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(54) BRAIDED ELECTRICAL CABLE

(57) An electrical cable comprising at least four individually isolated electrical wires configured to transmit different electrical signals is disclosed. The electrical wires are twisted and braided together to thereby form a braided net. The electrical cable is thereby being embodied as the braided net. The electrical wires are configured to move with respect to each other to thereby cause a change in a width of a section of the electrical cable

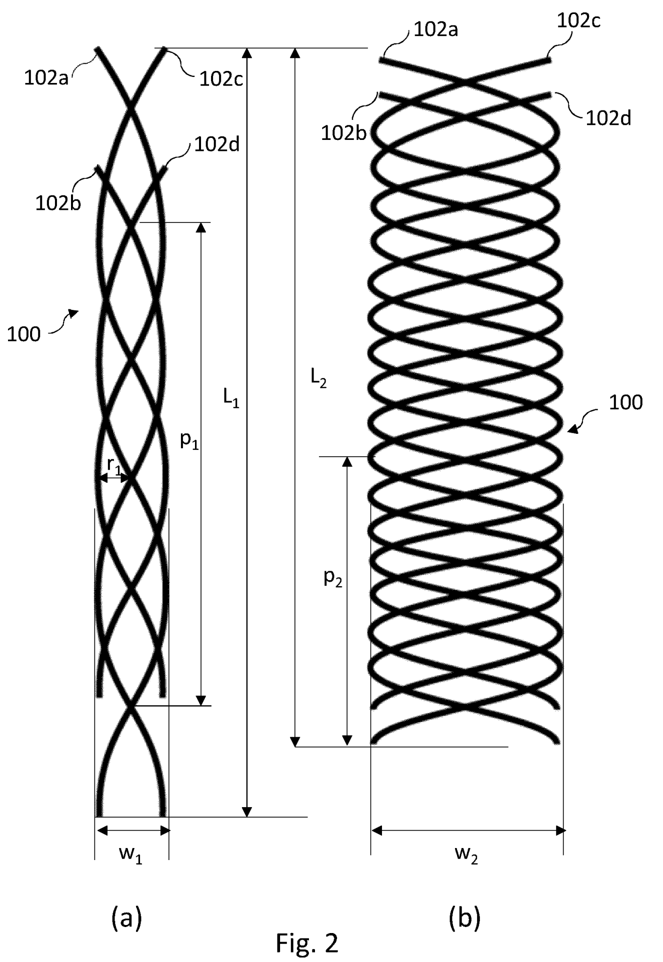


Fig. 2

Processed by Luminess, 75001 PARIS (FR)

Description

FIELD

[0001] The present disclosure relates to an electrical cable, and to an electrical cable for use in a headband of a headset.

BACKGROUND

[0002] A large number of electronic devices comprise bended, flexible, and extendable parts. These parts often comprise one or more electrical cables. Existing solutions require a large space for the electrical cable in one area to accommodate for the flexibility of the entire device.

[0003] One of such devices are headsets. The headsets may be used in various settings and the users may be wearing the headsets during long time spans. Headset users require a comfortable design, what normally requires a lightweight headset. Therefore, it is desired to have a lightweight headset which provides a good overall fit with the user's head and at the same time good comfort for the user. These characteristics are partly determined by weight of an electrical cable arranged in the headband and extending from the left to the right earcup. Furthermore, since the headband typically conforms the user's head, the electrical cable arranged in the headband also needs to follow this curvature, and therefore, the cable needs to be bendable and flexible. When the headset features a telescopic arm to provide a headset with adjustable length, the cable also needs to change length and move to thereby follow the movements of the telescopic arm.

[0004] Current solutions for headsets cables include coiled cables. However, such cable requires a lot of space, has increased weight, and also coiling can influence durability of the cable.

[0005] Therefore, there is a need for an improved electrical cable for use in various electronic devices, such as a headband of a headset or other devices which require flexibility of a cable to overcome problems of the prior art.

SUMMARY

[0006] It is an object of embodiments of the present invention to provide an electrical cable which is lightweight, flexible, and bendable.

[0007] It is also an object of embodiments of the present invention to provide an electrical cable which, when arranged in an electronic device, such as a headband, takes up minimum space, and which is not stressed during use of the device.

[0008] It is a yet further object of embodiments of the present invention to provide an electrical cable which is easy to manufacture.

[0009] It is a further object of embodiments of the present invention to provide an electrical cable for use in a headset having an extendable headband.

[0010] In a first aspect, the invention discloses an electrical cable comprising at least four individually isolated electrical wires. At least one of the electrical wires is configured to transmit an electrical signal. The electrical wires are twisted and braided together to thereby form a braided net. The electrical cable is thereby embodied as the braided net. The electrical wires are configured to move with respect to each other to thereby cause a change in a width of a section of the electrical cable.

[0011] The electrical cable of the present invention is to be understood as an assembly of four or more wires bundled together, the assembly being used to carry electric current. The electrical cable may be used to connect two or more devices, enabling the transfer of electrical signals or power from one device to the other. The number of wires forming the cable can vary according to the need of a product the cable is used for.

[0012] In order to bundle the wires into the electrical cable of the present invention, at least four individually isolated electrical wires are required. At least one wire of the four wires forming the electrical cable may be configured to transmit electric current. Other wires, may be dummy wires, i.e., wires which are not configured to carry electric current. If more than one wire is configured to transmit electrical signals, these electrical signals may be different for different wires. Alternatively, all the wires may transmit the same electrical signal. One or more of the wires may be a ground wire.

[0013] The wires used in the electrical cable may be typical wires used in the art embodied as flexible strands of metal. Each wire is individually isolated. The wires may be isolated with a material commonly used for insulation. One or more or all the electrical wires of the electrical cable may be configured to transmit electrical signals. The wires may transmit the same or different electrical signals.

[0014] The electrical wires are twisted and braided together to thereby form a braided net. In other words, the electrical wires form the braided net by interlacing the wires over each other in turn and then repeating it until the entire cable is formed. The wires may be braided together at regular intervals and twisted around a central axis to thereby form an enclosed braided net. In this way, the electrical cable is embodied as the braided net. The shape of the braided net may be adjusted according to requirements of a device which the cable is implemented in. The cross-section of the braided net may be a circle or have an oval shape, such as an ellipse or similar. The braided net may be formed only in a specific area of the cable which requires flexibility, bending, and expansion, while the rest of the cable may not be braided. Alternatively, the braided net may extend along the entire electrical cable.

[0015] The electrical wires are configured to move with respect to each other. This is achieved by loose braiding which allows the wires to change its position within the braided net and to thereby change the outer shape of the braided net, and thus the electrical cable. The wires may be equivalent in zig-zagging forward through the overlapping braided structure formed by the other wires.

[0016] By moving the wires with respect to each other a change in a width of the electrical cable is achieved. The width of the cable can be defined as the largest extent of the cable taken from side to side in a direction perpendicular to a central axis of the cable. The change in the width can be achieved at a desired position along the cable. Also, the change in the width can be simultaneously achieved at different positions along the cable. Such change may occur when the electrical cable is bended, compressed in length, or pulled. Furthermore, the electrical cable may comprise a braided section and a non-braided section with or without a jacket. Finally, the cable can expand in width along its entire length. The electrical cable may have a first width in a relaxed, initial state and a second width in a compressed, bended, or extended state. When the electrical cable is bended or compressed, at first, only a section of the electrical cable will change its width, e.g. a bended section will have a width different than the rest of the cable and different than the cable in its relaxed, initial state. A change in the cable width is accompanied by a change in the cable's length.

[0017] Having the electrical cable formed by the braided wires that can move with respect to each other is advantageous as the resulting cable is flexible and bendable thanks to the intertwined freely floating wires within the braided net. Each of the wire comprised in the cable may be braided in such a way that it forms a coil intertwined with other wires also forming coils. Furthermore, the net formed by the braided wires keeps the wires assembled and thereby the cable does not comprise (nor require) an outer jacket, resulting in a lightweight cable and a cable that does not take up large space. These advantages are in particular relevant when the electrical cable is implemented in devices which are exposed to stress during use. Flexibility and bendability of the cable ensures that the cable will not be stressed during use of the devices Finally, braiding of the wires is simple and therefore manufacturing of the electrical cable is simple.

