surface, a plurality of sinusoidal springs positioned in said elastomeric zone, each of the plurality of sinusoidal springs comprising a first end, and a second end, a force indicator tab in operative contact with said second end of at least one of said plurality of sinusoidal springs, wherein said force indicator tab is displaced in said at least one window by said second end when said helmet is impacted with sufficient force, and a transmission device.

[0008] According to aspects illustrated herein, there is provided a protective helmet having multiple protective zones, comprising an inner shell having a first inner surface and a first outer surface, an outer shell having a second inner surface and a second outer surface, said outer shell functionally attached to said inner shell, an elastomeric zone between said first outer surface and said second inner surface, a plurality of sinusoidal springs positioned in said elastomeric zone, each of the plurality of sinusoidal springs comprising a first end and a second end, and a transmission device, including a sensor arranged to determine the location of the second end, a transmitter arranged to transmit a signal indicating the location to a remote receiver, and a power source.

[0009] According to aspects illustrated herein, there is provided a protective helmet having multiple protective zones, comprising an inner shell having a first inner surface and a first outer surface, an outer shell having a second inner surface, a second outer surface, and at least one window defined by said outer shell, said outer shell functionally attached to said inner shell, an elastomeric zone between said first outer surface and said second inner surface, a plurality of sinusoidal springs positioned in said elastomeric zone, each of the plurality of sinusoidal springs comprising a first end and a second end, a plurality of piston devices arranged between the inner and outer shells, wherein each of said plurality of piston devices comprises a first component connected to the second end and a second component, and a force indicator tab in operative contact with said second end of at least one of said plurality of sinusoidal springs, wherein said force indicator tab is moved to said at least one window by said second end when said helmet is impacted with sufficient force, and a transmission device.

[0010] These and other objects, features, and advantages of the present disclosure will become readily apparent upon a review of the following detailed description of the disclosure, in view of the drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

Figure 1 is a side perspective view of an additional embodiment of a protective helmet;
Figure 2 is a cross-sectional view of a sinusoidal spring of the helmet shown in Figure 1;
Figure 3 shows the same view as the view shown in Figure 2 showing force, such as from a blow or hit, being applied to the helmet;
Figure 4 depicts the same view shown in Figures 2 and 3 after the outer shell and sinusoidal spring have returned to the neutral position;
Figure 5 is a cross-sectional view of an alternative embodiment of the helmet shown in Figure 1;
Figure 6 shows the same view as the view shown in Figure 5 showing force, such as from a blow or hit, being applied to the helmet;
Figure 7 depicts the same view shown in Figures 5 and 6 after the outer shell has returned to the neutral position;
Figure 8 shows the disengagement of an energy dissipation device and the return of the sinusoidal spring to the neutral position;
Figure 9 shows the helmet as shown in Figures 6-8 after the energy dissipation device has been completely disengaged;
Figure 10 is a cross-sectional view of an alternative embodiment of the helmet shown in Figure 1;
Figure 11 is a top perspective view of the alternative embodiment of the helmet shown in Figure 10;
Figure 12 is a top perspective view of the alternative embodiment of an energy dissipation device used in the helmet shown in Figure 10;
Figure 13 is a cross-sectional view of the energy dissipation device shown in Figure 12;
Figure 14 is a cross-sectional view of the energy dissipation device shown in Figure 12;
Figure 15 is a cross-sectional view of the energy dissipation device shown in Figure 12;
Figure 16 is a cross-sectional view of the energy dissipation device shown in Figure 12;
Figure 17 is a cross-sectional view of the energy dissipation device shown in Figure 12; and,
Figure 18 is a cross-sectional view of the energy dissipation device shown in Figure 12.

DETAILED DESCRIPTION OF EMBODIMENTS

[0012] At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements. It is to be understood that the claims are not limited to the disclosed aspects.

[0013] Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the claims.

[0014] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure pertains. It should be understood that any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the example embodiments.

[0015] It should be appreciated that the term "substantially" is synonymous with terms such as "nearly," "very nearly," "about," "approximately," "around," "bordering on," "close to," "essentially," "in the neighborhood of," "in the vicinity of," etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby," "close," "adjacent," "neighboring," "immediate," "adjoining," etc., and such terms may be used interchangeably as appearing in the specification and claims.

[0016] In one embodiment, the inner shell and outer shell are connected to each other by elastomeric cords that serve to limit the rotation of the outer shell on the inner shell and to dissipate energy by virtue of elastic deformation rather than passively transferring rotational force to the brain as with existing helmets. In effect, these elastomeric cords function like mini bungee cords that dissipate both angular and linear forces through a mechanism known as hysteretic damping, i.e., when elastomeric cords are deformed, internal friction causes high energy losses to occur. These elastomeric cords are of particular value in preventing so called contrecoup brain injury.

[0017] The outer shell, in turn, floats on the inner shell by virtue of one or more force absorbers or deflectors such as, for example, fluid-filled bladders, leaf springs, or sinusoidal springs, located between the inner shell and the outer shell. To maximize the instantaneous reduction or dissipation of a linear and/or angular force applied to the outer shell, the fluid-filled bladders interposed between the hard inner and outer shells may be intimately associated with, that is located under, one or more apertures in the outer shell with the apertures preferably being covered with elastomeric diaphragms and serving to dissipate energy by bulging outward against the elastomeric diaphragm whenever the outer shell is accelerated, by any force vector, toward the inner shell. Alternatively, the diaphragms could be located internally between inner and outer shells, or at the inferior border of the inner and outer shells, if it is imperative to preserve surface continuity in the outer shell. This iteration would necessitate separation between adjacent bladders to allow adequate movement of associated diaphragms.

[0018] In existing fluid-filled designs, when the outer shell of a helmet receives a linear force that accelerates it toward the inner shell, the interposed gas or fluid is compressed and displaced. Because gas and especially fluid is not readily compressible, it passes the force passively to the inner shell and hence to the skull and the brain. This is indeed the very mechanism by which existing fluid-filled helmets fail. The transfer of force is hydraulic and essentially instantaneous, negating the effectiveness of viscous fluid transfers as a means of dissipating concussive force.

[0019] Because of the elastomeric diaphragms in the present invention, any force imparted to the outer shell will transfer to the gas or liquid in the bladders, which, in turn, will instantaneously transfer the force to the external elastomeric diaphragms covering the apertures in the outer shell. The elastomeric diaphragms, in turn, will bulge out through the aperture in the outer shell, or at the inferior junction between inner and outer shells thereby dissipating the applied force through elastic deformation at the site of the diaphragm rather than passively transferring it to the padded lining of the inner shell. This process directs energy away from the brain and dissipates it via a combination of elastic deformation and tympanic resonance or oscillation. By oscillating, an elastic diaphragm employs the principle of hysteretic damping over and over, thereby maximizing the conversion of kinetic energy to low-level heat, which, in turn, is dissipated harmlessly to the surrounding air.

[0020] Furthermore, the elastomeric springs or cords that bridge the space holding the fluid-filled bladders (like the arachnoid membrane in the brain) serve to stabilize the spatial relationship of the inner and outer shells and provide additional dissipation of concussive force via the same principle of elastic deformation via the mechanism of stretching, torsion, and even compression of the elastic cords.

[0021] By combining the bridging effects of the elastic springs or cords as well as the elastomeric diaphragms strategically placed at external apertures, both linear and rotational forces can be effectively dissipated.

[0022] In an alternate embodiment, leaf springs may replace fluid-filled bladders as a force absorber/deflector. Leaf springs may be structured as a fully elliptical spring or, preferably, formed in a parabolic shape. In both forms, the leaf spring is anchored at a single point to either the outer shell or, preferably, the hard inner shell and extends into the zone between the outer shell and inner shell. The springs may have a single leaf (or arm) or comprise a plurality of arms arrayed radially around a common anchor point. Preferably, each arm tapers from a thicker center to thinner outer portions toward each end of the arm. Further, the ends of each arm may include a curve to allow the end to more easily slide on the shell opposite the anchoring shell. In contrast to the use of leaf springs in vehicles, the distal end of the spring arms are not attached to the nonanchoring or opposite shell. This allows the ends to slide on the shell to allow independent movement of each shell when the helmet is struck by rotational forces. This also enables the frictional dissipation of energy. Preferably, the distal ends contact the opposite shell in the neutral condition, that is, when the helmet is not in the process of being struck.

[0023] Adverting to the drawings, Figure 1 is a side perspective view of a further additional embodiment of a helmet **200** with outer shell **202** removed. Helmet **200** includes an integral or continuous outer shell **202** (not shown in Figure 1) and inner shell **204** functionally connected. By integral or continuous is meant that shell **202** is formed as a single unit. By functionally connected, it is meant that outer shell **202** and inner shell **204** are connected such that outer shell **202** may move, such as rotate, relative to inner shell **204** such as, for example, the sliding connection discussed above. Elastomeric zone **203** ("zone **203**") lies between a first inner surface **206** of outer shell **202** and a first outer surface **205** of inner shell **204** (see Fig. 2). At least one sinusoidal spring **208** (spring(s) **208**") is positioned in zone **203.** Figure 1 depicts a preferred embodiment in which a plurality of springs **208** are positioned in zone **203.** In a more preferred embodiment shown here, springs **208** are sinusoidal springs **208** having a shape similar to or identical with a series of sine waves and can be manufactured as described in U.S. Patent Application Publication No. 2012/00773884 and U.S. Patent No. 4,708,757 both to Guthrie, which patent publications are hereby incorporated by reference in their entireties.

[0024] Although not necessary for the protective function of helmet **200,** in a further embodiment, a second end **260** of at least one of springs **208** is in operative contact with force indicator tab **216** ("tab **216**"). By "operative contact" it is meant that a component or device contacts but is not connected to a second component and causes that second component to function. For example, as described below, the operative contact end of spring **208** contacts a proximal edge **262** of tab **216** so that when spring **208** is extended, it pushes tab **216** to an outer position toward the outer perimeter of helmet **200.** When spring **208** retracts, tab **216** remains in its displaced position. Tab **216** preferably is a multi-color panel as represented by the different cross hatching patterns on the surface of tab **216,** shown in Figure 1.

[0025] Tab **216** is positioned within channel **212,** which is positioned on outer surface **205** of inner shell **204.** Channel **212** includes parallel rails **214** with tab **216** positioned between rails **214.** In this way, tab **216** is always pushed in the same direction when spring **208** is extended. Outer shell **202** defines at least one window **210,** shown in shadow, positioned so that tab **216** can be viewed through window **210** if spring **208** is extended sufficiently to push tab **216** into channel **212.** In the embodiment shown, rivet **218** forms the attachment of the plurality of springs **208** to outer shell **202** to form a radial or "spider-like" array of springs **208.** In the preferred embodiment, outer shell **202** is functionally connected to inner shell **204** such that window **210** remains at a constant location relative to inner shell **204.** The disclosure described herein refers to this embodiment. It should be appreciated that outer shell **202** is functionally attached to inner shell **204** such that movement of outer shell **202** relative to inner shell **204** does not affect the location of tab **216** (i.e., outer shell **202** does not contact tab **216**). In another embodiment (not shown), outer shell **202** is functionally attached to inner shell **204** such that window **210** varies in location. For example, in a resting or neutral position, window **210** is arranged on outer shell **202** and located in a first location relative to inner shell **204.** During (or just after) impact, when outer shell **202** moves relative to inner shell **204,** window **210** can be located in a second location, different than the first location. However, outer shell **202** is arranged to always return to its resting or neutral position at a period of time after impact. Thus, window **210** will always return to the first location. Readings of tab **216** should always be conducted when outer shell **202** is in the resting or neutral position and window **210** is located in the first location.

