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(54) **Title**: ATTACHMENT RING FOR ATTACHING A SHIELD OF AN ELECTRICAL CABLE TO BACKSHELL

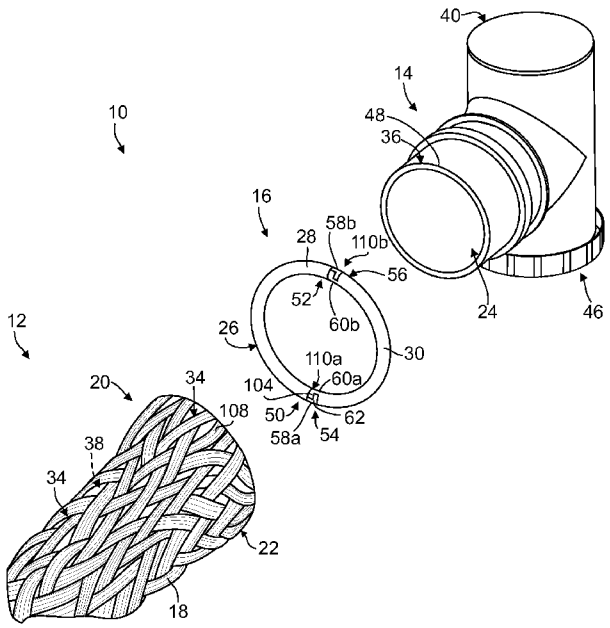


FIG. 2

(57) **Abstract**: An attachment ring (16) is provided for attaching a shield (18) of an electrical cable (12) to a backshell (14). The attachment ring includes an annular body (26) including a shape memory material that is heat recoverable. The body is configured to extend at least partially around the shield and a fitting (24) of the backshell to hold the shield on the fitting in contact with the fitting. The body includes a first segment (28) including an end (50) having a connection member (58a). The body also includes a second segment (30) that is discrete from the first segment. The second segment includes an end (54) having a connection feature (60a). The connection feature of the second segment is interlocked with the connection member of the first segment to connect the first and second segments together at the ends such that the first and second segments define at least a portion of a length of the body.

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ATTACHMENT RING FOR ATTACHING A SHIELD OF AN ELECTRICAL CABLE TO A BACKSHELL

BACKGROUND OF THE INVENTION

[0001] The subject matter described and/or illustrated herein relates generally to electrical cables, and more particularly, to attachment rings for attaching a shield of an electrical cable to a backshell.

[0002] Many electrical cables include an electrically conductive shield that extends around one or more insulated electrical conductors of the cable. The shield blocks electrical interference between the electrical conductors of the cable and the electrical conductors of neighboring cables and/or other neighboring electrical devices. An end of an electrical cable is sometimes terminated to an electrical connector to facilitate electrical connection of the electrical cable to another electrical cable or another electrical device. When terminated to an electrical connector, the shield of an electrical cable may be attached to a backshell that is connected to the electrical connector. The backshell may be used, for example, to protect, electrically shield, and/or provide strain relief to the connection points between the electrical conductors of the electrical cable and the corresponding electrical contacts of the electrical connector.

[0003] One method of attaching the shield of an electrical cable to a backshell includes receiving an end of the shield over a fitting of the backshell. An attachment ring fabricated from a shape memory material that is heat recoverable is sometimes used to hold the end of the shield on the fitting. Specifically, the attachment ring is positioned to extend around the circumference of the shield end. Heat is then applied externally by a heat source or generated by the application of current to the attachment ring. The heat applied to the attachment ring recovers, e.g., shrinks, the attachment ring into engagement with the end of the shield. The engagement between the end of the shield and the attachment ring holds the end of the shield on the fitting between the attachment ring and the fitting.

[0004] At least some known attachment rings are one-piece continuous rings. Accordingly, the attachment ring is typically positioned over the end of the shield before the end of the shield is received over the fitting of the backshell. In other words, the end of the shield and the insulated electrical conductors of the electrical cable are fed through the attachment ring before the end of the shield is received over the fitting. But, positioning the attachment ring over the end of the shield before the shield is received over the fitting may be

time consuming and/or difficult, which may increase a cost of terminating the electrical cable to the electrical connector and/or may decrease the number of electrical cables that can be terminated to electrical connectors within a given time period. For example, it may be difficult to hold the attachment ring in position over the end of the shield as the end of the shield is received over the fitting. Rather, the attachment ring may move along the length of the electrical cable in a direction away from the end that is being terminated to the electrical connector and toward the other end of the electrical cable. Once the end of the shield is received over the fitting of the backshell, it may be time consuming and/or frustrating for a person to locate the attachment ring along the length of the cable and position the attachment ring back over the end of the shield.

[0005] Moreover, the only way to position a one-piece continuous attachment ring over the end of the shield after the end of the shield is received over the fitting is to position the attachment ring over the other end of the cable. The attachment ring must then be moved along the entire length of the electrical cable to the end that is being terminated to the electrical connector, which may also be time consuming and/or difficult. Positioning the attachment ring over the other end of the cable and moving the attachment ring along the entire length of the cable may also require that the other end of the cable is not terminated and/or mechanically connected to an electrical connector or other electrical device.

[0006] Another disadvantage of at least some known attachment rings is removal of the attachment rings from the shield. An attachment ring may be removed from a shield during disassembly of the end of the electrical cable from the electrical connector to enable the shield to be removed from the fitting of the backshell. Another reason for removing an attachment ring is if the actual diameter of the circumference of the shield is greater than the estimated diameter for which the size of the attachment ring was selected, for example because additional components were added between the fitting and the shield and/or because of a greater than expected dimensional variance of the shield. Known methods for removing a one-piece continuous attachment ring from a shield include cutting the attachment ring. However, due to the relatively strong shape memory materials that are used to fabricate at least some known attachment rings, cutting the attachment ring may be difficult, time consuming, and/or require special tooling (e.g., an electrical power tool and/or the like). Moreover, cutting the attachment ring may damage the fitting of the backshell, the electrical cable, and/or the shield in the proximity of the cutting operation, which may result in a costly repair.

BRIEF DESCRIPTION OF THE INVENTION

[0007] In one embodiment, an attachment ring is provided for attaching a shield of an electrical cable to a backshell. The attachment ring includes an annular body including a shape memory material that is heat recoverable. The body is configured to extend at least partially around the shield and a fitting of the backshell to hold the shield on the fitting in contact with the fitting. The body includes a first segment including an end having a connection member. The body also includes a second segment that is discrete from the first segment. The second segment includes an end having a connection feature. The connection feature of the second segment is interlocked with the connection member of the first segment to connect the first and second segments together at the ends such that the first and second segments define at least a portion of a length of the body.

[0008] In another embodiment, an electrical cable assembly includes an electrical cable having a shield. The electrical cable assembly also includes a backshell having a fitting. The shield of the electrical cable is received over the fitting. The electrical cable assembly further includes an attachment ring for attaching the shield to the fitting. The attachment ring includes an annular body including a shape memory material that is heat recoverable. The body is configured to extend at least partially around the shield and the fitting of the backshell to hold the shield on the fitting in contact with the fitting. The body includes a first segment including an end having a connection member. The body includes a second segment that is discrete from the first segment. The second segment includes an end having a connection feature. The connection feature of the second segment is interlocked with the connection member of the first segment to connect the first and second segments together at the ends such that the first and second segments define at least a portion of a length of the body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a perspective view of a portion of an exemplary embodiment of an electrical cable assembly.

[0010] Figure 2 is a partially exploded perspective view of the electrical cable assembly shown in Figure 1.

[0011] Figure 3 is a perspective view of an exemplary embodiment of an attachment ring of the electrical cable assembly shown in Figure 1.

[0012] Figure 4 is an exploded perspective view of the attachment ring shown in Figure 3.

[0013] Figure 5 is an exploded perspective view of an exemplary alternative embodiment of an attachment ring.