[0018] In some embodiments, each of the electrical wires forms a helix extending along the length of the electrical cable. In other words, the wires are braided in such a way that each wire forms an individual helix intertwined with helices of the other wires. Helices formed by different wires may have the same key properties, such as a pitch, radius, slope, arch length, etc. The key property of a helix is that it has smooth curvatures without any sharp edges allowing the intertwined wires to move within each other providing flexibility to the electrical cable. The electrical cable may be characterized by properties of the helices forming the cable. These may include a pitch, radius, curvature, arc length, number of turns, and helicoid. The pitch of a helix is defined as the height of one complete helix turn measured parallel to the axis of the helix. The pitch may be defined for the cable in an initial state, i.e. when the cable is in a relaxed state, without being stretched or compressed in length. The radius of the helices is related to the width of the electrical cable. The helicoid is the minimal surface having a helix as its boundary. The length of the electrical cable is related to the number of turns of the helices. Different parameters of the helices define dimensions and flexibility of the electrical cable. The radius of the helices together with the total number of wires used define the width of the electrical cable. The pitch is related to flexibility of the cable. For instance, if the wires are braided such that formed helices have a large pitch, the cable will have a high flexibility as it will be possible to reduce the pitch such that turns of the helices touch each other. It should be noted that all the parameters of the helix lead to a large degree of freedom when designing the cables and therefore, such electrical cables can be used in a wide variety of devices having different requirements for the electrical cables.

[0019] In some embodiments, the electrical cable comprises at least two helices with the same axis, the helices differing by a translation along the axis. In this way, the braiding is made such that the wires are twisted in two directions over and over each other to form the braided net. Helices can be either right-handed or left-handed, and the electrical cable may comprise one wire being a left-handed helix and other wires may form right-handed helices. Typically, all the wires, i.e. all the helices of the electrical cable will have the same axis. Having the helices with a different handedness ensures formation of the enclosed braided net.

[0020] In some embodiments, a plurality of electrical wires are grouped together to form one helix. In this case, the electrical cable may still require at least four groups of electrical wires forming different helices. By grouping the electrical wires together into helices, the total number of wires used in the cable can be increased while the complexity of braiding can be kept simple. The total number of wires depends on the purpose that the electrical cable is used for and a number of different electrical signals that are to be transmitted by the electrical cable.

[0021] In some embodiments, the helix is defined by a pitch, and wherein the pitch of the helix is configured to change to thereby cause the change in the width of the section of the electrical cable. When the cable is compressed or bended or extended, the parameters of the helices forming the cable will change. Here, it will be considered that the electrical cable is formed by helices all having the same main parameters such as the pitch and radius. Typically, when the pitch of the helices is decreased, or specifically, when the pitch of a section of the helices is decreased, the width of the cable in that section will increase. The width of the cable can be increased as needed or up to a maximum width that can be achieved. For example, a cable with four wires may the smallest diameter of 1 mm. Depending on the pitch of the wires, the cable may expand in width up to the length of the pitch. For instance, if the pitch is 2 mm, the cable can expand up to 3 mm in diameter. Also, the electrical cable can be manipulated such that it has different width along its length. This is also advantageous as different portions of a device utilizing the cable may require different dimensions of the cable and changes in shape of the cable.

[0022] In some embodiments, the braided net has a tubular shape. As the braided net has the tubular shape, the electrical cable also has a tubular shape. The tubular shape may be an initial shape and then the cable can deform as required. The formed tubular shape can be circular in its cross-section or it can be ellipsoidal. The formed tube can form S-shaped-bends and/or U-shaped-bends. The tubular shape is advantageous as it can replace traditional cylindrical cables and add further advantages such as flexibility and lightweight.

[0023] In some embodiments, the electrical cable further comprises a guide arranged along an axial direction of the electrical cable. This central guide may serve to give a general direction to the cable. The central guide may be flexible to thereby allow the braided net to move as required by an application. The central guide may be made of plastic.

[0024] Alternatively, a tube in which the electrical cable can be arranged may serve as a guide for the electrical cable. The electrical cable may comprise the tube arranged around the electrical wires. The outer tube may be arranged around the braided net and may accommodate the electrical cable either with or without a guide that is arranged along the axial direction of the cable. The outer tube may have a diameter that fulfills requirements of a device which the electrical cable is used in. The diameter of the outer tube will limit the maximum diameter of the electrical cable. Similar to the central guide, the outer tube is used to control and guide the wires of the cable. The outer tube may also be understood as a protection for the electrical cable if such protection is needed. Finally, the outer tube, as well as the central guide, may direct the electrical cable in intended areas. The outer tube may comprise areas with smaller and larger diameter than the rest of the tube if that is required by the product. The electrical cable can then accommodate such changes in diameter of the tube.

[0025] In some embodiments, the change in the width of the section of the electrical cable is an increase of the section width and wherein the electrical cable is simultaneously contracted in length. The braided electrical cable can be compressed, and this compression will cause a change in cable's width, i.e. the cable will expand in width. If the wires form helices, the pitch of the helices will decrease, while the radius will increase thereby increasing the width of the cable. As the pitch of the helices decreases, the electrical cable will contract in length. The width of the cable is related to the radius of the helices forming the cable. Thereby, changes in the cable's width are related to the changes in the radius of the helices. Also, changes in the cable's width are related to the changes in the changes of the length of the cable. The electrical cable may be flexed such that one or more cable sections change in width. The electrical cable may be flexed such that the entire cable changes in width. Simultaneous changes in width and length of the cable are beneficial for consumer devices which have parts that move, collapse, extend, etc., and which at the same time require an electrical cable to go through these parts.

[0026] In some embodiments, the width of the section is configured to change such that a midpoint of the section has the longest width and the width of the section gradually decreases towards the ends of the section. The section of the electrical cable may therefore form an ovoid. The helices formed by the wires may have a pitch and radius which change along the electrical cable. The ability of the electrical cable to gradually change in width are beneficial as various consumer devices may have parts which gradually move, and may require gradual changes in width and length of the electrical cable.

[0027] In some embodiments, the electrical cable provides that in a fatigue test in which a load is repeatedly applied in an axial direction of the electrical cable, an electrical resistance value of the electrical cable is increased by 10-20%, such as 15%, with respect to an initial value at a time when the load is repeatedly applied at least 10.000 times. The fatigue test may also be performed with bended movements and similar properties can be achieved. In order to optimize the cable and achieve high durability, the tightness of the braid can be optimized to fulfill requirements of different consumer devices used for music, or similar in terms of durability.

[0028] In some embodiments, the length of the electrical cable is at least 5% shorter than the length of the individual electrical wires forming the electrical cable. When the electrical cable is in its initial state, the difference between the cable length and the length of the individual wires is the smallest and can be at least 5%. The larger the pitch of the helix is, the smaller the difference between the wires length and the cable length is. When the cable is expanded in width, this difference increases as the cable length is decreasing while the wires length remains constant. All the wires forming the electrical cable may have the same length. Having an electrical cable in which the wires forming the cable are longer than the cable itself is advantageous as it saves space as the cable can be made shorter than what the requirement on the wire's length is.

[0029] In some embodiments, a cable jacket is absent from the electrical cable. The electrical cable of the present invention typically does not comprise a cable jacket as the wires are assembled and held together by the way they are braided. Therefore, the jacket is not required unless the application of the electrical cable requires a specific protection of the cable. However, in this case, an outer tube may be used and the electrical cable will be arranged therein. This way of protecting the cable is simpler than arranging the cable jacket which is normally tightly fitted to the wires and prevents the electrical wires from any movements. The electrical cable without a jacket is easier to produce, it is lighter than those with a cable jacket, and additionally it is more flexible than those with a jacket.

[0030] In some embodiments, in the electrical cable cross-section, the individual electrical wires occupy at most 90% of the cable's cross-section when the electrical cable is in an initial state, and wherein the individual electrical wires occupy at most 5% of the cross-section when the electrical cable is in an expanded state. The initial state may be defined by the maximum length of the cable and the minimum width and/or the minimum diameter. In such a case, the length of the cable cannot be increased upon extension as well as the width/diameter. Alternatively, the initial state may be the electrical cable in a relaxed state characterized by a first length and a first width. In this case, the cable can be extended to a second length, longer than the first length and the width can be decreased to a second width. Depending on how much space the wires occupy in the initial state, the electrical cable will have a different flexibility. In general, the more space in the cross-section the wires occupy, the more dense the cable is braided and less flexible it is. In order to allow the electrical cable to flex and bend, 90% of the cross-section may be occupied at most. The expanded state may be defined by a maximum width which the cable can achieve.