[0026] Figure 2 is a cross-sectional view of helmet **200.** The helmet **200** comprises the outer shell **202** and the inner shell **204.** The outer shell **202** has a second inner surface **206** and a second outer surface **207.** The inner shell **204** has a first inner surface **201** and a first outer surface **205.** The cross-sectional view of helmet **200** shows a sinusoidal spring **208.** Spring **208** is positioned in elastomeric zone **203** resting on the outer surface **205** of inner shell **204.** The second end **260** of spring **208** is either close to or in contact with tab **216,** which is positioned between rails **214.** In the resting or neutral position shown, tab **216** is arranged under outer shell **202** and not exposed in window **210.** Spring(s) **208** may be attached to outer shell **202,** inner shell **204,** or both outer shell **202** and inner shell **204.** Helmet **200** may also comprise substrate **210a** arranged over window **210.**

[0027] Figure 3 shows the same view of helmet **200** as shown in Figure 2 in which force **A,** represented by arrow **A,** is applied to helmet **200.** The force **A** may be a blow impacting helmet **200.** The dotted lines of outer shell **202** and spring **208** show those components in the neutral state. The solid lines show outer shell **202** pressed into elastomeric zone **203** by force **A.** When force **A** strikes outer shell **202,** one or more of springs **208** are pushed into a compressed mode as shown by the reduced amplitude of the sine wave formed in sinusoidal spring **208** as well as the expanded length of spring **208.** As spring **208** lengthens, as represented by arrow **B,** it pushes tab **216** toward and/or into window **210.** Persons of ordinary skill in the art will recognize that the increase in the length of spring **208** is a function of the amount of force striking helmet **200.** Thus, the amount of exposure of tab **216** in window **210** depends on the amount of force striking helmet **200.** Preferably, tab **216** includes different colors, such as green, yellow, and red, or other indicators, each of which may appear in window **210** depending on the force of the blow. It will be recognized that more than one spring **208** may be extended when helmet **200** is struck.

[0028] Figure 4 depicts the same view shown in Figures 2 and 3 after outer shell **202** and sinusoidal spring **208** have returned to the neutral position. The return movement of outer shell **202** is shown by arrow **C** while the return of spring **208** is shown by arrow **D.** Tab **216** remains under window **210** after spring **208** retracts back to its normal state.

[0029] Figure 5 is a cross-sectional view of an alternative embodiment of the helmet **200** shown in Figure 1. In the alternative embodiment shown, helmet **200** further comprises energy dissipation device **215** arranged radially between outer shell **202** and inner shell **204.** Energy dissipation device **215** comprises first portion **215A** and second portion **215B,** which are arranged to engage, and lock, with each other. In this exemplary embodiment, first portion **215A** is connected to spring **208** and comprises plurality of teeth **215A'** facing radially inward in direction **RD1.** The spring **208** is in contact with the second inner surface **206** of the outer shell **202** and the outer surface **205** of the inner shell **204.** Second portion **215B** is connected to inner shell **204** and comprises plurality of teeth **215B'** facing radially outward in direction **RD2.** Energy dissipation device **215** further comprises release **217** for disengaging first portion **215A** and second portion **215B.** For example, pressing release **217** displaces first portion **215A** radially outward in direction **RD2** and disengages teeth **215A'** of first portion **215A** from teeth **215B'** of second portion **215B.** Indicator tab **216** comprises return tab **219** connected thereto. Return tab **219** is arranged radially inward of indicator tab **216** such that the user can return indicator tab **216** to the position shown in Figure 5. Helmet **200** may also comprise substrate **210a** arranged over window **210** such that indicator tab **216** can only be accessed using return tab **219** inside helmet **200** (i.e., indicator tab **216** cannot be accessed through window **210**).

[0030] Figure 6 shows the same view of helmet **200** as shown in Figure 5 in which force **A,** represented by arrow **A,** is applied to helmet **200.** The effect of the force is the same as that shown and described with respect to Figure 3 above. However, as spring **208** extends in direction **B,** first portion **215A** displaces in direction **B** relative to second portion **215B,** which displaces indicator tab **216.** First portion **215A** engages with second portion **215B,** for example, via teeth **215A'** and **215B'.** In this exemplary embodiment, outer shell **202** is functionally connected to inner shell **204** such that window **210** remains in a constant location and does not vary in size (i.e., outer shell **202** does not displace circumferentially relative to inner shell **204** at or around the location of window **210**).

[0031] Figure 7 depicts the same view shown in Figures 5 and 6 after outer shell **202** has returned to the neutral position. The return movement of outer shell **202** is shown by arrow **C.** Unlike the embodiment shown in Figure 4, however, spring **208** does not return to its neutral position because of energy dissipation device **215.** First portion **215A** is still engaged, and thus locked, with second portion **215B.** Figure 8 shows the disengagement of energy dissipation device **215,** wherein release **217** is activated. In an example embodiment, release **217** is connected to first portion **215A** and is displaced in direction **G** to disengage energy dissipation device **215.** For example, pressing release **217** displaces first portion **215A** radially outward in direction **RD2** (or **G**) and disengages teeth **215A'** from teeth **215B'.** The return of first portion **215A** is shown by arrow **D** while the return of spring **208** is shown by arrows **D** and **E.** In another example embodiment, a transmission device can be used to send a signal indicating when tab **216** is displaced into window **210,** so that another party (e.g., coach, doctor, medical professional, parent, etc.) is aware that a significant impact has occurred from a remote location (i.e., without having to be within viewing distance of window **210**). In addition, the transmission device can be used to send a signal indicating the position of tab **216** in window **210,** so that the party is aware of the magnitude of impact that occurred from the remote location. The transmission device is described in greater detail below with respect to Figure 11. Figure 9 shows helmet **200** after energy dissipation device **215** has been completely disengaged. The position of tab **216** remains in window **210** after spring **208** retracts back to its normal state.

[0032] Figure 10 is a cross-sectional view of an alternative embodiment of the helmet shown in Figure 1. In the alternative embodiment shown, helmet **200** further comprises piston device **221** arranged in inner shell **204.** In another embodiment, piston device **221** is arranged at any suitable location radially between inner shell **204** and outer shell **205.** Piston device **221** is an energy dissipation device comprising first rod **221a,** second rod **221b,** cylinder **221c,** and flange **221d.** First rod **221a** is connected to spring **208** at a first end and flange **221d** at a second end. Second rod **221b** is connected to flange **221d** at a first end and abuts against indicator tab **216** at a second end. Flange **221d** is arranged in cylinder **221c.** In an example embodiment, piston device **221** acts similar to a dashpot or any other suitable device such that displacement of spring 208 in direction **B** is not inhibited and the return of spring **208** in direction **D** occurs at a controlled rate, preferably slowly. In this embodiment, there is no need for a release because spring **208** always returns to its neutral position. Piston device **221** can be a hydraulic piston, a pneumatic piston, or any other suitable device capable of performing the above-identified function.

[0033] Figure 11 is a top perspective view of an alternative embodiment of the helmet shown in Figure 1. In this embodiment, helmet **200** comprises a plurality of brackets **240.** Brackets **240** are connected to inner shell **204** and arranged adjacent to springs **208.** Brackets **240** prevent and/or limit springs **208** from moving laterally. This system provides torsional damping as well as linear damping. Brackets **240** allow spring **208** to function as a torsion bar thereby mitigating rotational or angular force applied to helmet **200.** Helmet **200** further comprises transmission device **250.** Transmission device **250** is arranged to send a signal to a receiver (not shown) at a remote location indicating that an impact has occurred. Transmission device **250** generally comprises sensor **252,** transmitter **254,** and power source **256.** Power source **256** is intended to be a battery or any combination of multiple batteries that can produce sufficient voltage to power the components and circuitry in transmission device **250** (i.e., sensor **252** and transmitter **254**). Transmitter **254** includes an antenna and is operatively arranged to communicate with a remote receiver (e.g., a computer, a smartphone, an iPad® tablet computer, a Surface® computer, or any other computing device) and can be utilized to send/receive a wireless signal/communication. It should be appreciated that "wireless communication(s)" as used herein is intended to mean Radio Frequency Identification (RFID) communication, Bluetooth® protocols, Near field Communication (NFC), Near Field Magnetic Inductance Communication (NFMIC), Wi-Fi, LTE, Airdrop® communication, or any other wireless protocol sufficient to communicate with the remote receiver. Sensor **252** is any device, module, or subsystem capable of detecting that an impact has occurred and sending that information to transmitter **254** to be transmitted to a remote receiver. Sensor **252** is arranged to sense and store the position of indicator force indicator tab **216.** It should be appreciated that sensor **252** could be embodied as an optical sensor, limit switch, or other device capable of sensing a position of force indicator tab **216.** In an example embodiment, senor **252** could be embodied as a vibration sensor, magnetic sensor, position sensor, impact sensor, or any other sensor capable of detecting an impact or a movement of force indicator tab **216.**

[0034] In an example embodiment, and as previously discussed, transmission device **252** is used to send a signal indicating when tab **216** is displaced into window **210,** so that another party (e.g., coach, doctor, medical professional, parent, etc.) is aware that a significant impact has occurred from a remote location (i.e., without having to be within viewing distance of window **210**). In addition, the transmission device can be used to send a signal indicating the position of tab **216** in window **210,** so that the party is aware of the magnitude of impact that occurred from the remote location.

[0035] In an example embodiment, transmission device **250** further comprises a microcontroller. The microcontroller may include a memory element and a processing unit. The memory element is capable of storing a set of non-transitory computer readable instructions. The processing unit is arranged to execute the set of non-transitory computer readable instructions.

[0036] In an example embodiment, the microcontroller is programmed to perform the following steps: receive an indication from sensor **252** that an impact has occurred; send a signal to a remote receiver through transmitter **254** indicating that an impact has occurred.

[0037] In an example embodiment, the microcontroller is programmed to perform the following steps: receive an indication from sensor **252** that an impact force has occurred; determine if the impact force is greater than a predetermined threshold force; if the impact force is greater than the predetermined threshold force, send a signal to a remote receiver through transmitter **254** indicating that an impact has occurred.

[0038] In an example embodiment, the microcontroller is programmed to perform the following steps: receive a set of data from sensor **252** that an impact force has occurred; determine the magnitude of the impact force based on the set of data; send a signal to a remote receiver through transmitter **254** indicating the magnitude of the impact force.