[0014] Figure 6 is an exploded perspective view of another exemplary alternative embodiment of an attachment ring.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Figure 1 is a perspective view of a portion of an exemplary embodiment of an electrical cable assembly 10. The electrical cable assembly 10 includes an electrical cable 12, a backshell 14, and an attachment ring 16. The electrical cable 12 includes a shield 18. The backshell 14 is configured to be connected to an electrical connector (not shown) that terminates an end 20 of the electrical cable 12. The termination of the electrical cable end 20 to the electrical connector includes attaching an end 22 of the shield 18 to the backshell 14 using the attachment ring 16. More specifically, the end 22 of the shield 18 is received over a fitting 24 of the backshell 14. The attachment ring 16 extends at least partially around the end 22 of the shield 18 and the fitting 24 to hold the shield end 22 on the fitting 24 in contact with the fitting 24. As will be described in more detail below, the attachment ring 16 comprises a body 26 that includes at least two discrete segments 28 and 30 that are connected together to define a length L (Figure 3) of the body 26 that extends at least partially around a circumference 34 of the shield 18 (at the end 22) and a circumference 36 (Figure 2) of the fitting 24.

[0016] Figure 2 is a partially exploded perspective view of the electrical cable assembly 10. The electrical cable 12 extends a length from the end 20 to an opposite end (not shown). The electrical cable 12 includes one or more insulated conductor assemblies (not shown). Each insulated conductor assembly includes one or more electrical conductors (not shown) encapsulated by an electrically insulative layer (not shown). Some or all of the electrical conductors may be configured to carry electrical data signals. Optionally, the electrical conductors include one or more differential pairs of signal conductors. Some or all of the differential pairs are optionally arranged as twisted wire pairs. In some embodiments, one or more of the electrical conductors may be configured to carry electrical power and/or electrical ground. The electrical cable 12 may include any number of the insulated conductor assemblies, each of which may include any number of electrical conductors.

[0017] The shield 18 extends around the insulated conductor assemblies along at least a portion of the length of the electrical cable 12. The shield 18 includes a central passageway 38 that extends along the length of the shield 18 and receives the insulated conductor assemblies therein. The shield 18 facilitates shielding the insulated conductor assemblies of the electrical cable 12 from the electrical conductors (not shown) of neighboring cables (not shown) and/or other neighboring electrical devices (not shown). The shield 18 may be electrically connected to an electrical ground or other electrical source at one or both ends of the electrical cable 12. For example, the fitting 24 of the backshell 14 may provide an electrical connection between the end 22 of the shield 18 and an electrical ground or other electrical source. The shield 18 may be fabricated from any electrically conductive materials having any structure, such as, but not limited to, a conductive fabric, a conductive tape, a metallic (e.g., copper and/or the like) foil, aluminum/polyester (e.g., polyethylene terephthalate) tape, a conductive sleeve formed from one or more sheets of material, a braid of electrical conductor strands, and/or the like. In the exemplary embodiment, and as can be seen in Figures 1 and 2, the shield 18 is fabricated from a braid of electrical conductor strands.

[0018] Optionally, the electrical cable 10 includes an electrically insulative cable jacket (not shown) that extends around the circumference 34 of shield 18 along at least a portion of the length of the electrical cable 10. Although shown as including an approximately flat shape, the electrical cable 10 may additionally or alternatively include any other shape, such as, but not limited to, a cylindrical shape, a parallelepiped shape, and/or the like.

[0019] The backshell 14 includes a body 40, which includes the fitting 24. The backshell 14 includes a connection interface 46 at which the backshell 14 connects to the electrical connector (not shown). The electrical connector includes a plurality of electrical contacts (not shown) that include terminating segments (not shown)that terminate the electrical conductors of the electrical cable 12. More specifically, when the end 20 of the electrical cable 12 is terminated by the electrical connector, the terminating segments of the electrical contacts of the electrical connector are electrically connected to corresponding electrical conductors of the electrical cable 10 at corresponding connection points (not shown). The backshell 14 may surround the connection points to, for example, protect, electrically shield, and/or provide strain relief to the connection points.

[0020] The fitting 24 of the backshell 14 is configured to receive the end 22 of the shield 18 thereon in contact therewith. In the exemplary embodiment, the fitting 24 includes an approximately smooth outer surface 48 that receives the shield end 22 thereon. But, some or

all of the outer surface 48 of the fitting 24 may alternatively include a texture (such as, but not limited to, knurls, one or more threads, one or more grooves, one or more ridges, and/or the like) to, for example, facilitate providing friction and/or stiction between the shield 18 and the outer surface 48 of the fitting 24. In addition or alternative to providing friction and/or stiction, a ridge on the outer surface 48 may facilitate providing the fitting 24 with a portion that has a larger diameter than the attachment ring 16 after the body 26 of the attachment ring 16 has been shrunk into engagement with the end 22 of the shield 18, as will be described below. Such a larger-diameter ridge may prevent the attachment ring 16 from moving along the length of the electrical cable 12 off of the fitting 24. The outer surface 48 defines the circumference 36 of the fitting 24. When the end 20 of the electrical cable 12 is terminated by the electrical connector, the end 22 of the shield 18 is received over the fitting 24 in engagement with the outer surface 48 of the fitting 24. When the shield end 22 is received over the fitting 24, at least a portion of the fitting 24 is received within the central passageway 38 of the shield 18. Optionally, the body 40 of the backshell 14 is electrically conductive such that the engagement between the shield end 22 and the fitting 24 electrically connects the backshell 14 to the shield 18. The backshell 14 is optionally electrically connected to an electrical ground or other electrical source, for example via the electrical connector or otherwise.

[0021] Figure 3 is a perspective view of an exemplary embodiment of the attachment ring 16. The attachment ring 16 includes the body 26, which is configured to extend at least partially around the end 22 (Figures 1 and 2) of the shield 18 (Figures 1 and 2). More particularly, the body 26 extends the length L, which in the exemplary embodiment of the body 26 extends along a continuous annular path. In other words, the length L of the body 26 defines an annular shape of the body 26 that is continuous along the length L. The length L of the body 26 is configured to extend at least partially around the circumferences 34 and 36 (Figures 1 and 2) of the shield 18 (at the end 22) and the fitting 24 (Figures 1 and 2), respectively, to hold the shield end 22 on the fitting 24 in contact with the fitting 24. Specifically, the body 26 engages the shield end 22 to hold the shield end 22 between the fitting 24 and the body 26. In the exemplary embodiment of the body 26, the continuous length L of the body 26 extends around an entirety of the circumferences 34 and 36. But, the length L of the body 26 may alternatively be non-continuous such that the length L of the body 26 extends around only a portion of the circumferences 34 and 36. In such embodiments wherein the length L of the body 26 is not continuous, two segments (e.g., the segments 28 and 30) of the body 26 will have ends (e.g., the ends 52 and 56) that oppose each other, are spaced apart by a gap, and may not include any mechanical connectors.

[0022] At least a portion of the body 26 of the attachment ring 16 is fabricated from one or more shape memory materials that recover upon exposure to a heat source. In other words, at least a portion of the body 26 of the attachment ring 16 is heat recoverable such that at least a portion of the body 26 shrinks upon the application of heat thereto. As will be described below, the body 26 of the attachment ring 16 is positioned over the end 22 of the shield 18 and exposed to a heat source (not shown) to shrink the body 26 into engagement with the shield end 22. The body 26 may be fabricated from one or more shape memory materials, such as, but not limited to, a titanium/nickel-based alloy, a titanium/nickel/niobium alloy, a titanium/nickel/iron alloy, a copper based alloy, and/or the like.

[0023] Figure 4 is an exploded perspective view of the attachment ring 16. As briefly described above, the body 26 of the attachment ring 16 includes at least two segments 28 and 30. The segments 28 and 30 are discrete from each other and are connected together to define the length L (Figure 3) of the body 26. The exemplary embodiment of the body 26 includes two segments 28 and 30 that connect together to define an entirety of the length L of the body 26. But, the body 26 may include any number of segments that define the entirety of the length L of the body 26. As used herein, the term "discrete" is intended to mean constituting a separate part or component. In some embodiments, the discrete segments 28 and 30 are separately formed from each other. In other embodiments, the segments 28 and 30 are formed integrally with each other and are thereafter severed from each other. Once severed, the segments 28 and 30 are separate components from each other that may be connected together. Each of the segments 28 and 30 may be referred to herein as a "first segment" and/or a "second segment".