[0031] In a second aspect, disclosed is the electrical cable according to the first aspect for use in a headband of a headset. It should be understood that all the embodiments, benefits and advantages described in connection with the first aspect are equally relevant for this second aspect. The electrical cable of the present invention may also be used in other products that require lightweight, flexible, bendable electrical cables with adjustable width and length.

[0032] In the present context, the term "headband" is to be interpreted to refer to a band to be worn over the user's head, and in particular over the top of the user's head while the ends of the headband may abut sides of the user's head, e.g. at the ear(s).

[0033] The headset, in addition to the headband, comprises one or two earcups carried by the headband. The engagement between the headband and the earcups can be established in various ways known in the art. The earcup is typically arranged at one end of the headband. The other end of the headband may comprise a stabilization element abutting a side of the user's head to ensure proper positioning of the headband and headset. The earcup may comprise various electronic elements necessary for a proper functioning of the headset, and in particular a speaker configured to generate a sound signal. The headset may further comprise a microphone and/or another earcup to be arranged on the other ear of the user. The microphone may be arranged onto an earcup or, alternatively, directly on the headband. The microphone may be arranged on a microphone boom arm.

[0034] In some embodiments, the electrical cable is configured to be arranged in the headband of the headset. The headband is typically at least partly hollow and is configured to secure an electrical cable. The electrical cable may then extend through an interior volume of the headband. The cable may be arranged in a separate tube arranged in the headband. The cable may electrically connect two earcups arranged on two ends of the headband, thereby forming a stereo headset. The electrical cable is typically configured for electrically connecting the at least one earcup of the headset with another earcup and/or with a microphone, and/or with other electrical components which may form part of the headset. The headband typically accommodates any curvature of the head. The electrical cable of the present invention is advantageous as it is flexible and bendable and can thereby also follow any deformation of the headband and thereby accommodate any curvature of the user's head when the headset is worn by the user.

[0035] The headband of the headset may have adjustable length. The length extension may be arranged in the ends of the headband by means of a telescopic extension. In some embodiments, a section of the electrical cable is configured to change its width when the length of the headband changes. In other words, the electrical cable can follow the length adjustments of the headband while only changing in width and without requiring additional space, as for example a coiled cable commonly used in headsets with a telescopic extension. Flexibility of the electrical cable allows for such simple implementation of the cable in the headband. The electrical cable may be arranged in a tube which is arranged in the headband.

[0036] In some embodiments, the headband for a headset may further be configured to carry a headphone unit. The electrical cable may be attached to the carrier and configured for electrically connecting the headphone unit and the earcup. The headphone unit may comprise a microphone. The headphone unit may be arranged on the same side of the headband as the earcup. The electrical cable may be arranged in the headband and comprise all the wires needed for operation of the headphone unit.

[0037] In some embodiments, the electrical cable is configured to change its width in a bended section of the headband when arranged in the headband of the headset. The electrical cable, extending through the headband to another earcup, will be bended at the top of the user's head. In this region, the electrical cable will also have gradually changing width, with a maximum width at the top of the user's head and decreasing towards the ends of the headband. The change in the width will occur on its own accord upon arrangement of the cable in the headband. There is no need to form some special features of the cable to ensure proper bending in the bended headband section as the electrical cable of the present invention inherently possess required properties.

[0038] In some embodiments, the electrical cable is configured to follow movements of a telescopic extension of the headband. Similarly to the bending of the cable in the bended section of the headband, the electrical cable can change its length, and consequently the width, when the telescopic extension is moved. In this case, there is no need to form some special features of the cable to ensure proper extension and contraction in length as the electrical cable of the present invention inherently possess required properties. It is therefore advantageous to use the electrical cable of the present invention in headsets with a telescopic extension as the electrical cable will not add additional weight or complexity to the headband and additionally will not require additional space as it is the case with commonly used cables.

[0039] In some embodiments, the electrical cable is configured to extend from a left earphone to a right earphone of the headset through a hollow tube such that when the headphone is moved from a stowed to a deployed position the electrical cable moves and twist following the movements of the headband. The electrical cable may bend in all directions to thereby follow movements of the headband. The tube, in which the electrical cable is arranged, may also be flexible. In embodiments in which the headset requires significant bending for the stowed position, the tube may be omitted and the electrical cable may be individually arranged in the headband to thereby ensure full range of motion of the headband.

[0040] The present invention relates to different aspects including the electrical cable described above and in the following, and the electrical cable for use in a headband of a headset, each yielding one or more of the benefits and advantages described in connection with the first mentioned aspect, and each having one or more embodiments corresponding to the embodiments described in connection with the first mentioned aspect and/or disclosed in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The above and other features and advantages will become readily apparent to those skilled in the art by the following detailed description of exemplary embodiments thereof with reference to the attached drawings, in which:

Fig. 1 schematically illustrates an exemplary embodiment of an electrical cable according to the present invention,

Fig. 2 schematically illustrates a section of the electrical cable in (a) an initial state and in (b) an expanded state,

Fig. 3 schematically illustrates another exemplary embodiment of the electrical cable according to the present invention,

Fig. 4 schematically illustrates yet another exemplary embodiment of an electrical cable according to the present invention,

Fig. 5 schematically illustrates yet another exemplary embodiment of an electrical cable according to the present invention,

Fig. 6 schematically illustrates yet another exemplary embodiment of an electrical cable according to the present invention,

Fig. 7 schematically illustrates yet another exemplary embodiment of an electrical cable according to the present invention,

Fig. 8 schematically illustrates cross-sections of the exemplary embodiment shown in Fig. 1,

Fig. 9 schematically illustrates an electrical cable according to an embodiment of the present invention used in a headband of a headset.

DETAILED DESCRIPTION

[0042] Various embodiments are described hereinafter with reference to the figures. Like reference numerals refer to like elements throughout. Like elements will, thus, not be described in detail with respect to the description of each figure. It should also be noted that the figures are only intended to facilitate the description of the embodiments. They are not intended as an exhaustive description of the claimed invention or as a limitation on the scope of the claimed invention. In addition, an illustrated embodiment needs not have all the aspects or advantages shown. An aspect or an advantage described in conjunction with a particular embodiment is not necessarily limited to that embodiment and can be practiced in any other embodiments even if not so illustrated, or if not so explicitly described.

[0043] Throughout, the same reference numerals are used for identical or corresponding parts.

[0044] Fig. 1 illustrates an exemplary embodiment of an electrical cable 100 according to the present invention. The electrical cable 100 comprises at least four individually isolated electrical wires 102a, 102b, 102c, and 102d. At least one of the four electrical wires 102a-d is configured to transmit an electrical signal. The electrical wires 102a-d are twisted and braided together to thereby form a braided net. The electrical cable 100 is thereby embodied as the braided net. The electrical wires 102a-d are configured to move with respect to each other to thereby cause a change in a width w of a section of the electrical cable 100. The electrical cable 100 is to be understood as an assembly of four wires 102a-d bundled together and configured to carry electric current. The number of wires forming the cable can vary according to the need of a product the cable is used for. Fig. 6 shows an embodiment of the electrical cable 600 comprising 8 wires 602a-h braided together in a tubular braided net.

[0045] At least one wire of the four wires 100a-d forming the electrical cable is configured to transmit electric current. Alternatively, two or more wires 102a-d are configured to transmit, the same or different, electrical signals. One of the wires 102a-d may be a ground wire. Each wire 102a-d is individually isolated. The electrical wires 102a-d are twisted and braided together over each other in turn thereby forming the braided net.

[0046] The wires 102a-d are braided together at regular intervals and twisted around a central axis x. The shape of the braided net may be adjusted according to requirements of a device which the cable is implemented in.

[0047] Having the electrical cable 100 formed by braided wires that can move with respect to each other is advantageous as the resulting cable is flexible and bendable thanks to the intertwined freely floating wires within the braided net. Each of the wires 102a-d comprised in the cable 100 forms a coil intertwined with other wires also forming coils. The braided wires keep the wires assembled together and thereby the cable 100 does not require an outer jacket to keep the wires together. The resulting cable is therefore lightweight.

[0048] Fig. 2 schematically illustrates a section of the electrical cable 100 in (a) an initial state and in (b) an expanded state (expanded in width and compressed in length). The cable 100 shown in Fig. 2a is the same as the one shown in Fig. 1. As the electrical wires 102a-d are configured to move with respect to each other this allows the wires to change its position within the braided net and to thereby change the outer shape of the braided net, and thus the electrical cable. By moving the wires with respect to each other a change in a width of the electrical cable from w_1 to w_2 is achieved. Such change may occur when the electrical cable is bended, compressed, or pulled. Fig. 2 illustrates compression of the cable from its initial state shown in Fig. 2a to its compressed state in Fig. 2b, and it is also shown that the length of the cable is changed from L_1 to L_2.