[0039] Figure 12 is a top perspective view of an alternative embodiment of energy dissipation device **300** used in helmet **200** shown in Figure 1. Energy dissipation device **300** comprises dashpot **301,** arm **302,** cylinder **306,** and barrier **314.** Dashpot **301** is a linear mechanical device, a damper which resists motion via viscous friction. Arm **302** comprises a plurality of notches and is slidingly engaged within dashpot **301.** Cylinder **306** is connected to sinusoidal spring **308** and is arranged to slide in levels **310** and **312.** Levels **310** and **312** are separated by barrier **314.** Barrier **314** comprises a plurality of doors **316,** which are operatively arranged to allow cylinder **306** to pass from level **310** to level **312.** Barrier **314** also comprises door **318,** which is operatively arranged to allow cylinder **306** to pass from level **312** to level **310.**

[0040] Figures 13-18 are cross-sectional views of energy dissipation device **300** shown in Figure 12. Figure 13 shows energy dissipation device **300** in a neutral position. Cylinder **306** is arranged in level **310** and arm **302** is fully extended from dashpot **301.** Figure 14 shows energy dissipation device **300** during an impact in direction **H.** Sinusoidal spring **308,** and thus cylinder **306,** extends along level **310** in direction **I.** Cylinder **306** displaces extension **320** and moves force indicator tab **216** into window **210.** Cylinder **306** also forces door **316** in direction **J.** Figure 15 shows energy dissipation device **300** during an impact in direction **H.** Sinusoidal spring **308** has extended such that cylinder **306** passes over door **316** in level **310.** Door **316** moves in direction **K** to return to its neutral position. Figure 16 shows energy dissipation device **300** after an impact. Cylinder **306** slips from level **310** to level **312** through door **316** in direction **L.** Cylinder **306** then engages one of notches **304** in arm **302.** Figure 17 shows energy dissipation device **300** after an impact. Cylinder **306,** now arranged in level **312,** engages one of notches **304.** Sinusoidal spring **308** returns to its neutral position in direction **M,** which pulls cylinder **306,** and thus arm **302,** in direction **N.** Figure 18 shows energy dissipation device **300** after an impact. Cylinder **306** slips from level **312** to level **310** through door **318** in direction **O.** Sinusoidal spring **308** has returned to the neutral position. Arm **302** returns to its fully extended position relative dashpot **301.** It should be appreciated that force indicator tab **216** can be manually returned to a neutral position.

[0041] It will be appreciated that various aspects of the disclosure above and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

REFERENCE NUMERALS

[0042]

200	Helmet
201	First Inner Surface
202	Outer Shell
203	Elastomeric Zone
204	Inner Shell
205	First Outer Surface
206	Second Inner Surface
207	Second Outer Surface
208	Sinusoidal Spring (Springs)
210	Window
210a	Substrate
212	Channel
214	Rails
215	Energy Dissipation Device
215A	First Portion
215B	Second Portion
215A'	Teeth
215B'	Teeth
216	Force Indicator Tab(s)
217	Release
218	Rivet
219	Return Tab
221	Piston Device
221a	First Rod
221b	Second Rod
221c	Cylinder
221d	Flange
240	Brackets
250	Transmission Device
252	Sensor
254	Transmitter
256	Power Source
260	Second End
262	Proximal edge
264	First End
300	Energy Dissipation Device
301	Dashpot

302	Arm
304	Notches
306	Cylinder
308	Sinusoidal Spring
310	Level
312	Level
314	Barrier
316	Doors
318	Door
320	Extension
A	Force (Force Arrow)
B	Direction
D	Direction
G	Direction
H	Direction
I	Direction
J	Direction
K	Direction
L	Direction
M	Direction
N	Direction
O	Direction
RD1	Radial Direction
RD2	Radial Direction

Claims

1. A protective helmet (200) having multiple protective zones, comprising:

   an inner shell (204) having a first inner surface (201) and a first outer surface (205);
   an outer shell (202) having a second inner surface (206), a second outer surface (207), and at least one window (210) defined by said outer shell (202), said outer shell (202) functionally attached to said inner shell (205);
   an elastomeric zone (203) between said first outer surface (205) and said second inner surface (206);
   a plurality of sinusoidal springs (208) positioned in said elastomeric zone (203), each of the plurality of sinusoidal springs (208) comprising:

      a first end (264); and,
      a second end (260);

   a force indicator tab (216) in operative contact with said second end of at least one of said plurality of sinusoidal springs (208), wherein said force indicator tab (216) is displaced in said at least one window (210) by said second end (260) when said helmet (200) is impacted with sufficient force; and,
   a transmission device (250).

2. The protective helmet (200) as recited in Claim 1, further comprising a plurality of piston devices (221) arranged between the inner shell (204) and the outer shell (202), wherein each of said plurality of piston devices (221) comprises:

   a first component (221A) connected to the second end (260); and,
   a second component (221B).

3. The protective helmet (200) as recited in Claim 1, wherein said first end (264) of at least one of said plurality of sinusoidal springs (208) is attached to said first outer surface (205).

4. The protective helmet as recited in Claim 1, wherein each one of said plurality of sinusoidal springs (208) is attached at a common point on said inner shell (204), wherein the common point in in the form of a rivet (218).

5. The protective helmet (200) as recited in Claim 1, further comprising a plurality of brackets (240) connected to said first outer surface (205), said second inner surface (206), or both said first outer surface (205) and said second inner surface (206), wherein said plurality of brackets (240) are operatively arranged adjacent to said plurality of sinusoidal springs (208) to limit with a lateral and torsional movement of said plurality of sinusoidal springs (208).

6. The protective helmet (200) as recited in Claim 1, wherein said at least one window (210) extends in a generally sagittal direction.

7. The protective helmet (200) as recited in Claim 1, wherein said force indicator tab (216) is positioned in a channel (212) and between two rails (214) of the channel.

8. The protective helmet (200) as recited in Claim 7, wherein said force indicator tab (216) comprises a return tab (219).

9. The protective helmet (200) as recited in Claim 1, wherein the transmission device (250) comprises:

   a power source (256);
   a sensor (252) arranged to determine a location of the force indicator tab (216) in the window (210); and,
   a transmitter (254) arranged to transmit a signal indicating the location to a remote receiver.

10. The protective helmet (200) as recited in Claim 1, wherein:

   a power source (256);
   a sensor (252) arranged to determine an extent

that the force indicator tab (216) is displaced; and,
a transmitter (254) arranged to transmit a signal indicating the extent to a remote receiver.

11. The protective helmet (200) as recited in Claim 2, wherein the second component comprises:

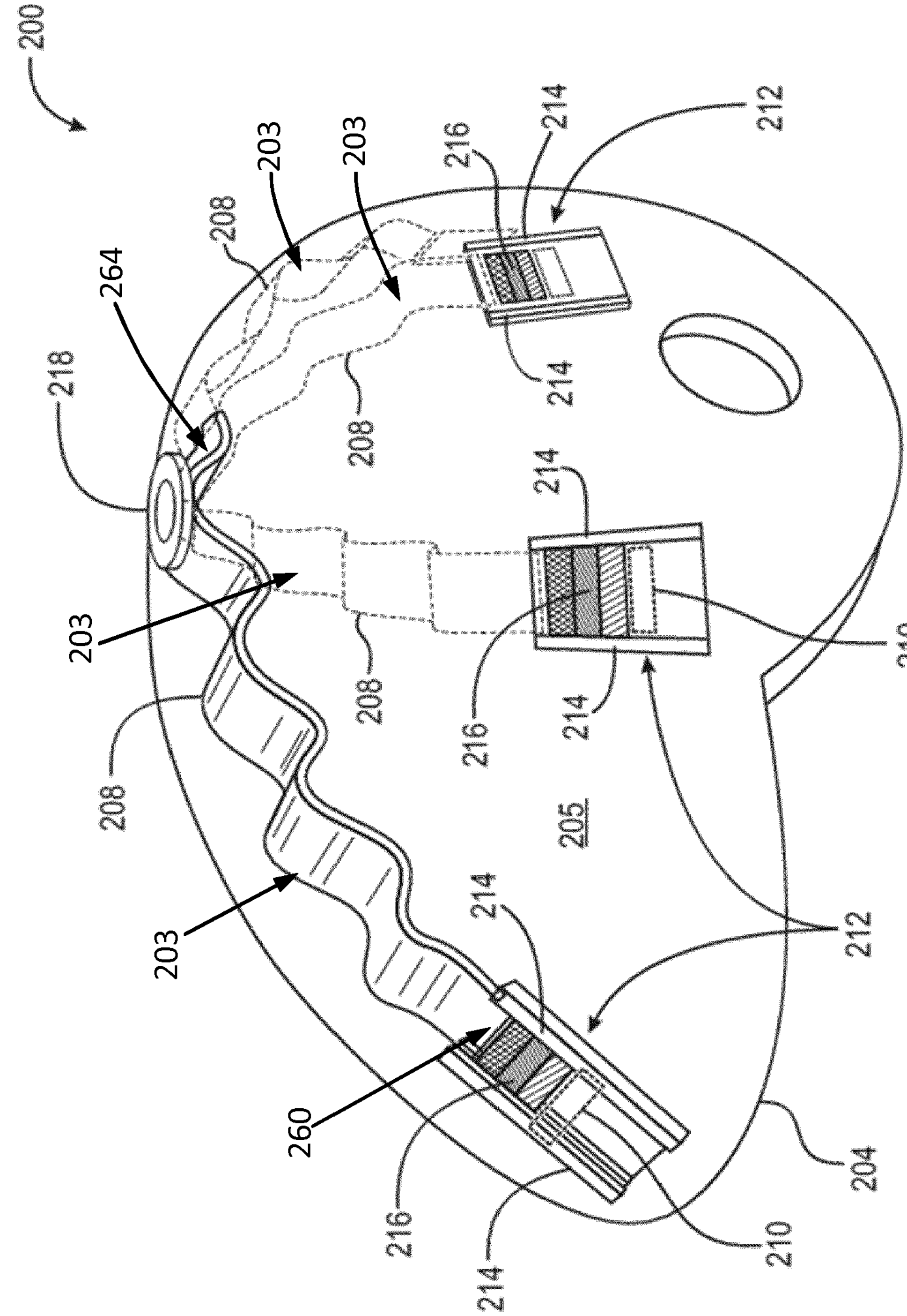
a dashpot (301);
an arm (302) including a plurality of notches (304), the arm (302) slidingly engaged with the dashpot (301); and,
a barrier (314) including a plurality of doors (316, 318).

12. The protective helmet (200) as recited in Claim 11, wherein the first component is a cylinder (316) and is operatively arranged to:

move axially along the barrier (314);
pass through the plurality of doors (316, 318); and,
engage the plurality of notches (304).

