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(54) Title: COMPRESSION CONNECTORS WITH INSULATING COVER

(57) Abstract: The present disclosure provides embodiments of insulated compression-type electrical connectors used to connect one or more branch wires or conductors to one or more run wires or conductors.

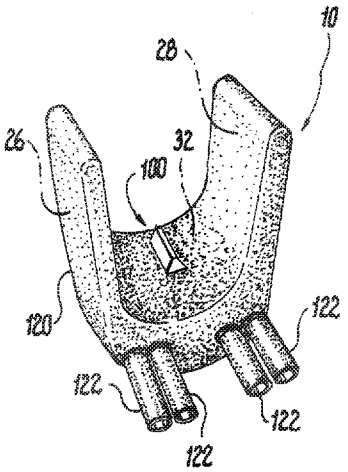


Fig. 1

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Patent Application for

COMPRESSION CONNECTORS WITH INSULATING COVER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure is based on and claims benefit from co-pending U.S. Provisional Patent Application Serial No. 62/794,296 filed on January 18, 2019 entitled "Compression Connectors with Insulating Cover" the contents of which are incorporated herein in their entirety by reference.

BACKGROUND

Field

[0002] The present disclosure relates generally to insulated electrical compression connectors for electrically and compressively connecting two or more solid or stranded wires or conductors together. More specifically, the present disclosure relates to compression-type electrical connectors for electrically and compressively connecting two or more solid or stranded wires or conductors together.

Description of the Related Art

[0003] Tap connectors have been used to establish an electrical connection between a continuous main power conductor to a branch conductor. Similarly, tap connectors have been used to establish an electrical connection between a distribution power conductor (also referred to as a run) and one or more main power conductors. Compression type tap connectors are typically adapted to receive a branch or tap conductor, to engage a continuous run conductor, and to be compressed by means of a crimping tool to achieve the desired connection. Such connectors are not coated with an insulating cover.

SUMMARY

[0004] The present disclosure provides embodiments of compression-type electrical connectors used to connect one or more branch wires or conductors to one or more run wires or conductors. In an exemplary embodiment, the compression connector includes a connector body and an insulating coating surrounding the connector body. The connector body is preferably made of compressible material adapted to be inserted into a crimping tool. The connector body includes a run conductor portion and a branch conductor portion. The run conductor portion includes a pair of side walls joined by a bottom wall, a run conductor opening between the pair of side walls and the bottom wall, and at least one insulation piercing member extending from at least one of the pair of side walls and the bottom wall into the run conductor opening. The branch conductor portion includes at least one branch conductor opening having a lead-in with a rib adjacent the lead-in, and a hinge portion between the branch conductor opening and the connector body. The insulation coating surrounds the connector body such that an interior wall of the at least one branch conductor opening and the at least one insulation piercing member are not covered by the insulation coating.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The figures depict embodiments for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures illustrated herein may be employed without departing from the principles described herein, wherein:

[0006] Fig. 1 is a front perspective view of an exemplary embodiment of a compression connector according to the present disclosure where a flexible insulating coating covers a connector body;

[0007] Fig. 2 is a rear perspective view of the compression connector of Fig. 1;

[0008] Fig. 3 is an exploded perspective view of the connector body of the compression connector of Fig. 1 prior to receiving the insulating coating, illustrating the connector body with an opening for receiving a conductor, an insulation piercing member removably attached to an interior wall of the body, a plurality of branch conductor openings and a plurality of pegs used to create branch conductor portals for receiving the branch conductors;

[0009] Fig. 4 is a perspective view of the compression connector of Fig. 1 positioned between a pair of dies of a hydraulic powered crimping tool with a run conductor and four branch conductors for crimping;

[0010] Fig. 5 is a perspective view of the compression connector of Fig. 4 where the compression connector has been subjected to a crimping operation to electrically connect a run conductor to four branch conductors and the dies of the crimping tool being removed;

[0011] Fig. 6 is an exploded perspective view of another exemplary embodiment of the connector body of the compression connector of Fig. 1 prior to receiving the insulating coating, illustrating the connector body with an opening for receiving a conductor, an insulation piercing member integrally formed into an interior wall of the body, a plurality of branch conductor openings and a plurality of pegs used to create branch conductor portals for receiving the branch conductors;