[0049] In Fig. 2, each of the electrical wires 102a-d forms a helix extending along the length of the electrical cable 100. The individual helices are intertwined with helices of the other wires. The electrical wire 100 of Fig. 2(a) comprises four helices formed by the wires 102a-d having the same key properties, such as a pitch p_1 and radius r_1. Smooth curvatures of the helices allow the intertwined wires 102a-d to move within each other providing flexibility to the electrical cable 100. The electrical cable 100 may be characterized by properties of the helices forming it. These may include a pitch, radius, curvature, arc length, number of turns, and helicoid. The pitch is typically defined for the cable in an initial state shown in Fig. 2(a) and being p_1. The radius r_1 of the helices is related to the width w_1 of the electrical cable 100. The length L_1 of the electrical cable 100 is related to the number of turns of the helices. The electrical cable 100 comprises four helices with the same axis, wherein two helices are right-handed and the other two are left-handed.

[0050] The pitch p_1 of the electrical cable 100 is configured to change to thereby cause the change in the width of the electrical cable 100. Fig. 2(b) shows the electrical cable 100 being compressed and having the pitch p_2 which is smaller than p_1. This decrease in pitch size results in an increase in the cable width to w_2. The width of the cable can be increased as needed or up to a minimum pitch that can be achieved resulting in a maximum possible width and minimum possible length. This is advantageous as different portions of a device utilizing the electrical cable 100 may require different dimensions of the cable and changes in shape of the cable.

[0051] Fig. 3 schematically illustrates another exemplary embodiment of the electrical cable 300 according to the present invention. The electrical cable 300 shown in Fig. 3a comprises four braided wires defining two different sections, a lower section 304 with loosely braided wires and an upper section 306 with densely braided wires. The pitch of the lower section 304 is larger than the pitch of the upper section 306, while the width of the lower section 304 is smaller than the width of the upper section. The electrical cable shown in Fig. 3(a) may be the cable in its initial state. A device, implementing the electrical cable 300, may require extension of the cable 300. The electrical cable can then extend as shown in Fig. 3(b) such that it is longer than the cable in its initial state and wherein the pitch of the upper section 304 is increased, resulting in a decrease in the cable width in the upper section.

[0052] Fig. 4 schematically illustrates yet another exemplary embodiment of an electrical cable 400 according to the present invention. The electrical cable 400 is similar to the one shown in Fig. 3 and additionally comprises a central guide 408 arranged along an axial direction of the electrical cable 400. This central guide 408 serves to give a general direction to the cable. The central guide 408 may be flexible to thereby allow the braided net to move as required by an application.

[0053] Fig. 5 schematically illustrates yet another exemplary embodiment of an electrical cable 500 according to the present invention. Alternatively to the central guide 408 of Fig. 4, a tube 510 in which the electrical cable 500 can be arranged may serve as a guide for the electrical cable 500. The outer tube 510 is arranged around the braided net and accommodates the electrical cable 500. The outer tube may also be understood as a protection for the electrical cable if such protection is needed.

[0054] Figs. 5 (c) and (d) schematically illustrates the electrical cable 500 arranged in a bended tube 512. Fig. 5(c) shows the cable in its initial state and arranged in the bended tube 512. The pitch of the bended upper potion 506 changes in the bended section 514 compared to the non-bended portion of the upper section 506. Figs. 5 (c) and (d) show several degrees of freedom achieved with the electrical cable 500: 1) changes in width/thickness of the cable, 2) changes in length of the cable, 3) changes in direction of the cable.

[0055] Fig. 6 schematically illustrates yet another exemplary embodiment of an electrical cable 600 according to the present invention. The cable 600 comprises 8 individually isolated electrical wires 600a-h intertwined into a braiding net. The upper section 606 is densely braided and comprises helices with a pitch smaller than the pitch of the lower section 604, as illustrated in Fig. 6(a). Fig. 6(b) illustrates the cable 600 in an extended state in which the length of the cable is doubled compared to the cable in its initial state shown in Fig. 6(a).

[0056] Fig. 7 schematically illustrates yet another exemplary embodiment of an electrical cable 700 according to the present invention. The electrical cable 700 is formed by a plurality of electrical wires being grouped together to form one helix. In this case, the electrical cable 700 comprises eight groups of electrical wires forming different helices. By grouping the electrical wires together into helices, the total number of wires used in the cable can be increased. Fig. 7(b) illustrates how the width of a section of the electrical cable 700 changes. The width of the section is configured to change such that a midpoint line 701 of the section has the longest width and the width of the section gradually decreases towards the ends 703 of the section. The helices formed by the wires may have a pitch which changes along the electrical cable. The ends 705 of the cable remain unchanged in width.

[0057] Fig. 8 schematically illustrates cross-sections of the exemplary embodiment of the electrical cable 100 shown in Fig. 1. The cross-sections are made in planes perpendicular to the central axis x of the electrical cable. The electrical cable 100, illustrated in Fig. 8(a) comprises four individual electrical wires. Fig. 8(a) also illustrates how the width of a section of the electrical cable 100 changes. The width of the section is configured to change such that the cable 100 is the widest in the middle and the width decreases towards the ends of the cable. Fig. 8(b) illustrates the electrical cable cross-section at a first position (1), where the individual electrical wires occupy most of the cable's cross-section. As the width of the electrical cable 100 changes, the individual wires occupy less of the cable's cross-section, as it can be seen on Figs. 8 (c) and (d). Fig. 8(d) shows that a very small percentage, e.g. 5% of the cross-section is occupied by the wires and the rest may be just air, as the electrical cable is in its expanded state. Depending on how much space the wires occupy in the initial state, the electrical cable will have a different flexibility. In general, the more space in the cross-section the wires occupy, the more dense the cable is braided and less flexible it is. In order to allow the electrical cable to flex and bend, 90% of the cross-section may be occupied at most.

[0058] The zoomed-in inserts show how the cross-section of the individual wires in the plane perpendicular to the central axis x of the electrical cable changes, depending on where the wire is and what the width of the cable is. In a section of the electrical cable 100 which is not bended or compressed, the cross section of the wire, when a cut is made in the plane perpendicular to the central axis x of the cable, is close to being circular, as the individual wires form helices with a large pitch. This is illustrated in Fig. 8(b). However, when the cable is pressed together and shorten in length, the cross section of the cable will change, and this will be accompanied by changes in a cross-section of the individual wires, as illustrated in the corresponding zoomed-in inserts of an individual wire. Fig. 8(d) shows that when the cross-section is made in the plane parallel to the central axis x of the cable, it can be seen how the wire is positioned in the cable. Fig. 8(d) shows that the individual wire is angled with respect to the central axis and therefore the cross-section of the wire is elliptical.

[0059] Fig. 9 schematically illustrates an electrical cable 100 according to an embodiment of the present invention used in a headband 802 of a headset 800. The two different sides of the headset 800 show different states of the electrical cable 100. The left-hand side of the headset 800 shows the left section of electrical cable 100 in its compressed and thereby shortened state. The electrical cable 100 is therefore shorter and wider in the left part of the headset compared to the section in the right-hand part of the headset 800 where the left earcup 806 is moved to thereby extend the length of the headset 800. Thereby, the section of the electrical cable 100 in the right-hand side of the headset is extended and the cable 100 is made long and thin.

[0060] The headset 800, in addition to the headband 802, comprises two earcups 804 and 806 carried by the headband 802. The headband 802 is typically at least partly hollow and is configured to secure the electrical cable 100. The cable electrically connects the two earcups 804, 806. The headband typically accommodates any curvature of the head. The electrical cable 100 is advantageous as it is flexible and bendable and can thereby also follow any deformation of the headband 802 and thereby accommodate any curvature of the user's head when the headset 800 is worn by the user.

[0061] The headband 802 of the headset 800 has adjustable length. The length extension is arranged in the right end of the headband by means of a telescopic extension 808. The electrical cable 100 is configured to accommodate for this length extension of the headband 802 by changing its width and length. In other words, the electrical cable can follow the length adjustments of the headband while only changing in width and without requiring additional space. The electrical cable 100 may be arranged in a tube which is arranged in the headband 802.