13. The protective helmet (200) as recited in Claim 1, further comprising a plurality of energy dissipation devices (215) arranged between the inner shell (204) and outer shell (202), wherein each of said plurality of energy dissipation devices (215) includes:

a first portion (215A) comprising a first plurality of teeth (215A'), the first portion (215A) connected to the second end;
a second portion (215B) comprising a second plurality of teeth (215B'), the second portion (215B) arranged on the first outer surface (205), wherein the first plurality of teeth (215A') are arranged to engage the second plurality of teeth (215B'); and,
a release (217) connected to the first portion (215A), the release (217) is operatively arranged to release said energy dissipation device (215).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260
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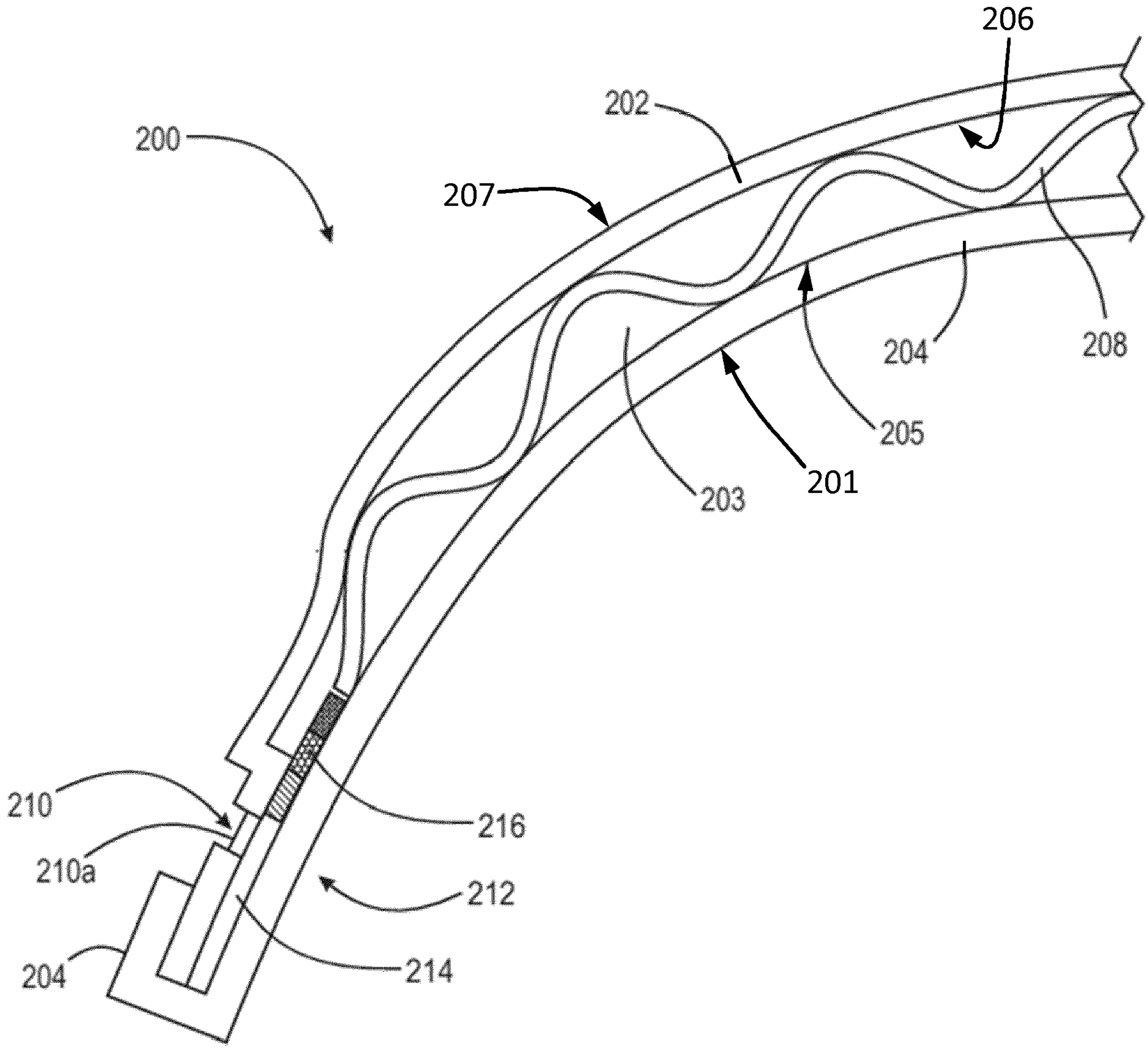
Fig. 1



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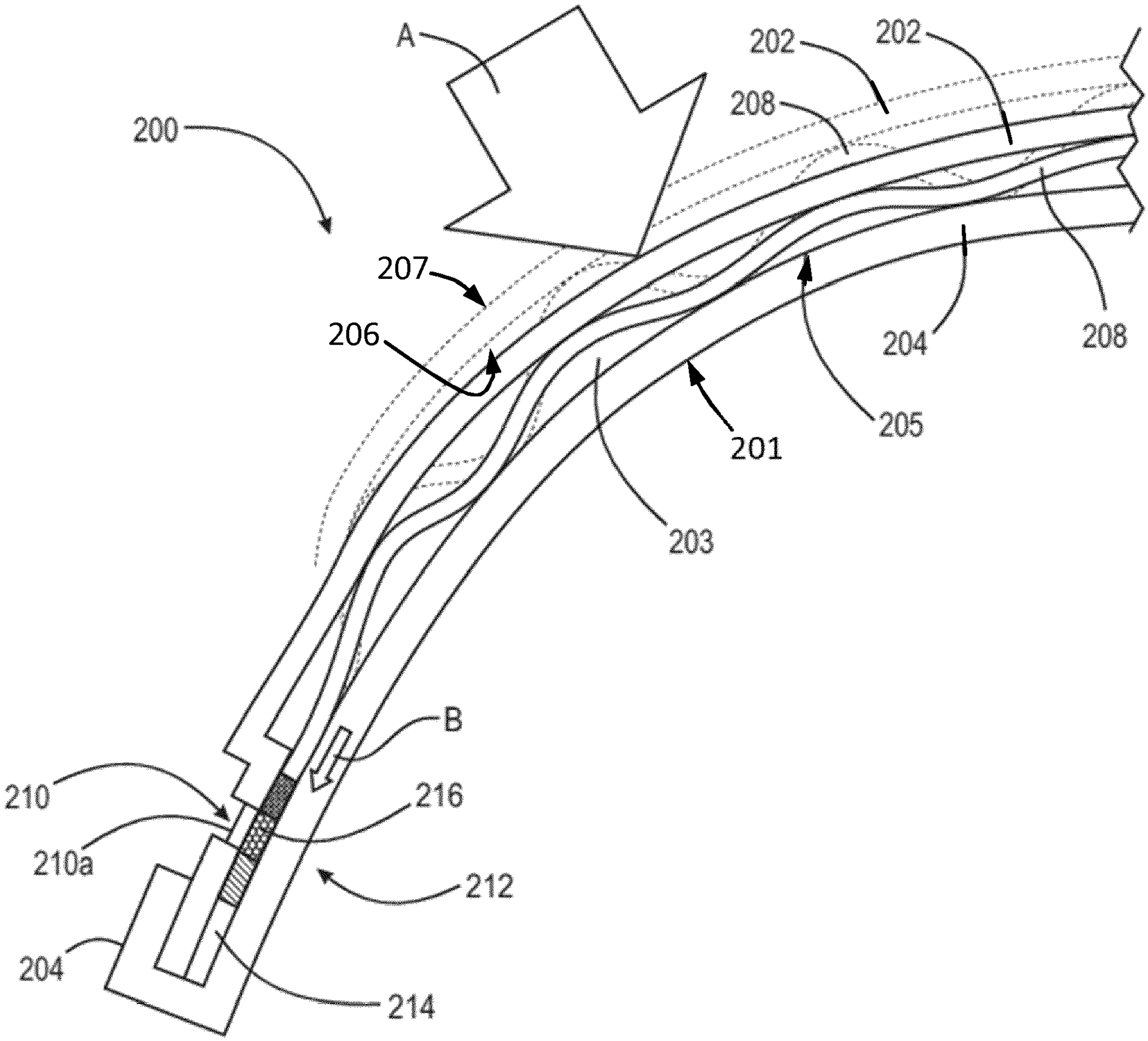
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Fig. 3