[0024] The segment 28 extends a length from an end 50 to an opposite end 52. Similarly, the segment 30 extends a length from an end 54 to an opposite end 56. In the exemplary embodiment of the body 26, each of ends 50 and 52 of the segment 28 includes a mechanical connector 58a and 58b, respectively, and each of the ends 54 and 56 of the segment 30 includes a mechanical connector 60a and 60b, respectively. The mechanical connector 58a of the end 50 of the segment 28 interlocks with the mechanical connector 60a of the end 54 of the segment 30 to connect the segments 28 and 30 together at the ends 50 and 54. Similarly, the mechanical connector 58b of the end 52 of the segment 28 interlocks with the mechanical connector 60b of the end 56 of the segment 30 to connect the segments 28 and 30 together at the ends 52 and 56. In the exemplary embodiment of the body 26, when the ends 50 and 54 are connected together and the ends 52 and 56 are connected together, the segments 28 and 30 define the entirety of the continuous length L of the body 26. In the exemplary

embodiment of the body 26, each of the segments 28 and 30 includes a circular cross-sectional shape. But, each segment 28 and 30 may additionally or alternatively include any other cross-sectional shape, such as, but not limited to, a quadrilateral shape, an oval shape, and/or the like. The mechanical connectors 58a, 58b, 60a, and 60b may each be referred to herein as a "connection member" and/or a "connection feature".

[0025] Optionally, the mechanical connectors 58a, 58b, 60a, and/or 60b are fabricated from the shape memory material(s) that recovers upon exposure to a heat source. In the exemplary embodiment of the body 26, the mechanical connectors 58a and 58b are substantially identical to each other, and the mechanical connectors 60a and 60b are substantially identical to each other. Accordingly, only the structure of the mechanical connectors 58a and 60a will be described herein in detail. Referring now to Detail A of Figure 4, the mechanical connector 58a includes a latch projection 62 having a notch 64 and an end 66. Optionally, the notch 64 extends into a radially inner side 68 of the latch projection 62. The notch 64 is defined by two walls 70 and 72 that intersect at an apex 74. The wall 72 defines a latch shoulder 76 of the latch projection 62. The end 66 of the latch projection 62 extends from the wall 72 to an end wall 78 of the latch projection 62. As will be described below, the latch projection 62 is configured to be received within a groove 80 of the mechanical connector 60a to connect the ends 50 and 54 of the segments 28 and 30, respectively, together. When the latch projection 62 is fully received within the groove 80, the notch 64 receives an embossment 82 of the mechanical connector 60a therein to interlock the connectors 58a and 60a together. More particularly, when the embossment 82 is received within the notch 64, the latch shoulder 76 of the latch projection 62 engages a latch shoulder 84 of the embossment 82 to interlock the connectors 58a and 60a together.

[0026] The walls 70 and 72 of the notch 64 may extend at any angle to each other. Although shown as being approximately planar, the wall 70 and/or the wall 72 may alternatively include a curved shape, a texture (such as, but not limited to, knurls, one or more threads, one or more grooves, one or more ridges, and/or the like), and/or the like. Moreover, rather than meeting at a pointed apex 74 as shown in the exemplary embodiment of the body 26, the walls 70 and 72 may meet at a curved apex (not shown). In the exemplary embodiment of the body 26, the notch 64 includes a triangular shape that is complementary with a shape of the embossment 82. But, the notch 64 may additionally or alternatively include any other shape besides triangular, whether or not the notch 64 includes a shape that is complementary with any shapes of the embossment 82.

[0027] The latch projection 62 may include any shape for being received within a groove 80 that includes any shape. In the exemplary embodiment of the body 26, excepting the notch 64, the latch projection 62 includes the shape of a parallelepiped. But, the latch projection 62 may additionally or alternatively include any other shape besides the shape of a parallelepiped. Optionally, the latch projection 62 includes a shape that is complementary with one or more shapes of the groove 80.

[0028] Referring now to Detail B of Figure 4, the mechanical connector 60a includes the groove 80, which extends into the end 54 of the segment 30. Optionally, the groove 80 extends through an end wall 86 of the end 54 of the segment 30. The groove 80 extends a length into the end 54 to an end wall 88 of the groove 80. The groove 80 includes a bottom side 90. The embossment 82 extends outwardly at the bottom side 90 of the groove 80 toward a top side 92 of the groove 80. The embossment 82 is defined by two walls 94 and 96 that intersect at an apex 98. The wall 96 defines the latch shoulder 84 of the embossment 82, while the wall 94 defines a latch ramp 100 of the embossment 82. The latch ramp 100 slopes outwardly at the bottom side 90 to the apex 98. The groove 80 includes a recess 102 defined between the wall 96 and the end wall 88 of the groove 80. As will be described below, the recess 102 receives the latch projection end 66 of the mechanical connector 58a therein when the latch projection 62 is fully received within the groove 80.

[0029] Optionally, the mechanical connector 60a includes one or more anti-twist members 104 that, as will be described below, engage the latch projection 62 to hold the latch projection 62 within the groove 80 when the body 26 is twisted. In the exemplary embodiment of the body 26, the mechanical connector 60a includes two opposing anti-twist members 104. The anti-twist members 104 extend outwardly from the bottom side 90 of the groove 80 to the top side 92. The anti-twist members 104 include side walls 106 that oppose each other and define side walls of the groove 80. In the exemplary embodiment of the body 26, each anti-twist member 104 extends from the end wall 86 of the segment end 54 toward the end wall 88 along only a portion of the length of the groove 80. In other words, each anti-twist member 104 extends from the end wall 86 of the segment end 54 but does not extend all the way to the end wall 88 of the groove 80. Accordingly, the side walls 106 extend along only a portion of the length of the groove 80. Alternatively, one or both of the anti-twist members 104 extends along an entirety of the length of the groove 80 or is located at a different location along the length of the groove 80. For example, in some alternative embodiments, one or both of the anti-twist members 104 extends from and/or proximate the end wall 88 of the groove 80.

[0030] The groove 80 may include any shape for receiving a latch projection 62 that includes any shape. Optionally, the groove 80 includes a shape that is complementary with one or more shapes of the latch projection 62. The embossment 82 may include any shape for being received within a notch 64 that includes any shape. In the exemplary embodiment of the body 26, the embossment 82 includes a triangular shape that is complementary with the triangular shape of the notch 64. But, the embossment 82 may additionally or alternatively include any other shape besides triangular, whether or not the embossment 82 includes a shape that is complementary with any shapes of the notch 64. The walls 94 and 96 of the embossment 82 may extend at any angle to each other, and the wall 94 may have any amount of slope to define a latch ramp 100 having any amount of slope. The wall 94 and 96 are not limited to the approximately planar shape shown herein. Rather, the walls 94 and/or 96 may alternatively include a curved shape, a texture (such as, but not limited to, knurls, one or more threads, one or more grooves, one or more ridges, and/or the like), and/or the like. Moreover, rather than meeting at a pointed apex 98 as shown in the exemplary embodiment of the body 26, the walls 94 and 96 may meet at a curved apex (not shown). Although shown as including the shape of a parallelepiped, the recess 102 may include any shape for receiving a latch projection end 66 that includes any shapes.

[0031] To connect the end 50 of the segment 28 to the end 54 of the segment 30, the latch projection 62 of the mechanical connector 58a is inserted into the groove 80 of the mechanical connector 60a. The end 66 of the latch projection 62 engages the latch ramp 100 of the embossment 82 when the latch projection 62 is initially received into the groove 80. As the latch projection 62 is inserted further into the groove 80, the latch projection end 66 rides along the latch ramp 100 until the latch shoulder 76 of the latch projection 62 moves past the apex 98. Once the latch shoulder 76 has cleared the apex 98, the end 66 of the latch projection 62 moves toward the bottom side 90 of the groove 80 and into the recess 102. In other words, the latch projection end 66 snaps into the recess 102 such that the mechanical connectors 58a and 60a interlock together with a snap-fit arrangement. The segment 28 may bend along the length of the segment 28 to enable the end 66 of the latch projection 62 to ride along the latch ramp 100 and snap into the recess 102. Additionally or alternatively, the latch projection 62 may bend to enable the end 66 of the latch projection 62 to ride along the latch ramp 100 and snap into the recess 102.