[0062] Although particular features have been shown and described, it will be understood that they are not intended to limit the claimed invention, and it will be made obvious to those skilled in the art that various changes and modifications may be made without departing from the scope of the claimed invention. The specification and drawings are, accordingly to be regarded in an illustrative rather than restrictive sense. The claimed invention is intended to cover all alternatives, modifications and equivalents.

LIST OF REFERENCES

[0063]

100	electrical cable
102a-d	electrical wires
200	electrical cable
300	electrical cable

304	lower section
306	upper section
400	electrical cable
408	central guide
500	electrical cable
506	upper portion
510	outer tube
512	bended tube
514	bended section
600	electrical cable
602a-h	electrical wires
604	lower section
606	upper section
700	electrical cable
701	midpoint of expanded section
703	ends of expanded section
705	ends of electrical cable
800	headset
802	headband
804,806	earcup
808	telescopic extension

Claims

1. An electrical cable comprising at least four individually isolated electrical wires, at least one electrical wire being configured to transmit an electrical signal,

   wherein the electrical wires are twisted and braided together to thereby form a braided net, the electrical cable being embodied as the braided net, and
   wherein the electrical wires are configured to move with respect to each other to thereby cause a change in a width of a section of the electrical cable.

2. The electrical cable of claim 1, wherein each of the electrical wires forms a helix extending along the length of the electrical cable.

3. The electrical cable of claim 1 or 2, wherein the electrical cable comprises at least two helices with the same axis, the helices differing by a translation along the axis.

4. The electrical cable of any of the preceding claims 2-3, wherein a plurality of electrical wires are grouped together to form one helix.

5. The electrical cable of any of the preceding claims 2-4, wherein the helix is defined by a pitch, and wherein the pitch of the helix is configured to change to thereby cause the change in the width of the section of the electrical cable.

6. The electrical cable of any of the preceding claims, wherein the braided net has a tubular shape.

7. The electrical cable of any of the preceding claims, further comprising a guide arranged along an axial direction of the electrical cable.

8. The electrical cable of any of the preceding claims, wherein the change in the width of the section of the electrical cable is an increase of the section width and wherein the electrical cable is simultaneously contracted in length.

9. The electrical cable of any of the preceding claims, wherein the width of the section is configured to change such that a midpoint of the section has the longest width and the width of the section gradually decreases towards the ends of the section.

10. The electrical cable of any of the preceding claims for use in a headband of a headset.

11. The electrical cable according to claim 10, wherein the electrical cable is configured to be arranged in the headband of the headset.

12. The electrical cable according to claim 10 or 11, wherein a section of the electrical cable is configured to change its width when the length of the headband changes.

13. The electrical cable according to claims 10-12, wherein the electrical cable is configured to change its width in a bended section of the headband when arranged in the headband of the headset.

14. The electrical cable according to claims 10-13, wherein the electrical cable is configured to follow movements of a telescopic extension of the headband.

15. The electrical cable according to claims 10-14, wherein the electrical cable is configured to extend from a left earphone to a right earphone of the headset through a hollow tube such that when the headphone is moved from a stowed to a deployed position the electrical cable moves and twist following the movements of the headband.

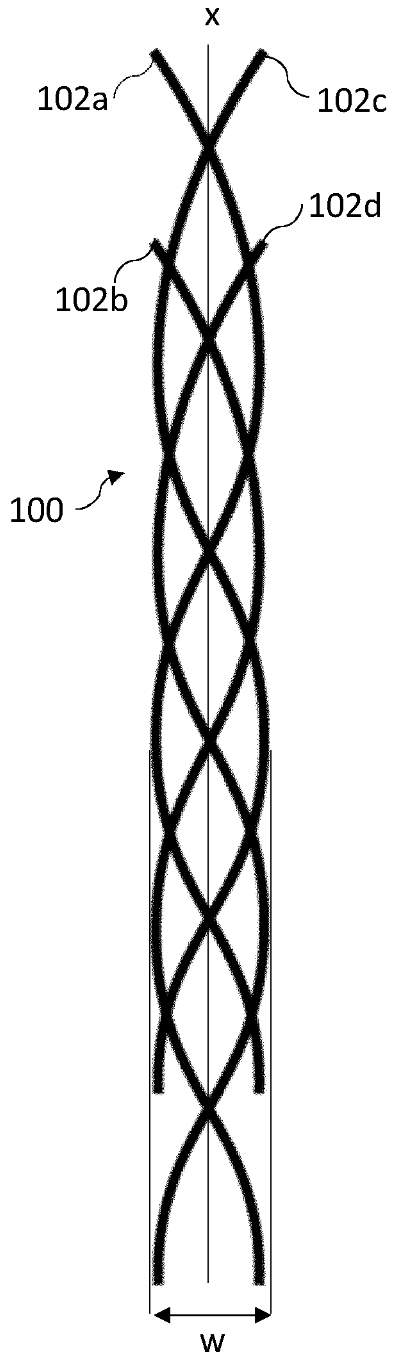
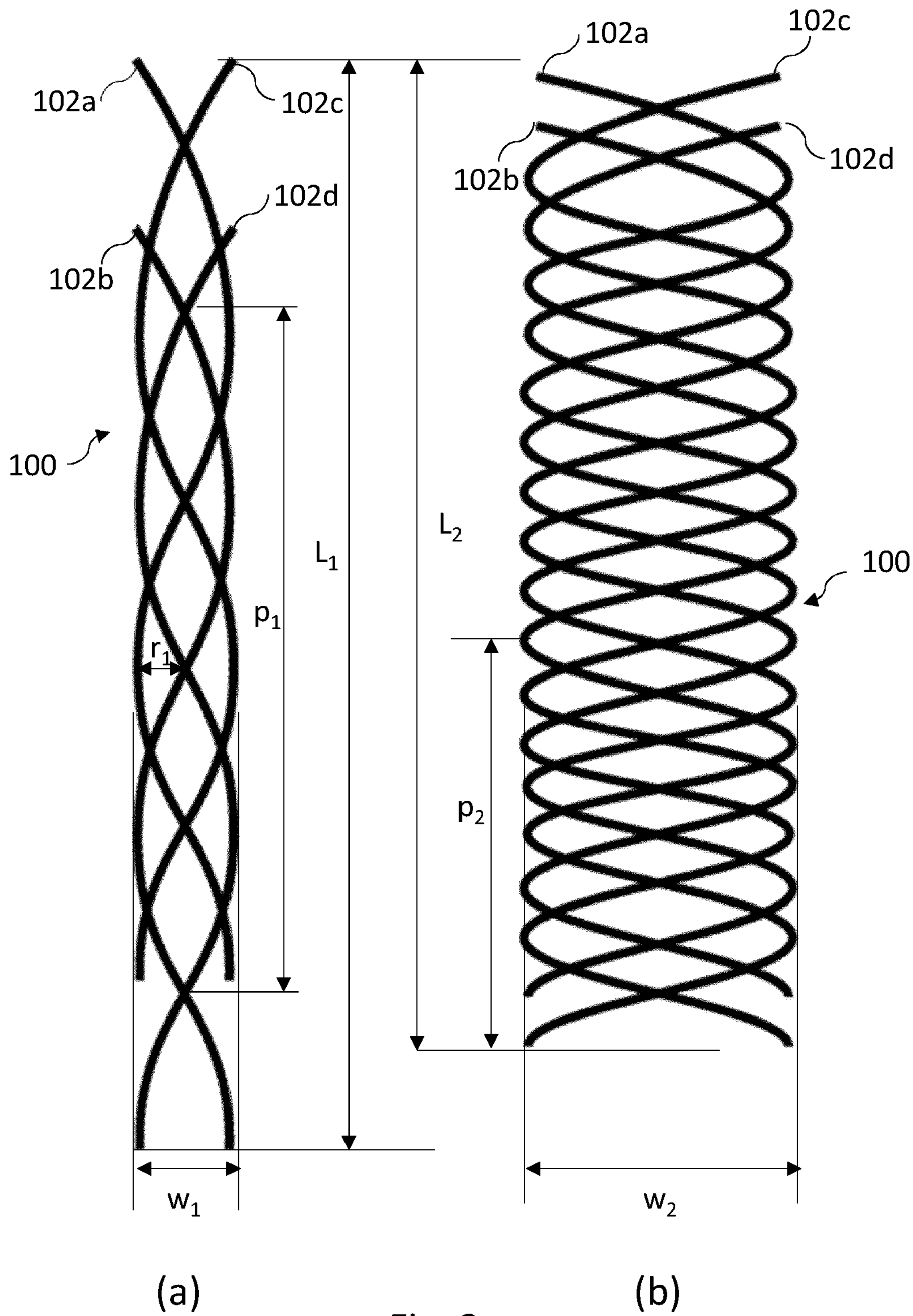