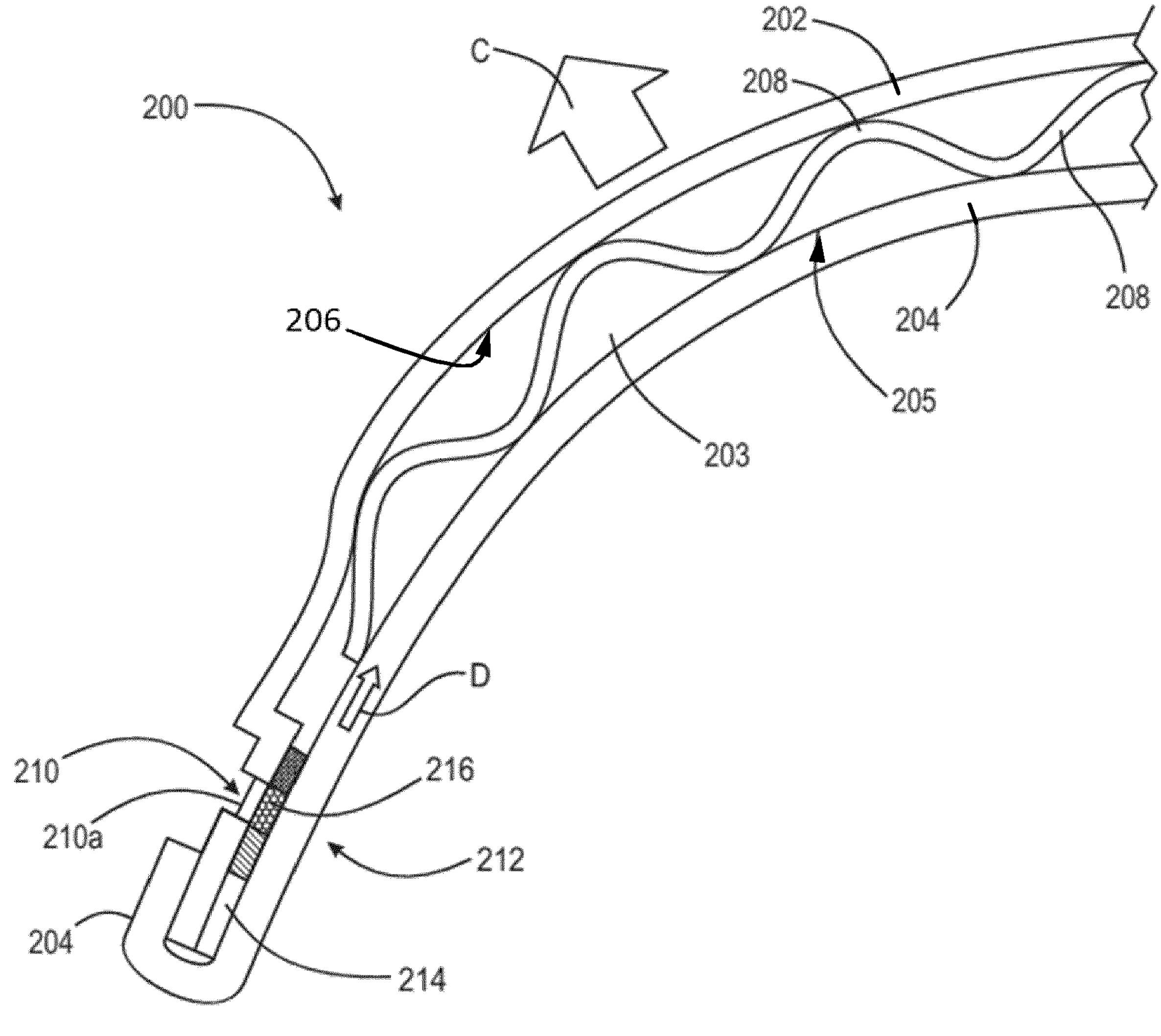
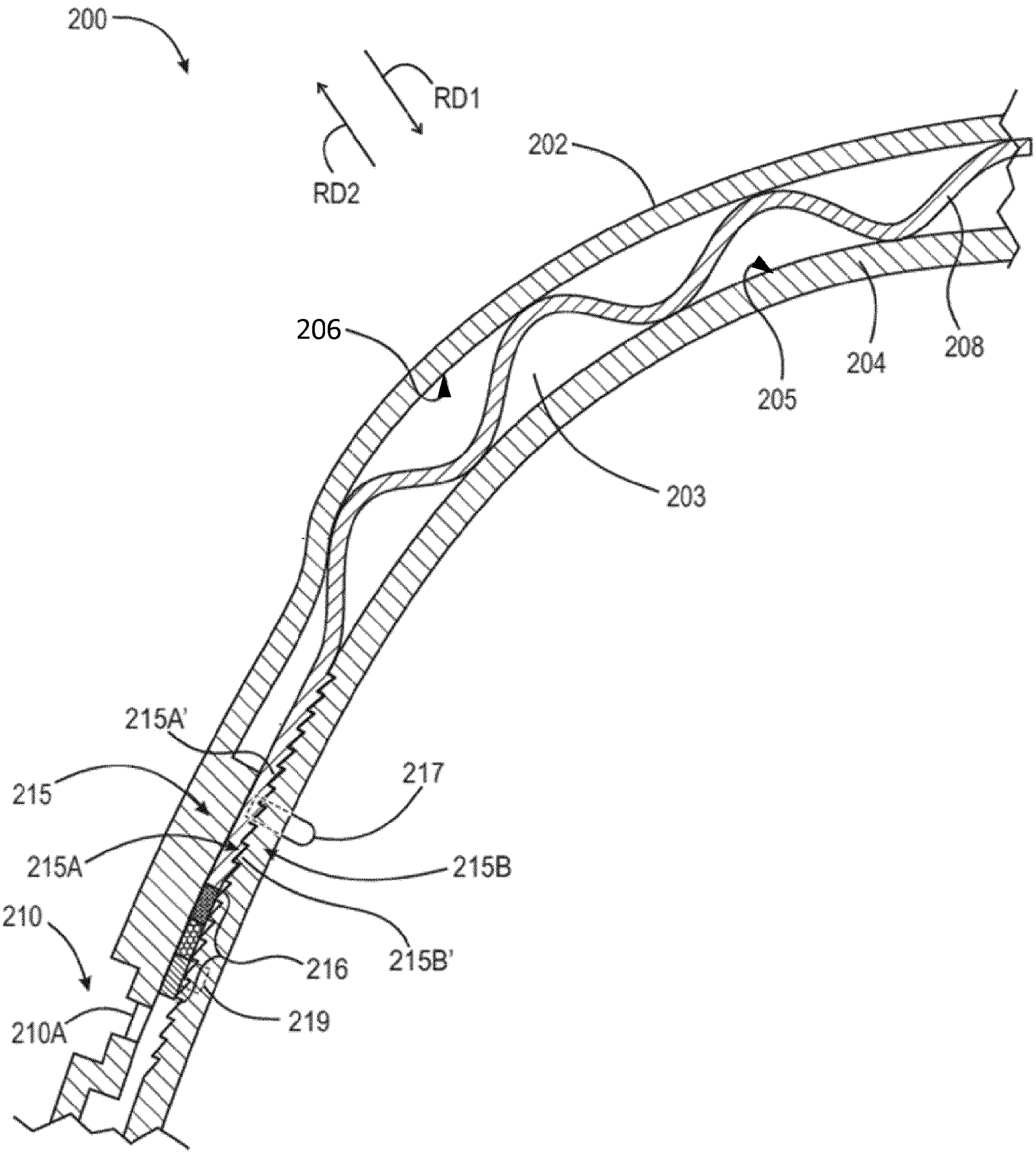


Fig. 4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215B'
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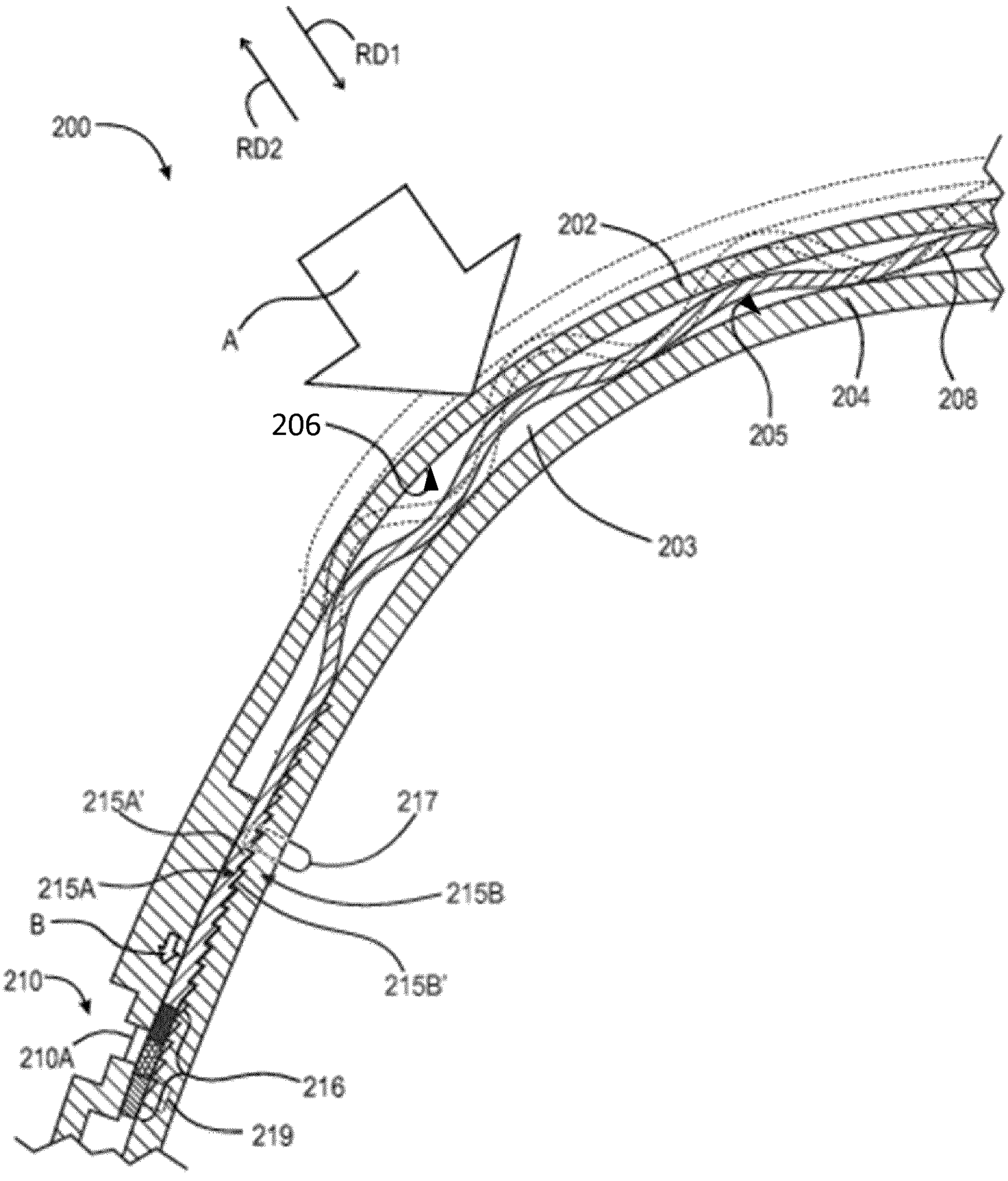
Fig. 5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219