[0012] Fig. 7 is a perspective view of the compression connector of Fig. 6 after the insulating coating is applied, and illustrating a portion of the insulating coating removed;

[0013] Fig. 8 is a cross-sectional view of the compression connector of Fig. 5 taken from line 8-8 after the compression connector has been subjected to a crimping operation to electrically and compressively connect the run conductors to the branch conductors;

[0014] Fig. 9 is a perspective view of another exemplary embodiment of a compression connector according to the present disclosure prior to receiving the insulating coating, illustrating branch conductor openings for receiving branch conductors each having an insulation piercing member integrally formed into an interior wall of the branch conductor opening;

[0015] Fig. 10 is a cross-sectional view of the compression connector of Fig. 9 taken from line 10-10;

[0016] Fig. 11 is a front perspective view of the compression connector of Fig. 9, illustrating a flexible insulating coating covering the connector body;

[0017] Fig. 12 is a midpoint cross-sectional view of the compression connector of Fig. 11 taken from line 12-12, illustrating a run conductor in the a run conductor opening, a branch conductor in each branch conductor opening and the compression connector having been subjected to a crimping operation to electrically and compressively connect the run conductor to the branch conductors;

[0018] Fig. 12a is an enlarged view of a portion of the compression connector of Fig. 12 taken from detail 12a, illustrating an insulation piercing member extending into a branch conductor opening and piercing through an insulating jacket of a branch conductor;

[0019] Fig. 13 is a perspective view of another exemplary embodiment of a compression connector according to the present disclosure, illustrating an H-shaped connector body with a portion of the flexible insulating coating removed, with openings for receiving conductors, and with insulation piercing members integrally formed into the body and extending into the openings;

[0020] Fig. 14 is a midpoint cross-sectional view of the compression connector of Fig. 13 taken from line 14-14, illustrating conductors positioned within the connector body openings and the compression connector having been subjected to a crimping operation to electrically and compressively connect the conductors;

[0021] Fig. 15 is a perspective view of another exemplary embodiment of a compression connector according to the present disclosure, illustrating a C-shaped connector body with a portion of the flexible insulating coating removed, with an opening for receiving conductors, and with insulation piercing members integrally formed into the body and extending into the opening;

[0022] Fig. 16 is a midpoint cross-sectional view of the compression connector of Fig. 15 taken from line 16-16, illustrating conductors positioned within the connector body opening and the compression connector having been subjected to a crimping operation to electrically and compressively connect the conductors;

[0023] Fig. 17 is a perspective view of another exemplary embodiment of a compression connector according to the present disclosure, illustrating an S-shaped connector body with a portion of the flexible insulating coating removed, with openings for receiving conductors, and with insulation piercing members integrally formed into the body and extending into the openings;

[0024] Fig. 18 is a midpoint cross-sectional view of the compression connector of Fig. 17 taken from line 18-18, illustrating conductors positioned within the connector body openings and the compression connector having been subjected to a crimping operation to electrically and compressively connect the conductors;

[0025] Fig. 19 is a perspective view of another exemplary embodiment of a compression connector according to the present disclosure, illustrating a connector body with a portion of the flexible insulating coating removed, with openings for receiving conductors, and with insulation piercing members integrally formed into the body and extending into the openings; and

[0026] Fig. 20 is a cross-sectional view of the compression connector of Fig. 19, illustrating conductors positioned within the connector body openings and the compression connector having been subjected to a crimping operation to electrically and compressively connect the conductors.

DETAILED DESCRIPTION

[0027] The present disclosure provides embodiments of compression connectors that are covered with a flexible insulating jacket and used to electrically and compressively connect, for example, one or more branch or tap conductors to one or more run or main conductors in such a

way that either the entire solid branch conductor or one or more wire strands of the branch conductor remain within their respective opening, port, slot, channel, aperture or the like. For ease of description, the compression connector may be referred to as the "connector" in the singular and the "connectors" in the plural. The branch or tap conductors may be referred to as the "branch conductor" in the singular and the "branch conductors" in the plural. The main or run conductors may be referred to as the "run conductor" in the singular and the "run conductors" in the plural. The port, slot, channel, aperture or other opening that receives the branch conductors may also be referred to as the "branch opening" in the singular and the "branch openings" in the plural. The port, slot, channel, aperture or other opening that receives the run conductors may also be referred to as the "run opening" in the singular and the "run openings" in the plural.