Fig. 1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102c
102d
102b
100
L1
p1
r1
w1
102a
102c
102b
102d
L2
100
p2
w2
(a)
(b)

Fig. 2

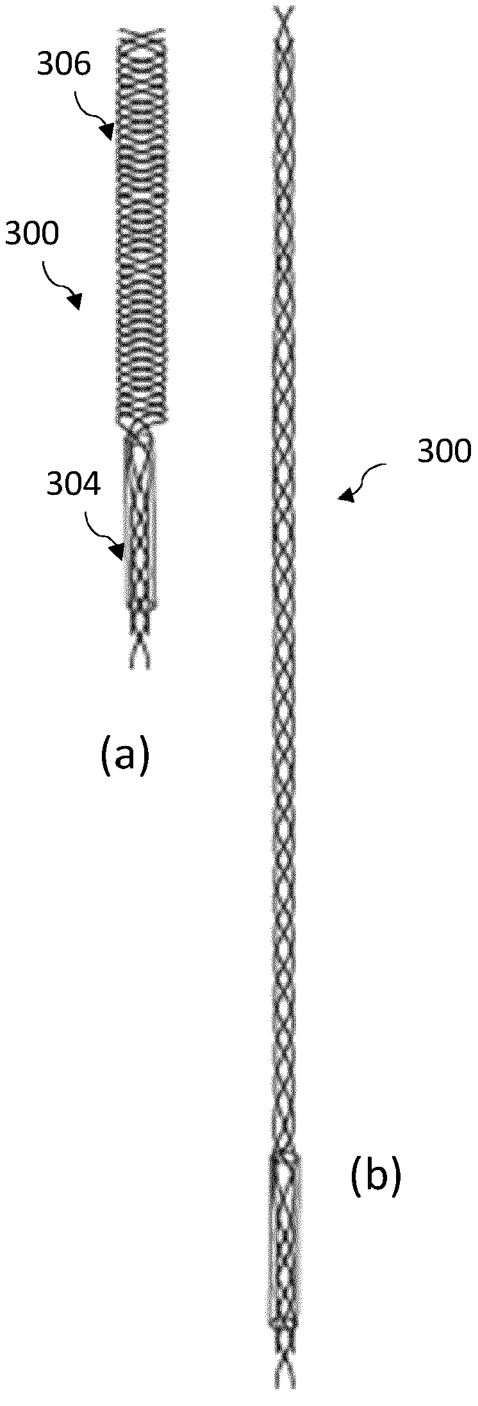

Fig. 3

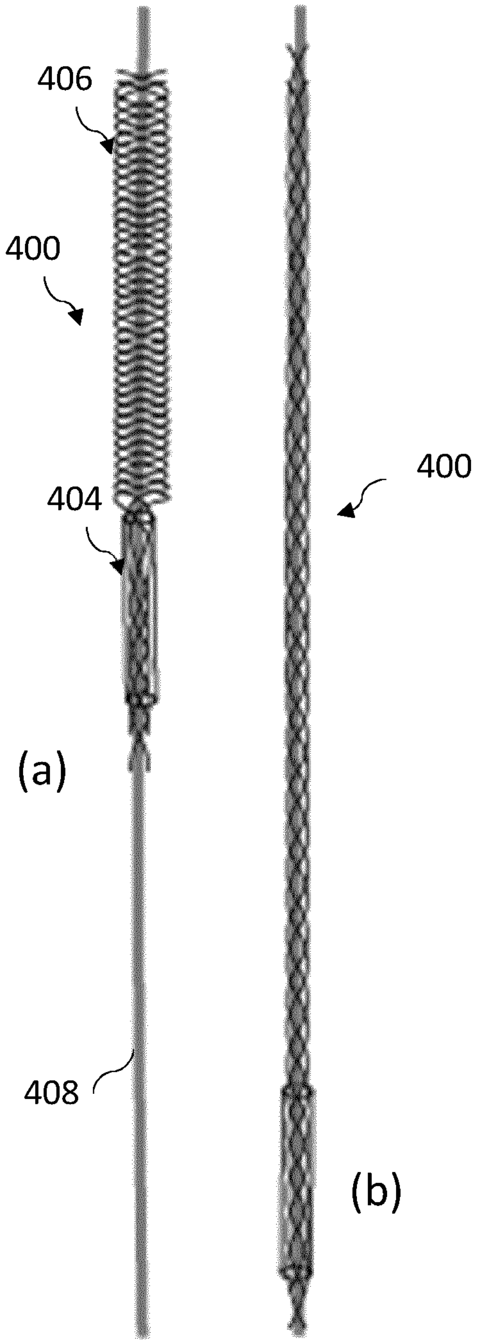