[0032] Referring again to Figure 3, the ends 50 and 54 of the segments 28 and 30, respectively, are shown connected together. When the mechanical connectors 58a and 60a are interlocked together as shown in Figure 3, the latch shoulders 76 and 84 engage each

other to hold the mechanical connectors 58a and 60a together. The anti-twist members 104 engage the latch projection 62 to hold the latch projection 62 within the groove 80. More particularly, the side walls 106 (Figure 4) of the anti-twist members 104 engage the latch projection 62 to prevent the latch projection 62 from moving out of the groove 80 in the directions into and out of the page, indicated by the arrows A and B, respectively, in Figure 3. For example, twisting the body 26 of the attachment ring 16 may exert a force on the latch projection 62 in the directions A and/or B. The side walls 106 (Figure 4) of the anti-twist members 104 prevent the latch projection 62 from moving out of the groove 80 in the directions A and/or B to hold the mechanical connectors 58a and 60a together.

[0033] Figure 3 also illustrates the ends 52 and 56 of the segments 28 and 30, respectively, connected together. The mechanical connectors 58b and 60b interlock together in a substantially similar manner to the mechanical connectors 58a and 60a and therefore connection of the ends 52 and 56 of the segments 28 and 30, respectively, will not be described in more detail herein.

[0034] Referring again to Figure 2, to attach the end 22 of the shield 18 to the backshell 14, the shield end 22 is received over the fitting 24 of the backshell 14. The body 26 of the attachment ring 16 is then positioned over the end 22 of the shield 18. Specifically, the segments 28 and 30 are assembled over the end 22 of the shield 18. The ends 50 and 54 of the segments 28 and 30, respectively, are connected together by interlocking the mechanical connectors 58a and 60a as described above. Likewise, the ends 52 and 56 of the segments 28 and 30, respectively, are connected together by interlocking the mechanical connectors 58b and 60b. Heat is then applied to the body 26 of the attachment ring 16 to recover, e.g., shrink, the body 26 into engagement with the end 22 of the shield 18. More particularly, exposing the body 26 to heat causes the diameter of the body 26 to reduce such that the body 26 engages a radially outer surface 108 of the shield 18. The length L of the body 26 extends at least partially around the circumferences 34 and 36 of the shield 18 (at the end 22) and the fitting 24. The body 26 thereby holds the shield end 22 between the fitting 24 and the body 26, as can be seen in Figure 1. When the mechanical connectors 58a, 58b, 60a, and/or 60b are fabricated from the shape memory material(s), shrinkage of a portion or all of the mechanical connectors 58a, 58b, 60a, and/or 60b may facilitate increasing the strength of the interlocking connection between the mechanical connectors 58a and 60a and/or the mechanical connectors 58b and 60b.

[0035] Although the body 26 of the attachment ring 16 is described above as being assembled over the end 22 of the shield 18 after the shield end 22 is received over the fitting

24, the body 26 of the attachment ring 16 may be positioned over the shield end 22 before the shield end 22 is received over the fitting 24 (whether or not the segments 28 and 30 are connected together before the shield end 22 is received over the fitting 24). Heat may be applied to the body 26 of the attachment ring using any suitable method, structure, means, and/or the like, such as, but not limited to, thermally (e.g., using a heat gun, an oven, and/or the like), electrically (e.g., resistance heating and/or the like), and/or the like. Optionally, if heat is applied to the body 26 electrically, the body 26 may include an electrically insulating layer (not shown) that electrically isolates the body 26 from the shield 18 to force electrical current to flow through the body 26 during the electrical heating.

[0036] The discrete segments 28 and 30 that make up the body 26 of the attachment ring enable the attachment ring 16 to be assembled over the end 22 of the shield 18 after the shield end 22 has been received over the fitting 24 of the backshell 14, which is sometimes referred to as "side-entry" of the attachment ring 16. Accordingly, the end 22 of the shield 18 and the insulated electrical conductors of the electrical cable 12 do not need to be fed through the attachment ring 16 to position the attachment ring 16 over the shield end 22. Moreover, the side-entry of the body 26 of the attachment ring 16 enables the attachment ring 16 to be positioned over the shield end 22 after the shield 22 has been received over the fitting 24 without positioning the attachment ring 16 over the other end of the shield 22 and moving the attachment ring 16 along the entire length of the electrical cable 12 to the shield end 22.

[0037] When it is desired to remove the attachment ring 16 from the shield 18 (e.g., to disassemble the end 20 of the electrical cable 12 from the electrical connector, and/or the like), the body 26 can be broken at a joint 110a between the mechanical connectors 58a and 60a and/or at a joint 110b between the mechanical connectors 58b and 60b. For example, twisting of the body 26 at the joint 110a and/or 110b will break one or both of the corresponding anti-twist members 104 and/or the corresponding latch projection 62 to enable the segments 28 and 30 to come apart at the joint 110a and/or 110b. The body 26 may be twisted at the joint 110a and/or 110b using any hand tool, such as, but not limited to, pliers, vice-grips, and/or the like. The anti-twist members 104 and the latch projection 62 are fabricated with a strength such that the segments 28 and 30 will not come apart during twisting of the body 26 during normal use, operation, and/or life of the attachment ring 16. However, the anti-twist members 104 and/or the latch projection 62 are fabricated with a strength that enables the anti-twist members 104 and/or the latch projection 62 to break when twisted at the joint 110a and/or 110b using the hand tool.

[0038] As described above, in the exemplary embodiment of the body 26, the mechanical connector 58a of the end 50 of the segment 28 of the body 26 is substantially identical to the mechanical connector 58b of the end 52 of the segment 28. Similarly, the mechanical connector 60a of the end 54 of the segment 30 is substantially identical to the mechanical connector 60b of the end 56 of the segment 30. However, the mechanical connector 58a of the end 50 of the segment 28 may alternatively have a different structure than the mechanical connector 58b of the end 52 of the segment 28. Similarly, the mechanical connector 60a of the end 54 of the segment 30 may alternatively have a different structure than the mechanical connector 60b of the end 56 of the segment 30. For example, the end 52 of the segment 28 could include a mechanical connector 60a and the end 56 of the segment 30 could include a mechanical connector 58a. Moreover, the structures of the mechanical connectors 58a and 60a that connects the segment ends 50 and 54 together may be different than the structures of the mechanical connectors 58b and 60b that connect the segment ends 52 and 56 together. For example, while the mechanical connectors 58a and 60a may have the structures described above and illustrated in Figures 1-4, the mechanical connectors 58b and 60b may have other structures, such as, but not limited to, the structures of the mechanical connectors 258a, 260a, 258b, and/or 260b or the structures of the mechanical connectors 458a, 460a, 458b, and/or 460b.

[0039] Figure 5 is an exploded perspective view of an exemplary alternative embodiment of an attachment ring 216. The attachment ring 216 includes a body 226, which is configured to extend at least partially around the end 22 (Figures 1 and 2) of the shield 18 (Figures 1 and 2). The body 226 of the attachment ring 216 includes at least two segments 228 and 230. The segments 228 and 230 are discrete from each other and are connected together to define the length of the body 226. As will be described below, the segments 228 and 230 of the body 226 are hermaphroditic. Each of the segments 228 and 230 may be referred to herein as a "first segment" and/or a "second segment".

[0040] The segment 228 extends a length from an end 250 to an opposite end 252. Similarly, the segment 230 extends a length from an end 254 to an opposite end 256. Each of ends 250 and 252 of the segment 228 includes a respective mechanical connector 258a and 260b and each of the ends 254 and 256 of the segment 230 includes a mechanical connector 260a and 258b, respectively. The mechanical connector 258a of the end 250 of the segment 228 interlocks with the mechanical connector 260a of the end 254 of the segment 230 to connect the segments 228 and 230 together at the ends 250 and 254. Similarly, the mechanical connector 260b of the end 252 of the segment 228 interlocks with the mechanical

connector 258b of the end 256 of the segment 230 to connect the segments 228 and 230 together at the ends 252 and 256. The mechanical connector 258a of the segment 228 is substantially identical to the mechanical connector 258b of the segment 230. Similarly, the mechanical connector 260b of the segment 228 is substantially identical to the mechanical connector 260a of the segment 230. Accordingly, the segments 228 and 230 are hermaphroditic. The mechanical connectors 258a, 258b, 260a, and 260b may each be referred to herein as a "connection member" and/or a "connection feature".