Fig. 6

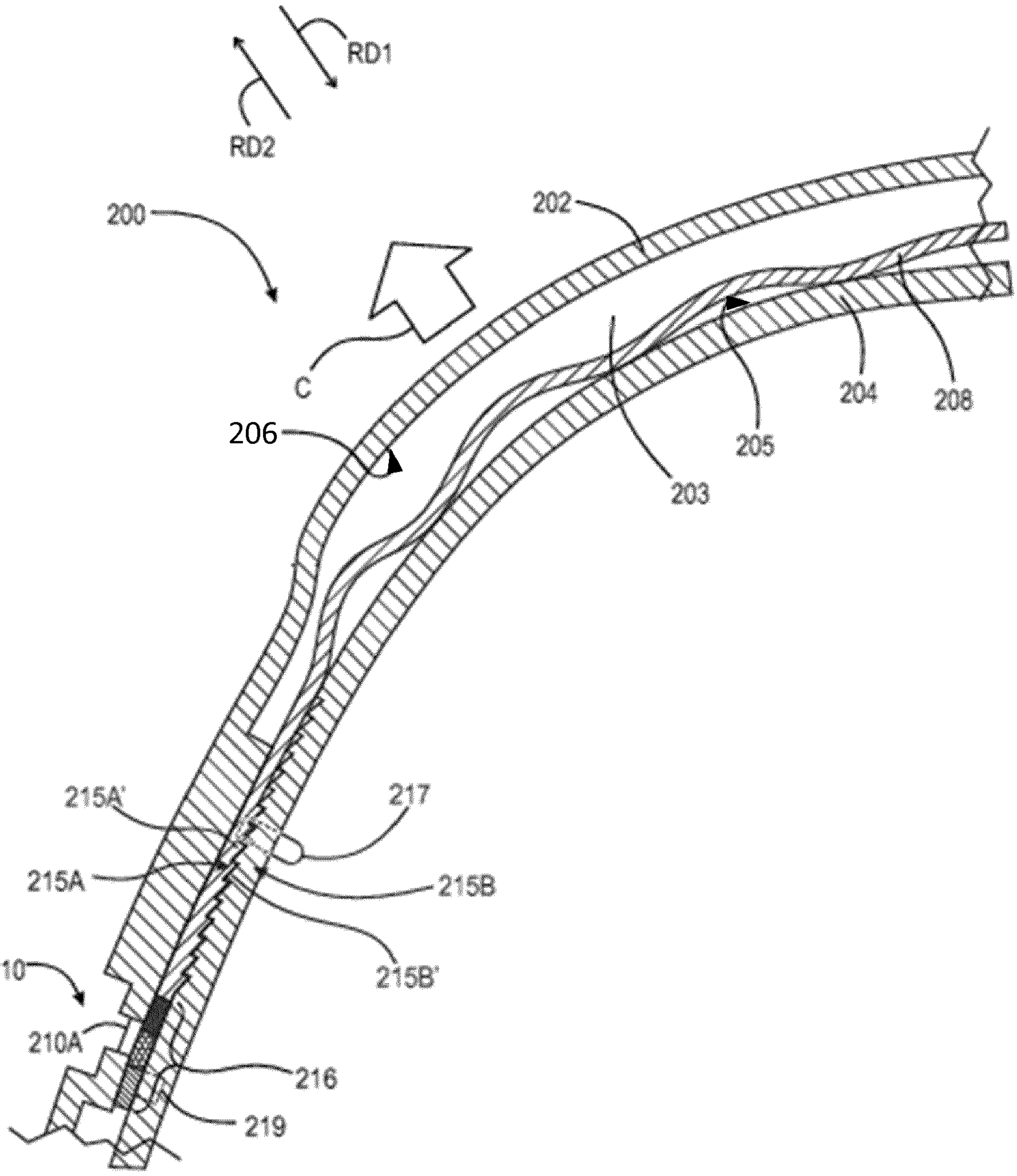
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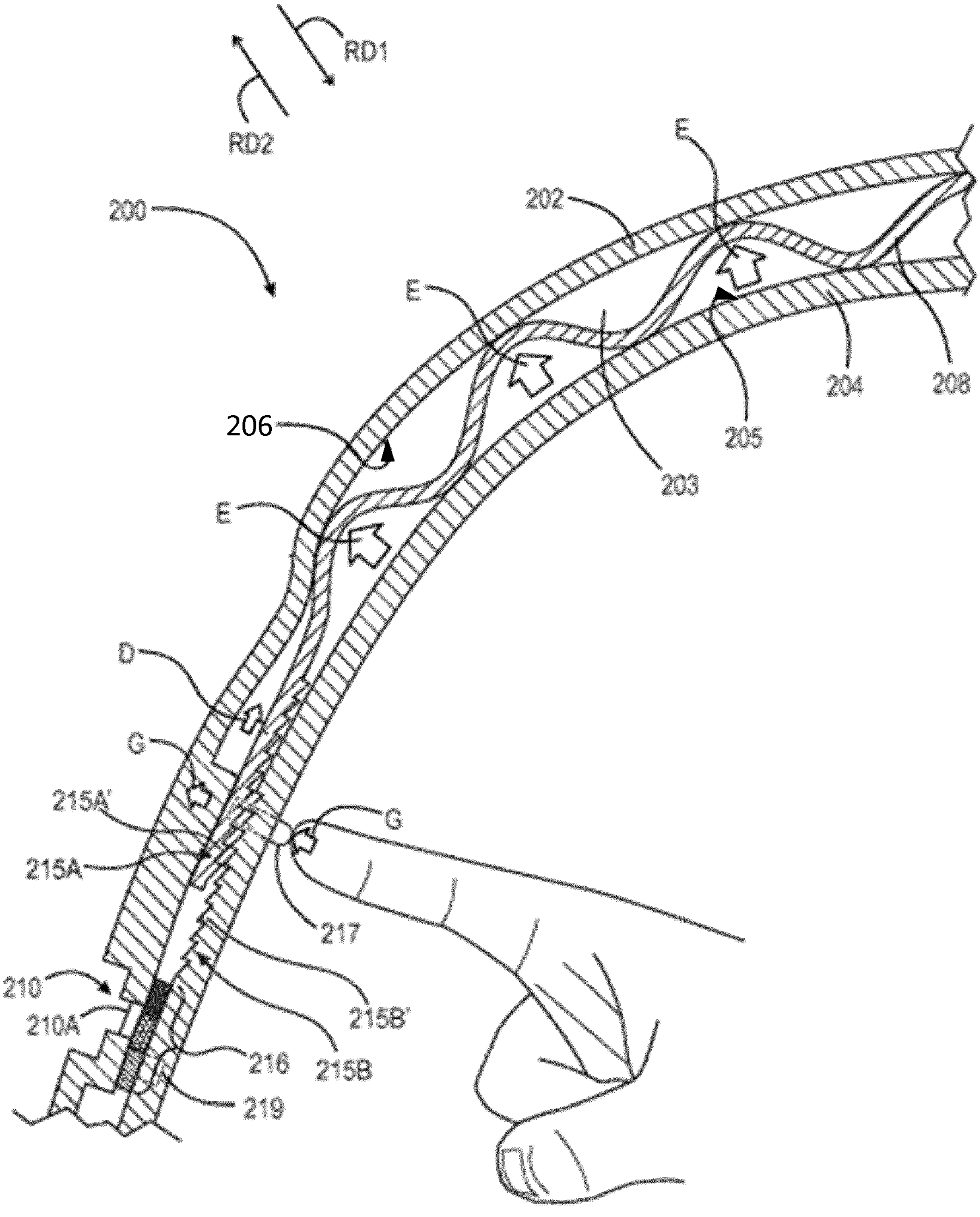
Fig. 7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215B'
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215B
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Fig. 8

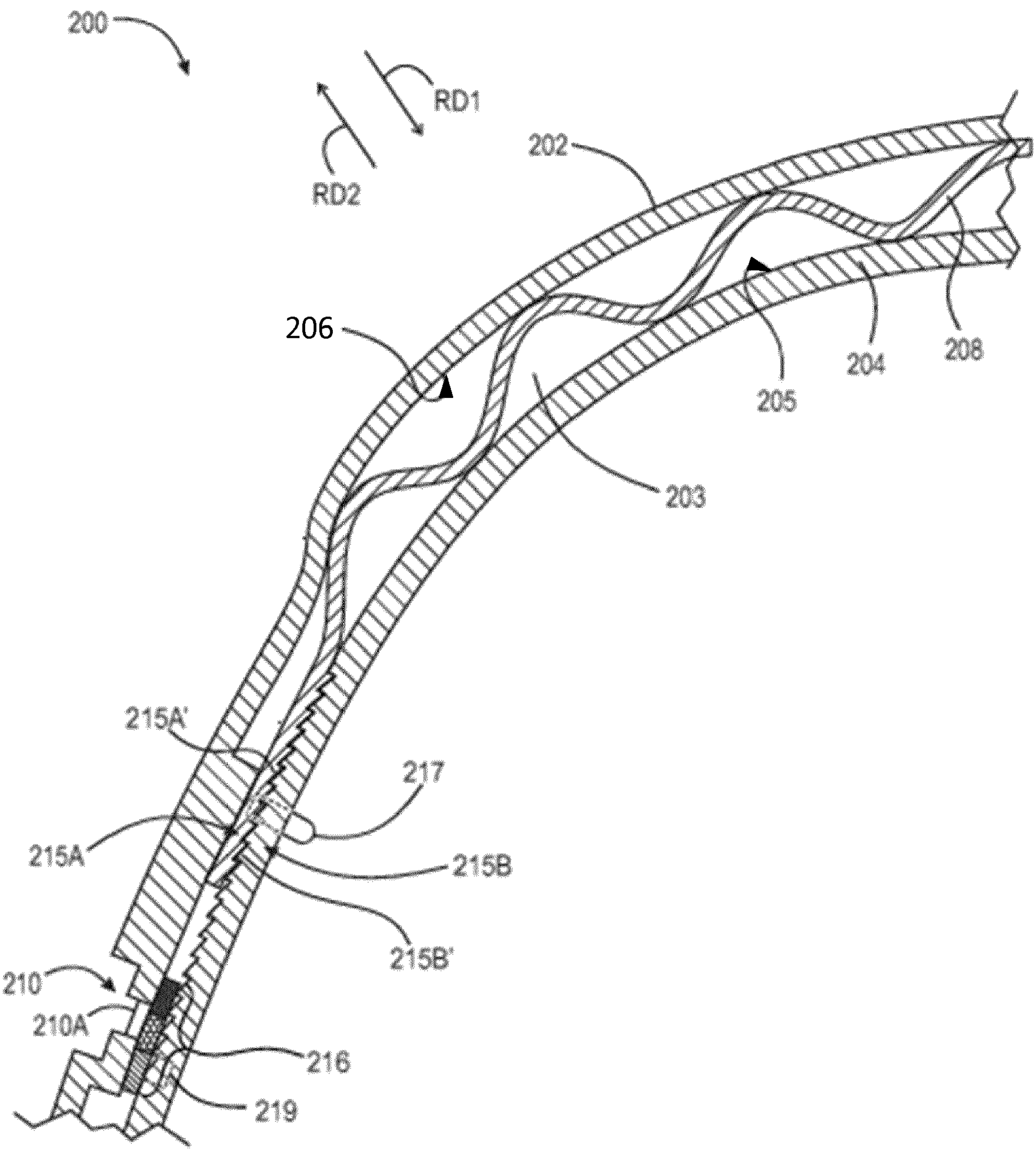
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Fig. 9

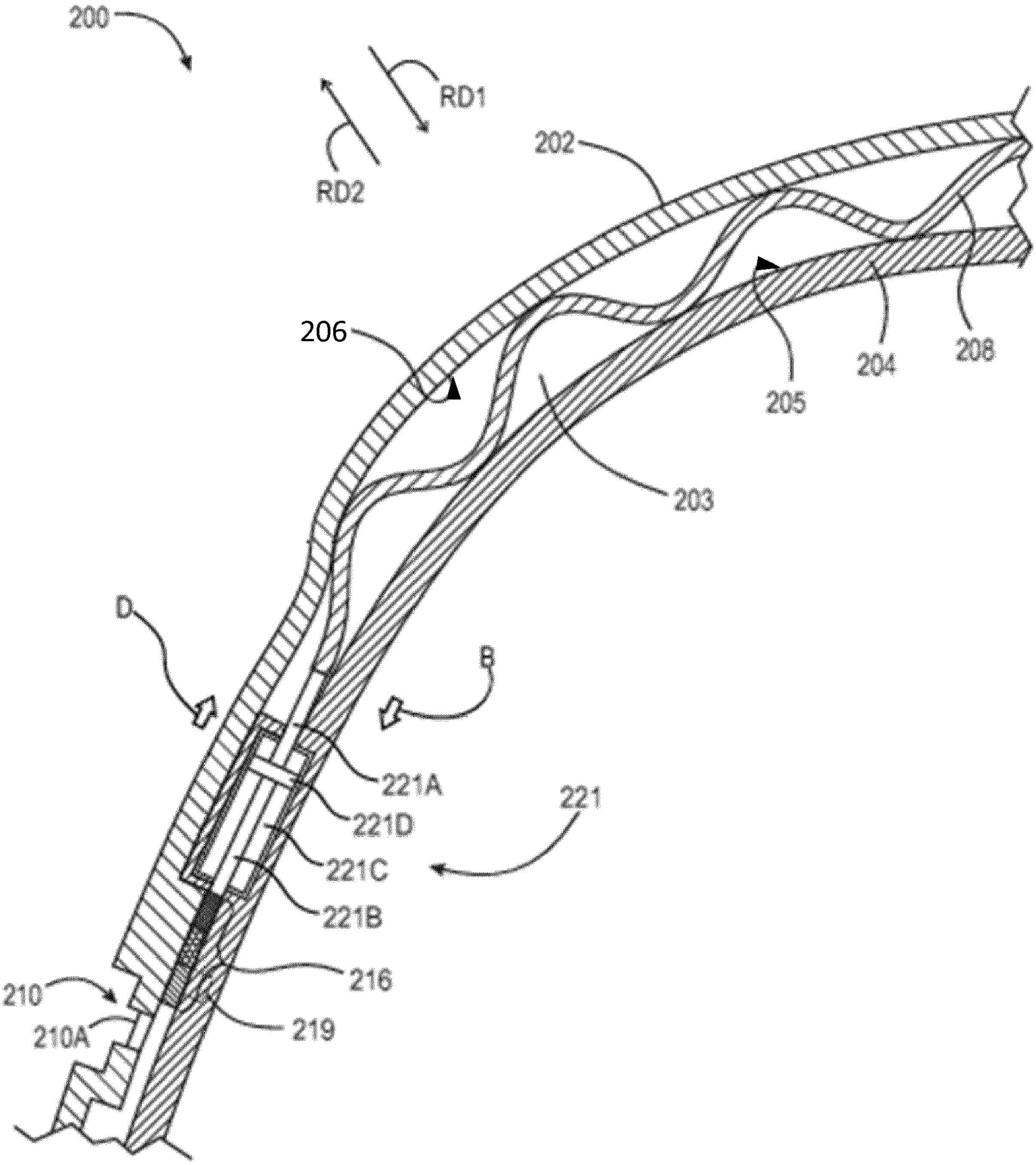
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Fig. 10