Fig. 4

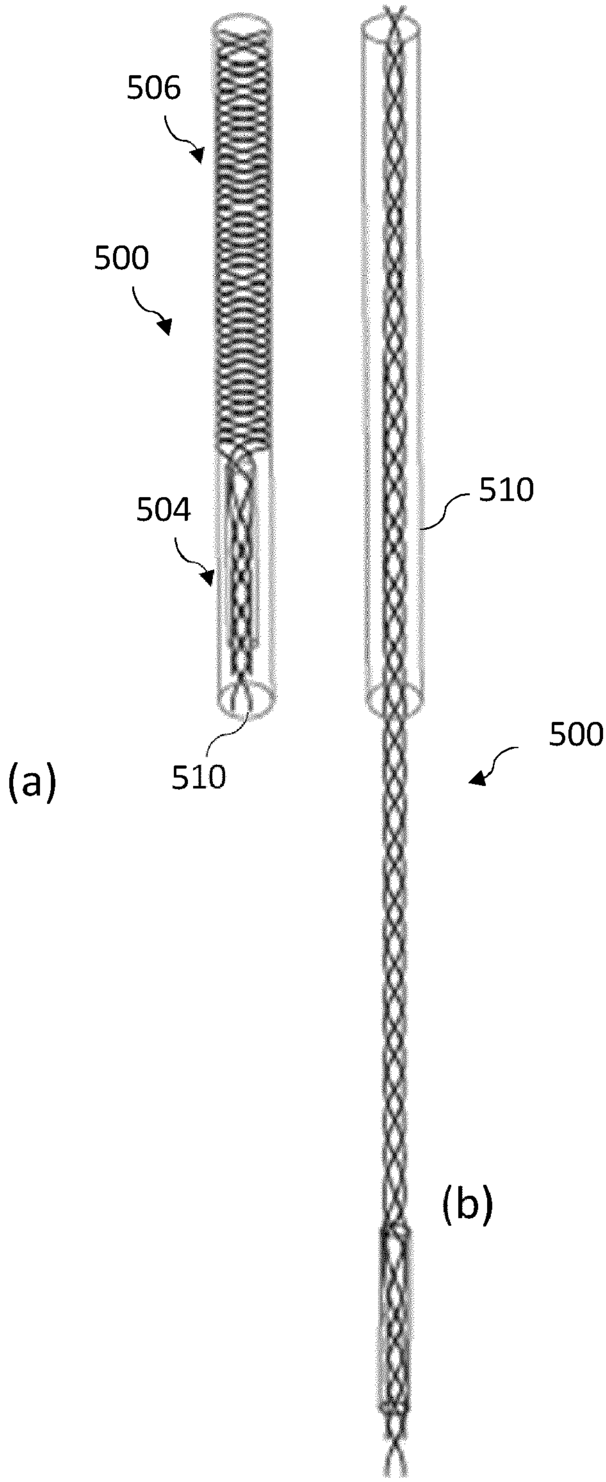

Fig. 5

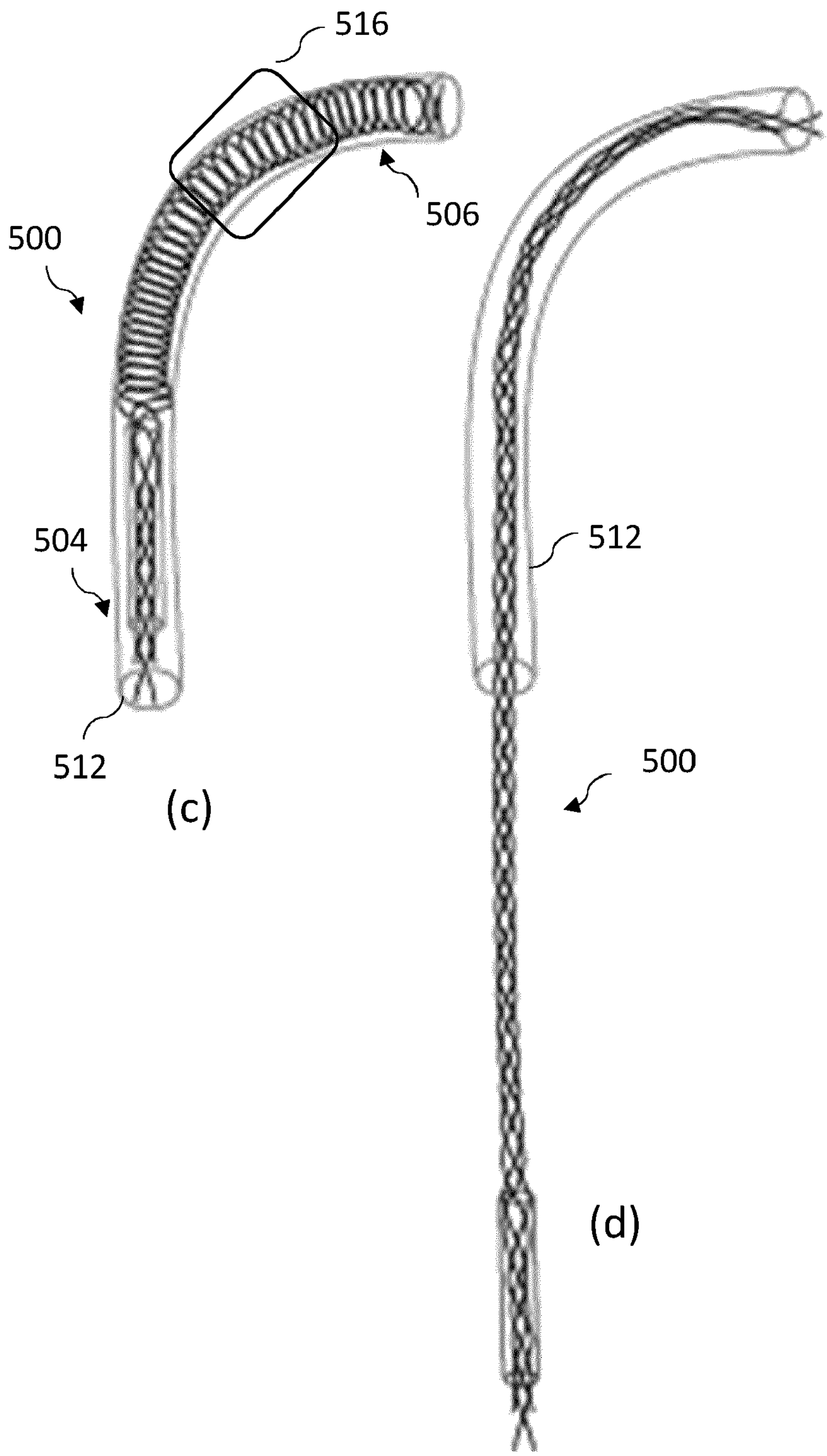

Fig. 5

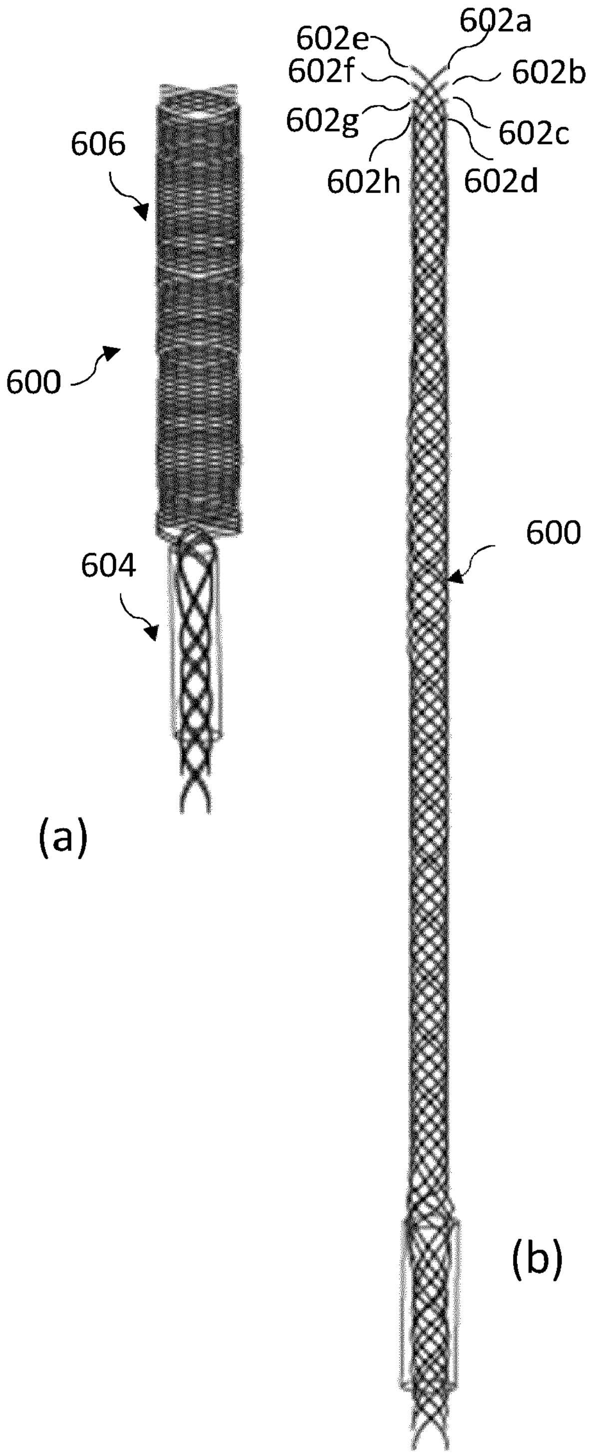

Fig. 6

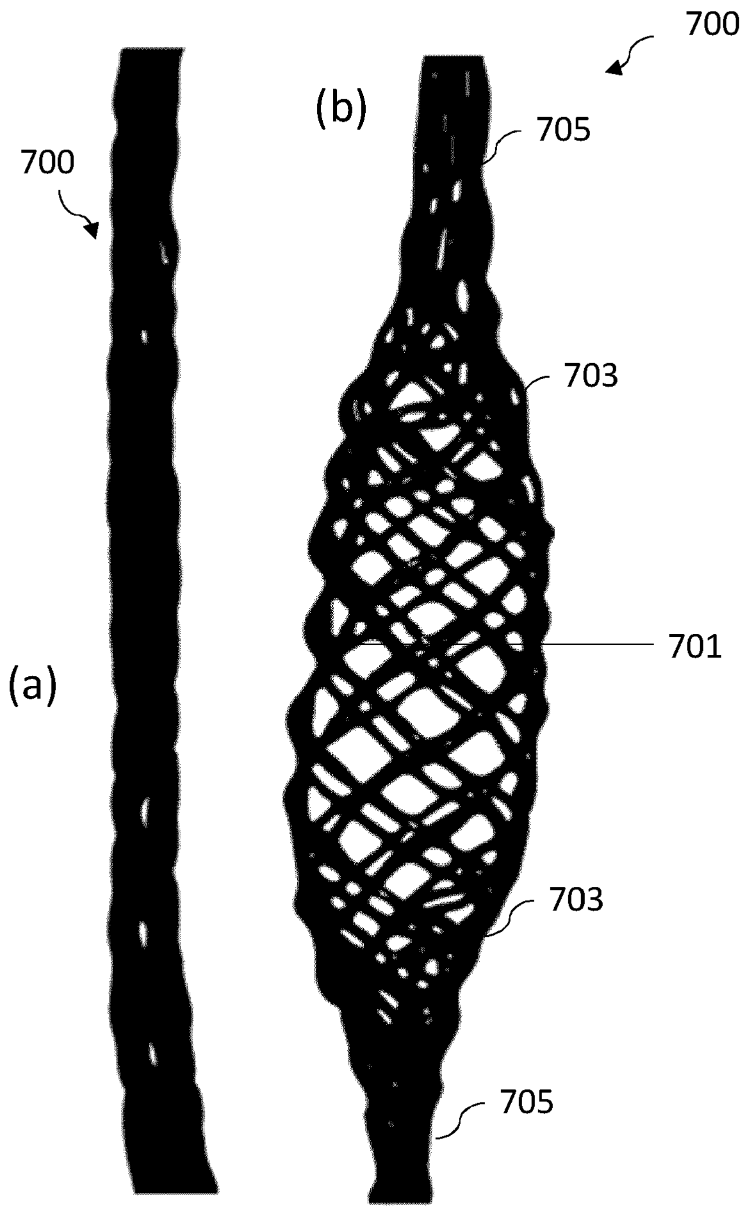