[0041] The mechanical connector 258a includes a latch projection 262 having a base 264 and an end 266. The base 264 includes two opposite walls 270 and 272 that define latch shoulders 276 of the latch projection 262. The end 266 of the latch projection 262 includes two opposing anti-twist members 277 that also define latch shoulders 278 of the latch projection 262. The mechanical connector 260a includes a groove 280, which extends into the end 254 of the segment 230. For clarity, some of the substantially identical elements/components of the mechanical connector 260b have been labeled in Figure 5 to better illustrate the structure of the mechanical connector 260a. Optionally, the groove 280 extends through an end wall 286 of the end 254 of the segment 230. The groove 280 includes a groove segment 288 that extends between opposing anti-twist members 304 of the mechanical connector 260a. The anti-twist members 304 define opposing latch shoulders 290 of the groove 280. The groove 280 also includes a base 292 having two opposite walls 294 and 296 that define latch shoulders 298 of the groove 280.

[0042] To connect the end 250 of the segment 228 to the end 254 of the segment 230, the latch projection 262 of the mechanical connector 258a is inserted into the groove 280 of the mechanical connector 260a. The anti-twist members 277 of the end 266 of the latch projection 262 straddle the base 292 of the groove 280 such that the latch shoulders 278 of the latch projection 262 engage the corresponding latch shoulders 298 of the groove base 292. The base 264 of the latch projection 262 is received within groove segment 288 of the groove 280 such that the anti-twist members 304 of the groove 280 straddle the base 264 of the latch projection 262. The latch shoulders 276 of the base 264 of the latch projection 262 engage the corresponding latch shoulders 290 of the groove 280. When the mechanical connectors 258a and 260a are interlocked together as described above, the engagement between the latch shoulders 278 and 298 and the engagement between the latch shoulders 276 and 290 holds the mechanical connectors 258a and 260a together. The anti-twist members 277 and 304 prevent the latch projection 262 from moving out of the groove 280 when the body 226 is twisted.

[0043] Figure 6 is an exploded perspective view of another exemplary alternative embodiment of an attachment ring 416. The attachment ring 416 includes a body 426, which is configured to extend at least partially around the end 22 (Figures 1 and 2) of the shield 18 (Figures 1 and 2). The body 426 of the attachment ring 416 includes at least two segments 428 and 430. The segments 428 and 430 are discrete from each other and are connected together to define the length of the body 426. The segment 428 extends a length from an end 450 to an opposite end 452, while the segment 430 extends a length from an end 454 to an opposite end 456. Each of ends 450 and 452 of the segment 428 includes a respective mechanical connector 458a and 458b, and each of the ends 454 and 456 of the segment 430 includes a mechanical connector 460a and 460b, respectively. The mechanical connector 458a of the end 450 of the segment 428 interlocks with the mechanical connector 460a of the end 454 of the segment 430 to connect the segments 428 and 430 together at the ends 450 and 454. Similarly, the mechanical connector 458b of the end 452 of the segment 428 interlocks with the mechanical connector 460b of the end 456 of the segment 430 to connect the segments 428 and 430 together at the ends 452 and 456. The mechanical connector 458a of the segment 428 is substantially identical to the mechanical connector 458b of the segment 428, while the mechanical connector 460a of the segment 430 is substantially identical to the mechanical connector 460b of the segment 430. Each of the segments 428 and 430 may be referred to herein as a "first segment" and/or a "second segment". The mechanical connectors 258a, 258b, 260a, and 260b may each be referred to herein as a "connection member" and/or a "connection feature".

[0044] The mechanical connectors 458a and 560a include reciprocal shapes relative to each other. The mechanical connector 458a includes a latch projection 462 having a base 464 and an end 466. The end 466 of the latch projection 462 includes a rear wall 470 that defines a latch shoulder 476 of the latch projection 462. The mechanical connector 460a includes a groove 480, which extends into the end 454 of the segment 430. Optionally, the groove 480 extends through an end wall 486 of the end 454 of the segment 430. The groove 480 includes a groove segment 488 that extends between opposing anti-twist members 504 of the mechanical connector 460a. Rear walls of the anti-twist members 504 define a latch shoulder 490 of the groove 480. The groove 480 also includes a recess 492 defined between the latch shoulder 490 and an end wall 494 of the groove 480.

[0045] To connect the end 450 of the segment 428 to the end 454 of the segment 430, the latch projection 462 of the mechanical connector 458a is inserted into the groove 480 of the mechanical connector 460a. The base 464 of the latch projection 462 is received within the

groove segment 488 of the groove 480 such that the anti-twist members 504 straddle the base 464 of the latch projection 462. The end 466 of the latch projection 462 is received within the recess 492 of the groove 480. When the mechanical connectors 458a and 460a are interlocked together as described above, the latch shoulder 476 of the latch projection 462 engages the latch shoulder 490 of the groove 480 to hold the mechanical connectors 458a and 460a together. The anti-twist members 504 prevent the latch projection 462 from moving out of the groove 480 when the body 426 is twisted.

[0046] The embodiments described and/or illustrated herein may provide an attachment ring that is less time-consuming, less difficult, and/or less costly to position over the end of a shield than at least some known attachment rings. The embodiments described and/or illustrated herein may provide an electrical cable that is less time-consuming, less difficult, and/or less costly to terminate to an electrical connector than at least some known electrical cables. The embodiments described and/or illustrated herein may increase the number of electrical cables that can be terminated to corresponding electrical connectors within a given time period. The embodiments described and/or illustrated herein may provide an attachment ring that is less difficult, less time consuming, and/or less costly to remove from a shield than at least some known attachment rings. The embodiments described and/or illustrated herein may provide an attachment ring that may be removed from a shield without using special tooling (e.g., without using an electrical power tool and/or the like). The embodiments described and/or illustrated herein may provide an attachment ring that may be removed from a shield without damaging a fitting of a backshell to which the shield is attached.

[0047] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Dimensions, types of materials, orientations of the various components, and the number and positions of the various components described herein are intended to define parameters of certain embodiments, and are by no means limiting and are merely exemplary embodiments. Many other embodiments and modifications within the spirit and scope of the claims will be apparent to those of skill in the art upon reviewing the above description. The scope of the subject matter described and/or illustrated herein should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled

What is claimed is:

1. An attachment ring for attaching a shield of an electrical cable to a backshell, said attachment ring comprising:

an annular body comprising a shape memory material that is heat recoverable, the body being configured to extend at least partially around the shield and a fitting of the backshell to hold the shield on the fitting in contact with the fitting, wherein the body comprises:

a first segment comprising an end having a connection member; and

a second segment that is discrete from the first segment, the second segment comprising an end having a connection feature, wherein the connection feature of the second segment is interlocked with the connection member of the first segment to connect the first and second segments together at the ends such that the first and second segments define at least a portion of a length of the body.

2. The attachment ring according to claim 1, wherein the connection member of the first segment comprises a groove that extends within the end of the first segment, the connection feature of the second segment comprising a latch projection that is received within the groove of the connection member of the first segment to connect the first and second segments together, preferably wherein (a) the groove is at least partially defined by an anti-twist member that engages the latch projection to hold the latch projection within the groove when the body is twisted, or (b) the groove and the latch projection have reciprocal shapes relative to each other..

3. The attachment ring according to claim 1, wherein the connection member of the first segment comprises a latch ramp and a latch shoulder, the connection feature of the second segment comprising a latch projection that rides along the latch ramp as the first and second segments are connected together and engages the latch shoulder to interlock the connection feature and the connection member.