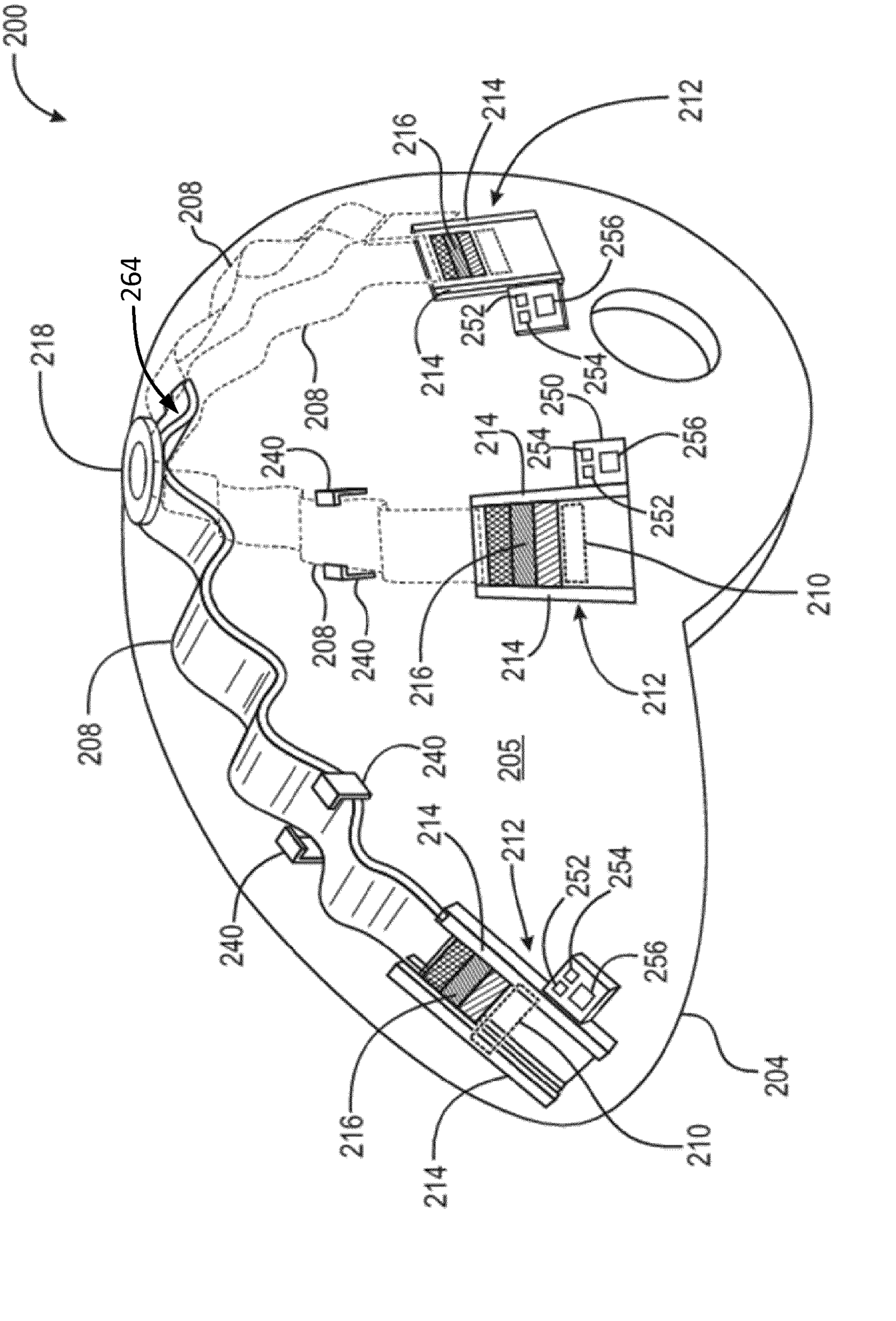

Fig. 11

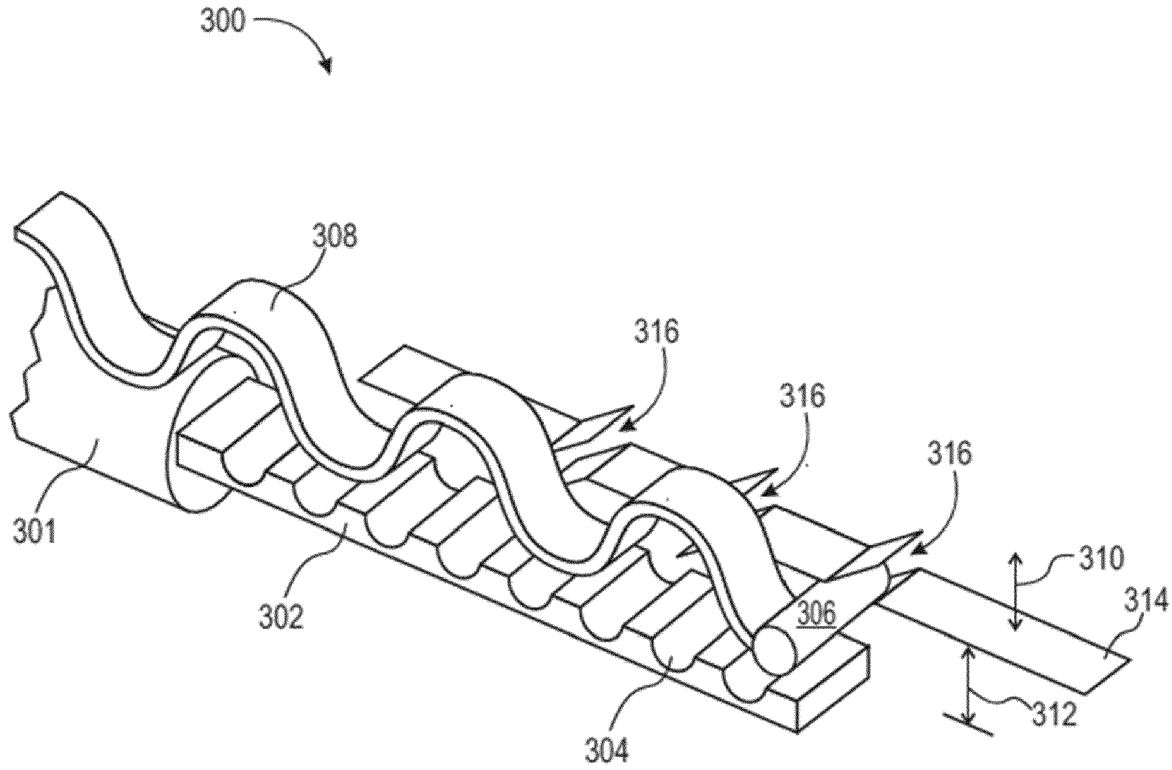

Fig. 12

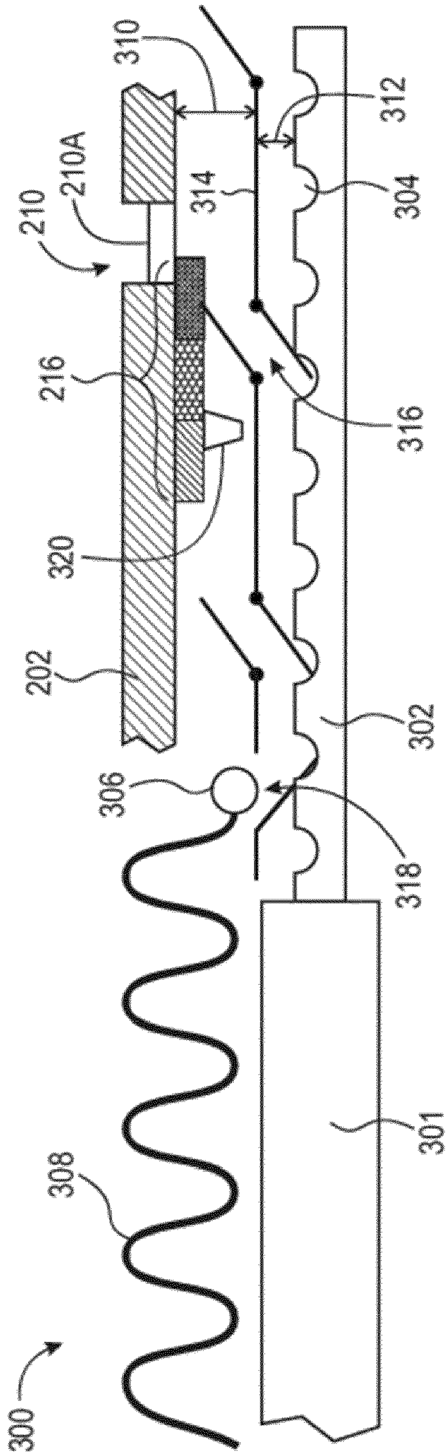
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Fig. 13

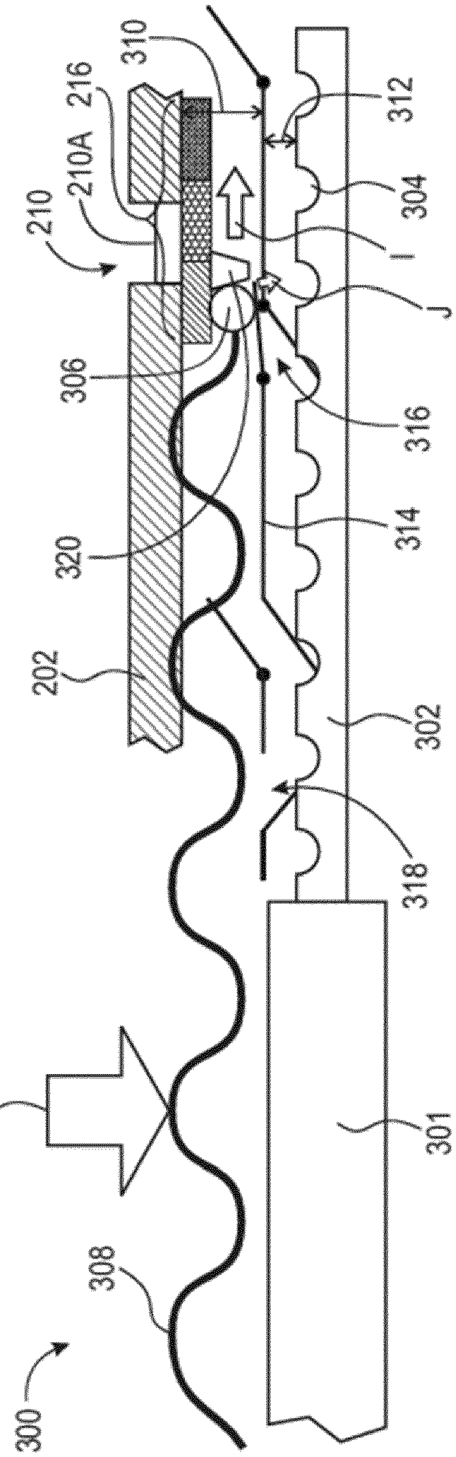
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Fig. 14