Fig. 7

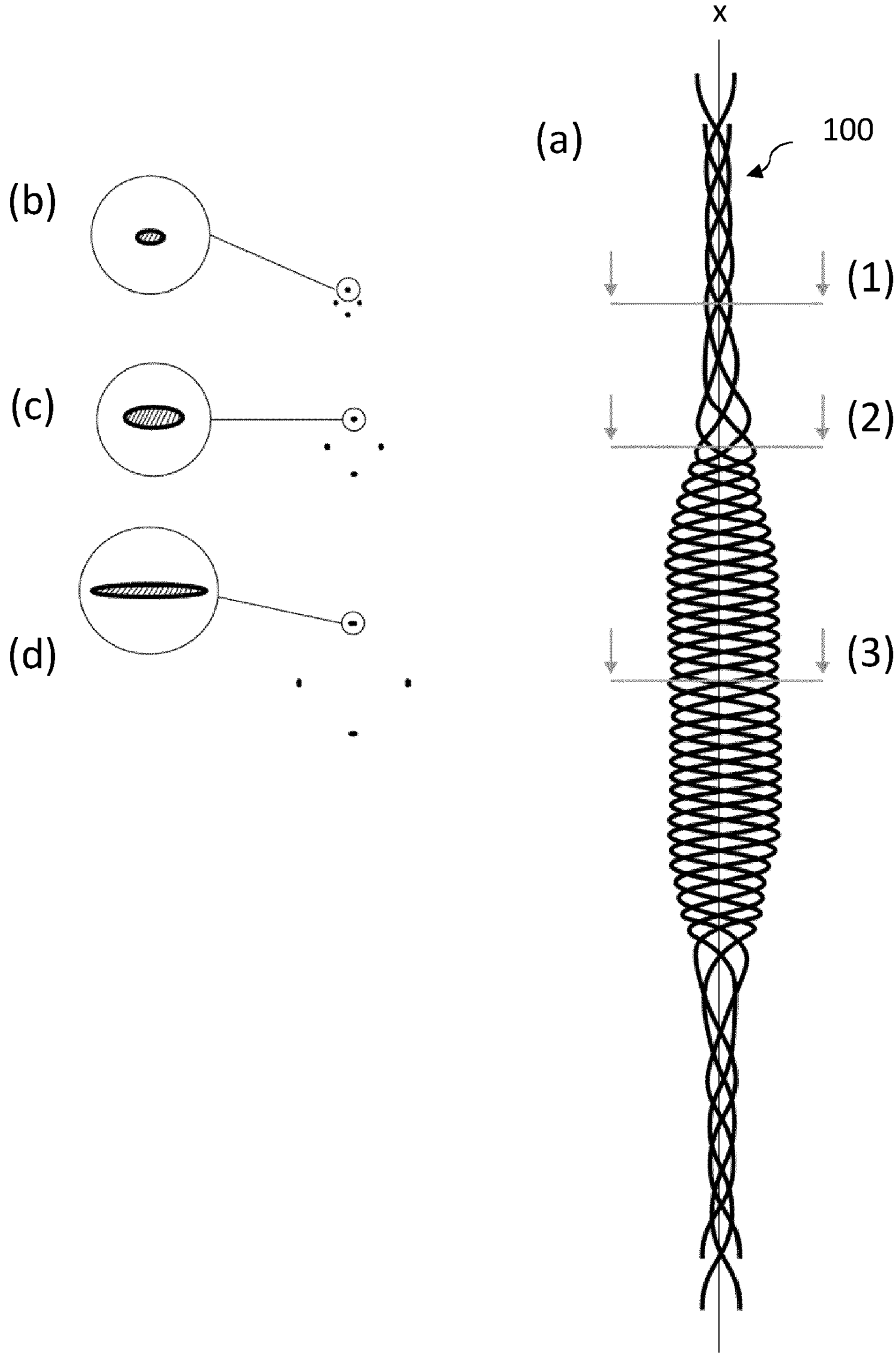

Fig. 8

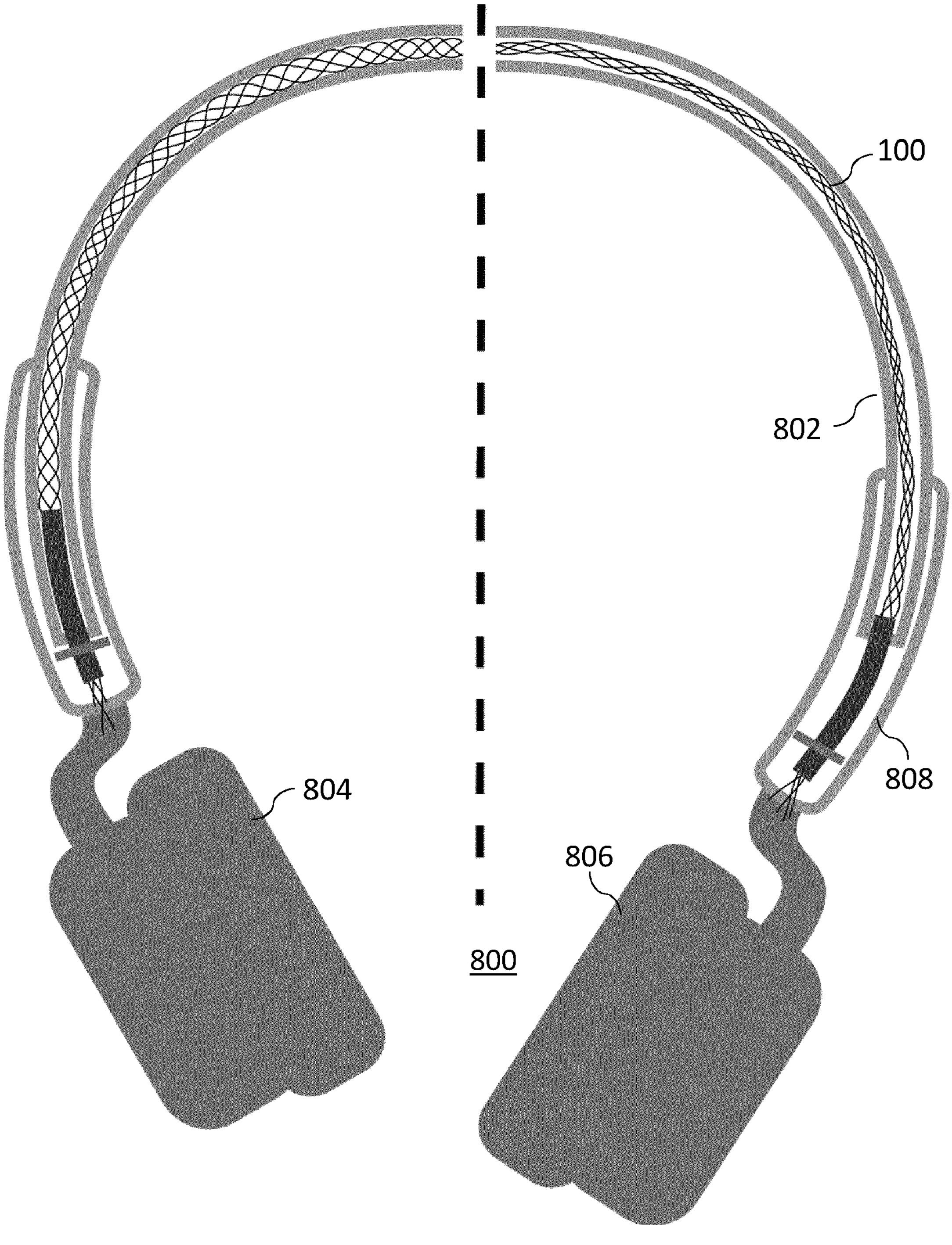

Fig. 9

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
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