4. The attachment ring according to claim 1, wherein the connection member of the first segment comprises an embossment, the connection feature of the second segment comprising a notch having a complementary shape relative to the embossment, the embossment being received within the notch to interlock the connection member and the connection feature together.

5. The attachment ring according to claim 1, wherein the first segment extends a length from the end of the first segment to an opposite end of the first segment, each of the ends of the first segment comprising one of the connection members, the second segment extending a length from the end of the second segment to an opposite end of the second segment, each of the ends of first segment comprising one of the connection features, wherein the connection feature of each end of the second segment is connected to the connection member of the corresponding end of the first segment such that the length of the body is continuous and the first and second segments define an approximate entirety of the length of the body.

6. The attachment ring according to claim 1, wherein the first and second segments of the body are (a) hermaphroditic, or (b) comprise a cylindrical cross-sectional shape.

7. The attachment ring according to claim 1, wherein the connection between the first and second segments is configured to be broken by twisting the body at a joint of the connection feature of the first segment and the connection member of the second segment.

8. The attachment ring according to claim 1, wherein the connection member of the first segment and the connection feature of the second segment interlock with a snap-fit arrangement.

9. The attachment ring according to claim 1, wherein at least one of the connection member or the connection feature comprises a shape memory material that is heat recoverable.

10. An electrical cable assembly comprising:

an electrical cable comprising a shield;

a backshell comprising a fitting, the shield of the electrical cable being received over the fitting; and

an attachment ring according to any one of claims 1 to 9.