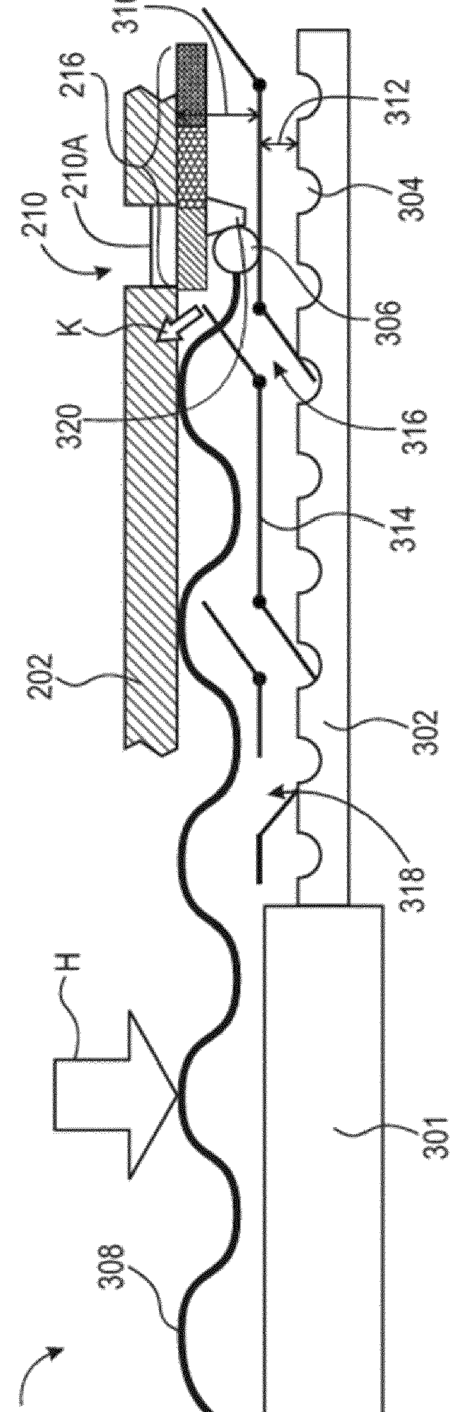
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Fig. 15

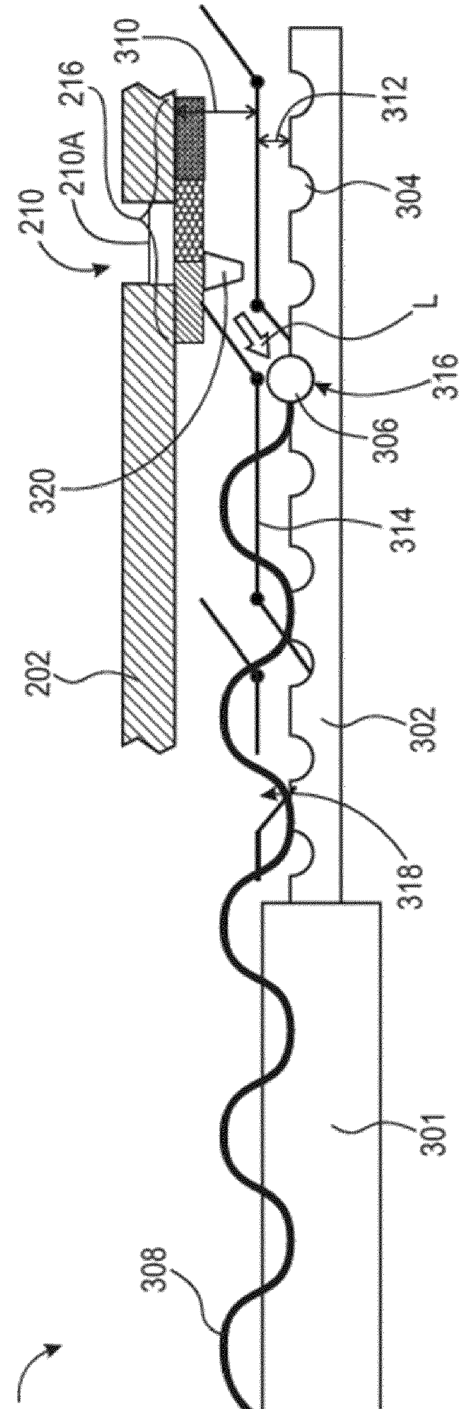
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Fig. 16

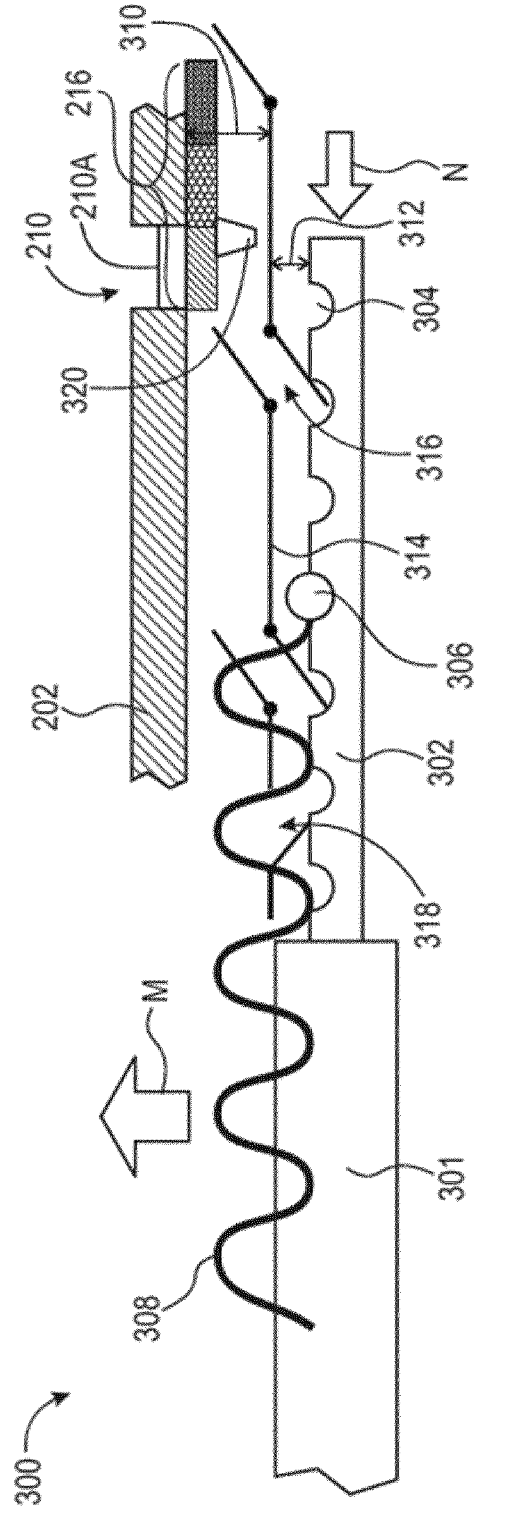
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Fig. 17

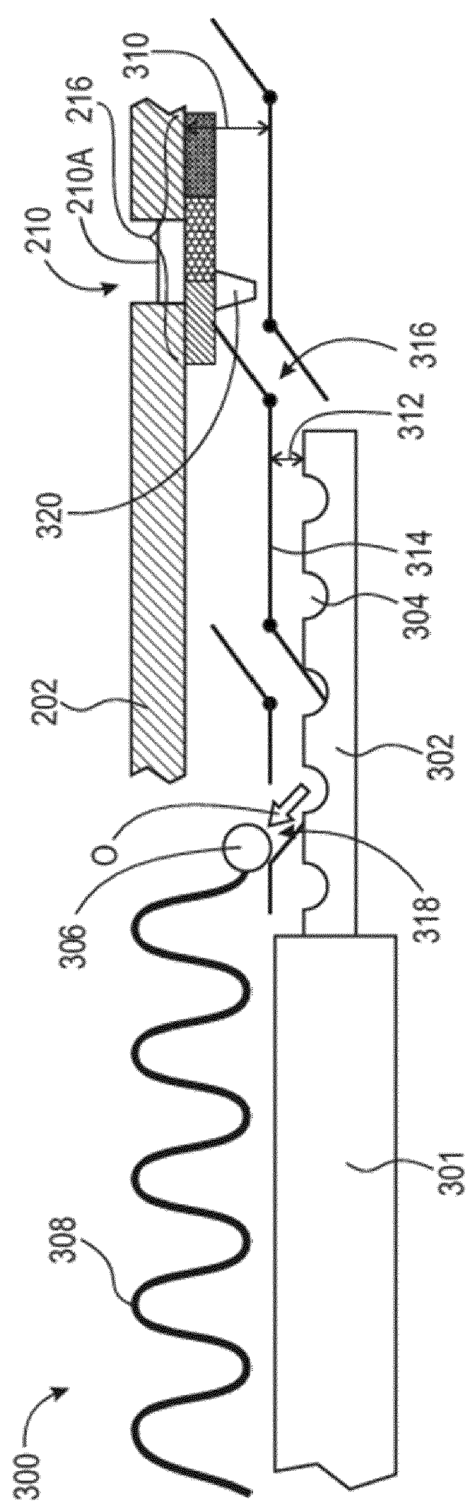
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Fig. 18

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 3498

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2017/112220 A1 (SUDDABY L S) 27 April 2017 (2017-04-27) * paragraphs [0111] - [0127] * * claims 1-35 * * figures 20-36 * -----	1-13	INV. A42B3/06
X,P	WO 2018/129447 A1 (SUDDABY LOUBERT S [US]) 12 July 2018 (2018-07-12) * paragraph [0052] - paragraph [0068] * * claims 1-36 * * figures 20-36 * -----	1-13	

TECHNICAL FIELDS SEARCHED (IPC)
A42B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	18 June 2019	Guisan, Thierry

CATEGORY OF CITED DOCUMENTS

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18-06-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017112220 A1	27-04-2017	NONE	
WO 2018129447 A1	12-07-2018	NONE	

EPO FORM P0459

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Patent documents cited in the description

- US 40125717 A **[0001]**
- US 61501115 A **[0001]**
- US 84107613 A **[0001]**
- US 9795178 B **[0001]**
- US 41278212 A **[0001]**
- US 201200773884 A **[0023]**
- US 4708757 A, Guthrie **[0023]**