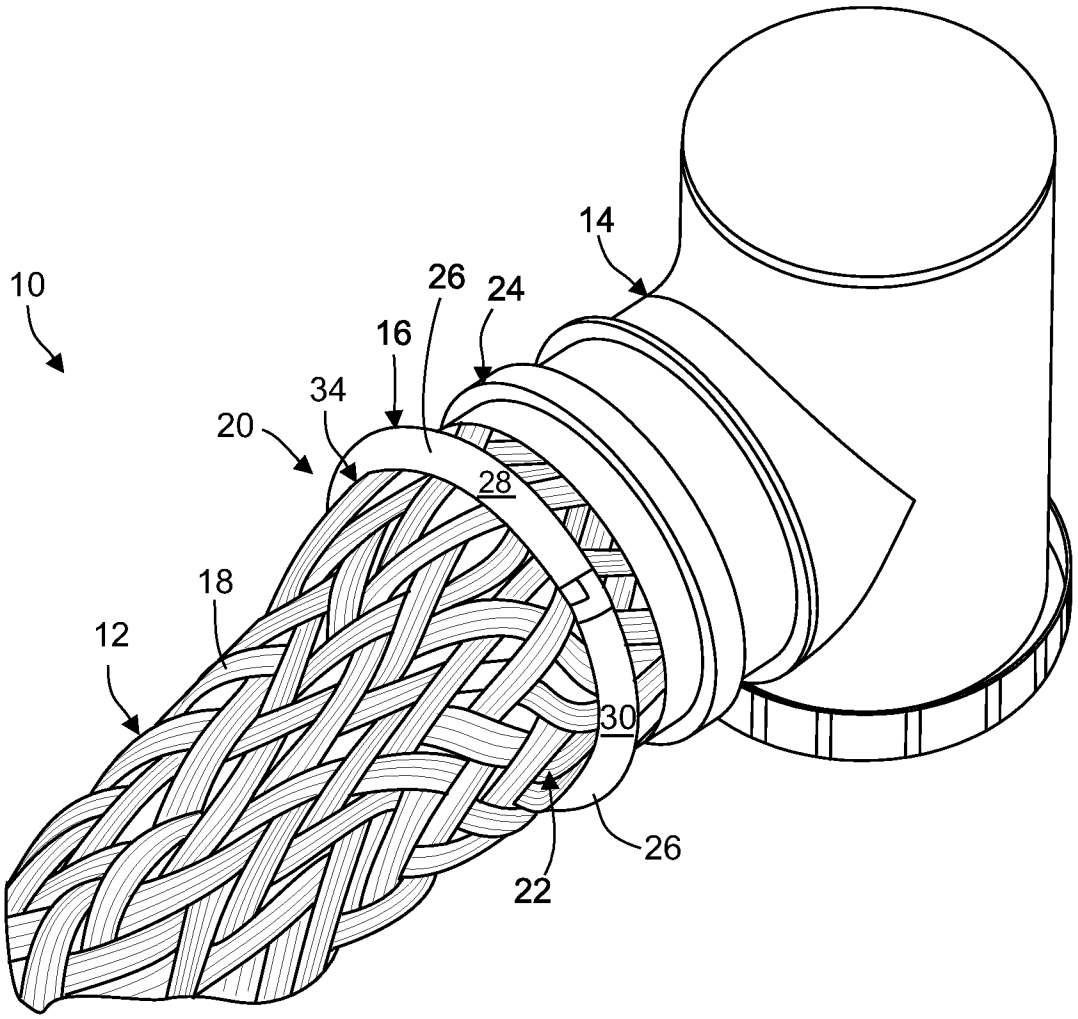


FIG. 1

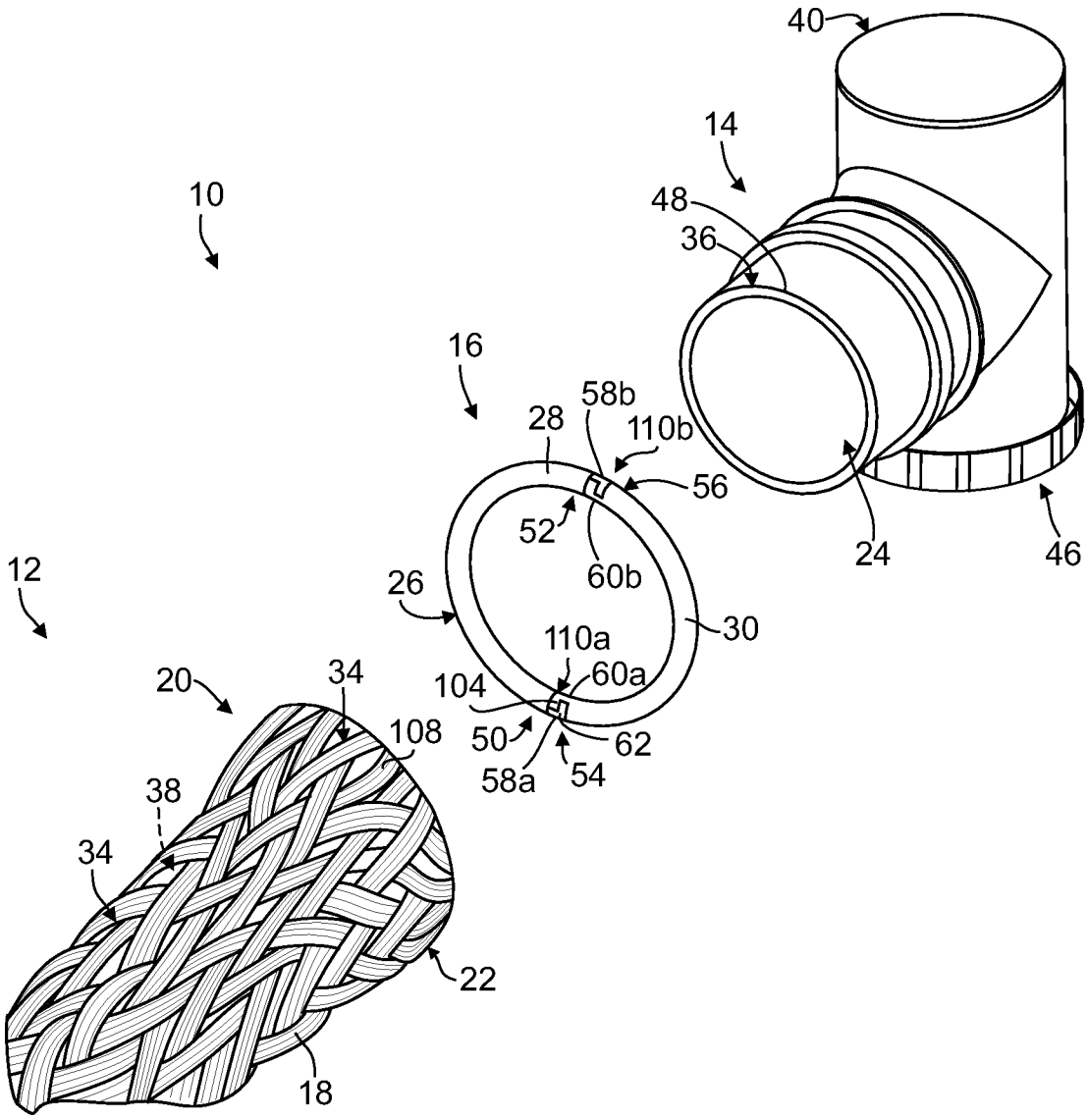

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FIG. 2

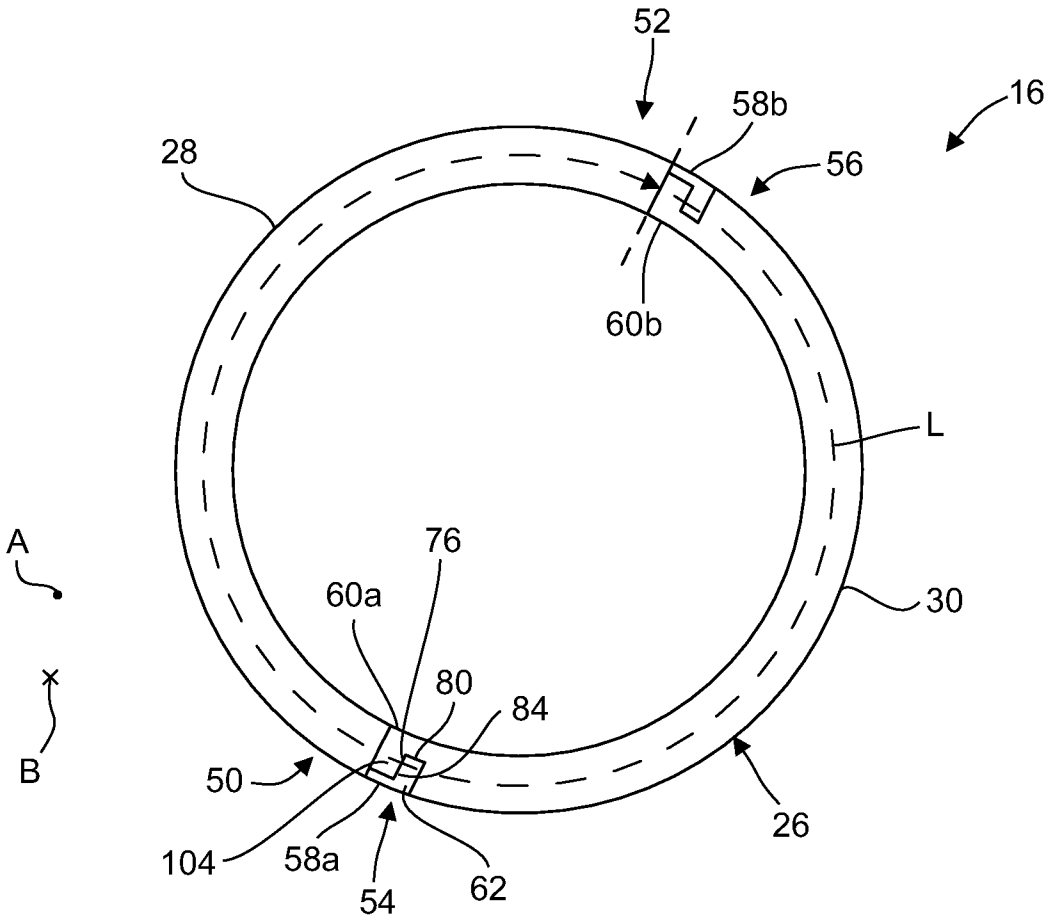


FIG. 3

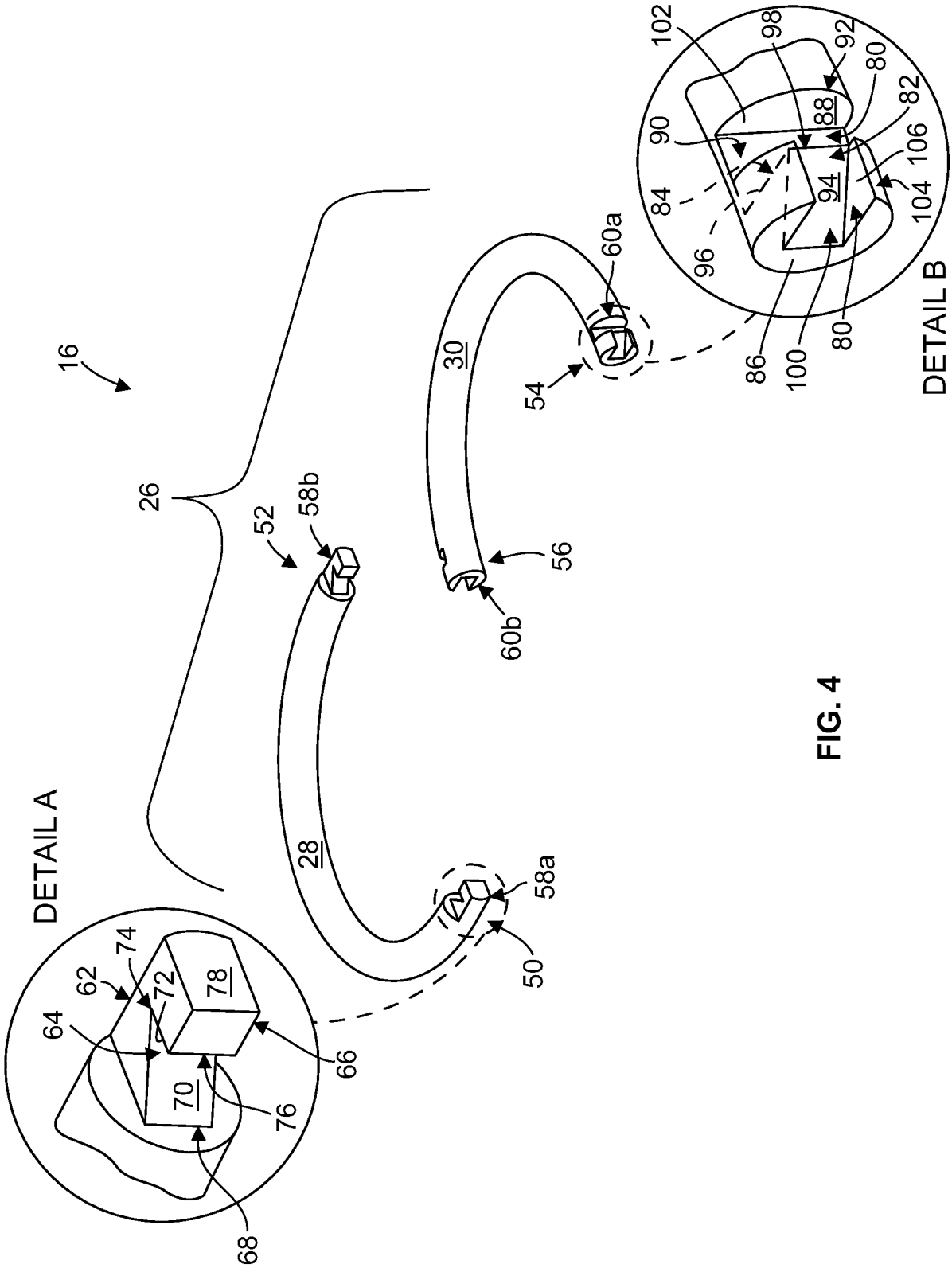

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58b
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DETAIL A
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DETAIL B
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FIG. 4

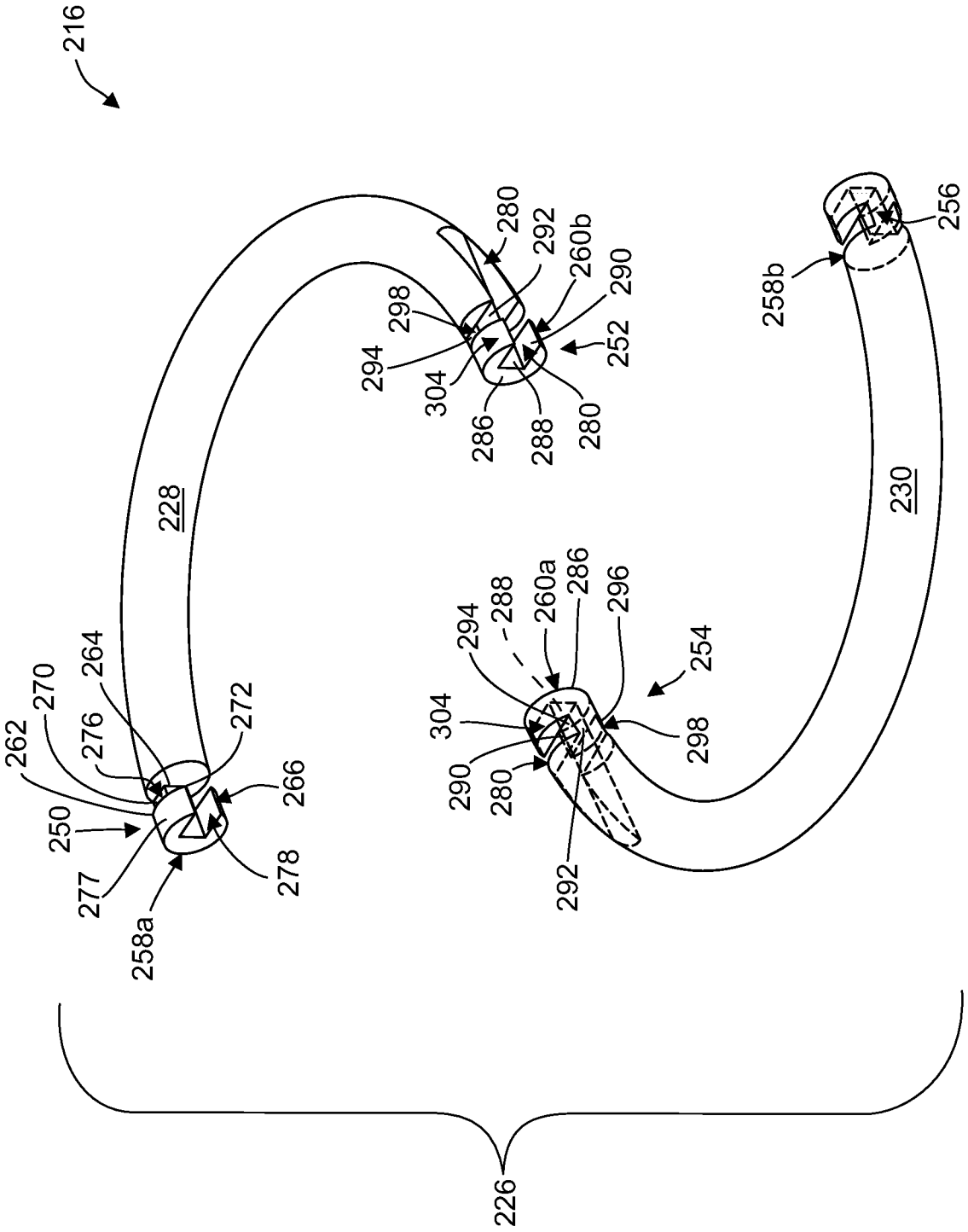

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FIG. 5

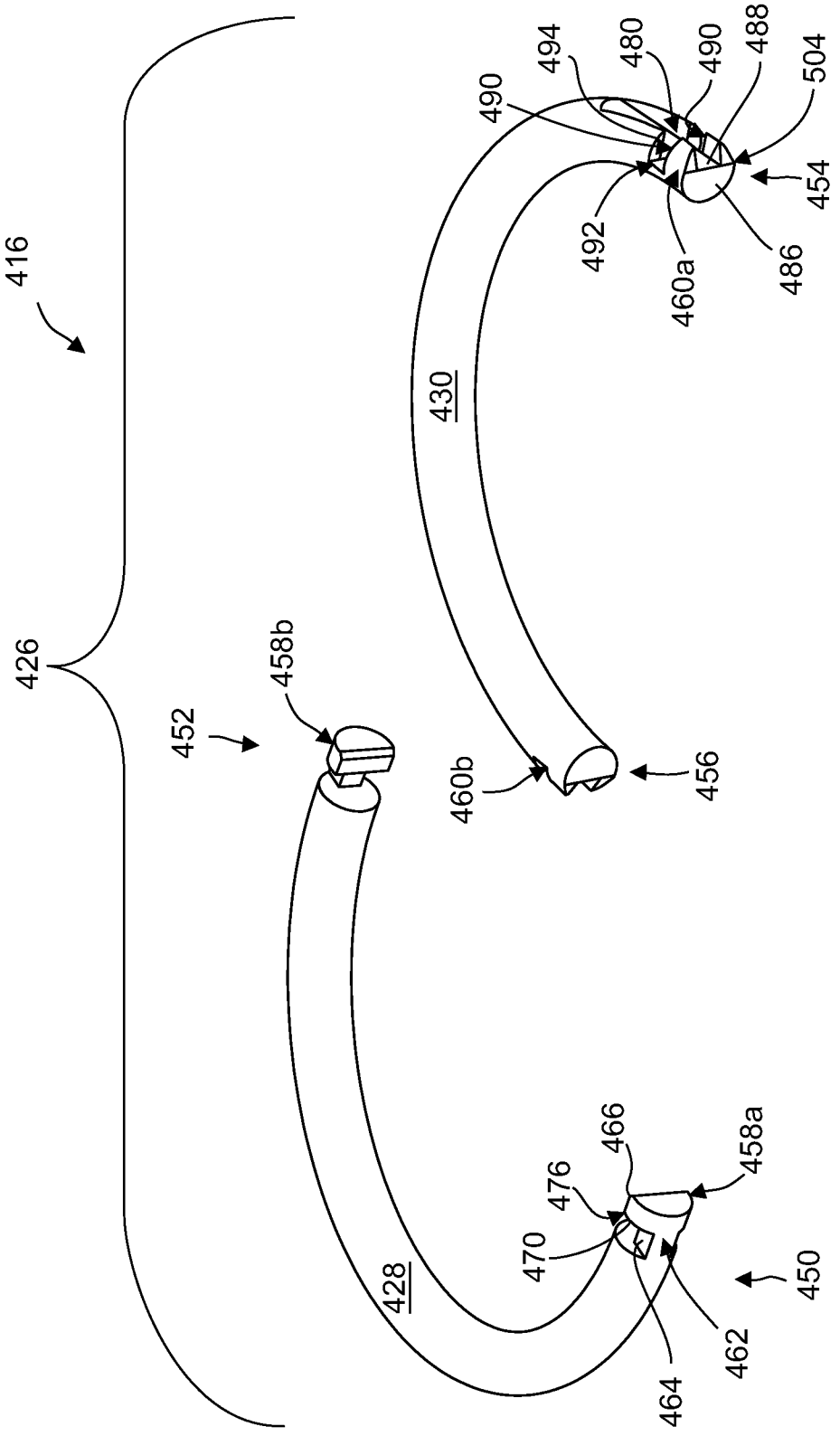

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458a
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FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/057525

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R4/01 H01R13/58
ADD. H01R9/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 236 183 A1 (SOURIAU & CIE [FR]) 9 September 1987 (1987-09-09) figure 1b	1
A	EP 0 053 745 A1 (SCHALTBAU GMBH [DE]) 16 June 1982 (1982-06-16) paragraph [0010]; figures 6-8	1
A	US 6 663 415 B1 (WU JERRY [US]) 16 December 2003 (2003-12-16) figure 1	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2011	02/12/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hugueny, Bertrand

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/057525

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