[0028] Referring to Figs. 1-3 and 6, an exemplary embodiment of a compression connector according to the present disclosure is shown. In this exemplary embodiment, the connector 10 includes a body 20 having a run conductor portion 22 and a branch conductor portion 24. The run conductor portion 22 includes two side walls 26 and 28, a run opening 30 between the two side walls and a bottom wall 32 between the two side walls 26 and 28 that define a portion of the run opening 30. The bottom wall 32 in this exemplary embodiment is a rounded bottom wall. One of the walls 26 or 28 may include a more rounded shape at its free end than the other wall so that when the connector 10 is compressed, e.g., crimped, the more rounded end can overlay the run conductor. In the exemplary embodiment shown, the run conductor portion 22 is substantially a U-shaped structure with the rounded bottom wall 32 shaped to receive a run conductor. The configuration of the opening 30 can vary depending upon the size of the run conductor. As a non-limiting example, the run conductor can be a round cable having a gauge in the range from about 250 Kcmil to about 750 Kcmil. The walls 26, 28 and 32 may include one or more channels 34 that extend along a width "W1" of the body 20. The channels 34 have a width "W2" and are configured and dimensioned to receive and releasably hold an insulation piercing member 100 to the body 20 as described in more detail below. In the exemplary embodiment shown, a channel 34 extends along a width "W1" of the bottom wall 32.

[0029] Continuing to refer to Figs. 1-3 and 6, the run conductor portion 22 of the body 20 also includes one or more insulation piercing members 100 extending from an inner surface of one or more walls 26, 28 and/or 32. In the embodiment shown in Figs. 1-3, an insulation piercing member 100 extends from the bottom wall 32 into the opening 30. In this exemplary embodiment, the insulation piercing member 100 includes a base 102 and a tip member 104. The base 102 is configured and dimensioned to fit within the channel 34 in wall 26, 28 and/or 32 of the body 20, as shown, so that the insulation piercing member 100 is removably attached to the body 20. More specifically, as noted above, in the exemplary embodiment shown, the channel 34 extends along the width "W1" of the bottom wall 32 of the body 20 and forms the mortise portion of a sliding dove-tail type connection joint. The base 102 of the insulation piercing member 100 is tapered to form the tenon or tongue of the sliding dove-tail connection joint. Preferably, there is sufficient friction between the channel 34 and the base 102 so that after the base 102 is inserted into the channel 34, the insulation piercing member 100 remains in position within the channel 34 for the subsequent insulation coating process described below. The base 102 has a length "L1" that is substantially the same as the width "W1" of the body 20, and a width "W3" that is substantially the same as the width "W2" of the channel 34 so that the base 102 can slide into the channel 34 and remain fixed in position due to friction between the walls of the base 102 and the walls of the channel 34.

[0030] The tip member 104 is, in this exemplary embodiment, a triangular shaped member extending from the base 102 into the opening 30 in the body 20. More specifically, the tip member 104 includes a base side 104a that is integrally or monolithically formed into the base 102 and two side walls 104b and 104c extending away from the base side 104a and joined to form a piercing tip 104d. The piercing tip 104d is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in the run conductor 700 when the connector 10 is crimped, and to contact the electrical wire within the run conductor 700 to create an electrical path between the connector 10 and the run conductor 700, as shown in Fig. 8. The tip member 104 has a length "L2" that is less that the length "L1" of the base 102. The length "L2" of the tip member 104 should be sufficiently less than the length "L1" of the base 102 so that the insulation jacket 120, seen in Fig. 7, applied to the body 20 surrounds the base side 104a

of the tip member 104. By having the length of the tip member 104 less than the length of the base 102, a seal can form between the connector 10 and the run conductor 700 when the run conductor 700 is crimped to the connector 10. This seal minimizes and possibly prevents water and/or gas from contacting the tip member 104 of the insulation piercing member 100. As a non-limiting example, if the length "L1" of the base 102 is 1 inch, the length "L2" of the tip member 104 would preferably be ½ inch and the tip member would be centered along the width of the body 20 as shown in Figs. 1 and 2. As such, in this exemplary embodiment, the length "L2" of the tip member 104 is ½ the length "L1" of the base 102. In this exemplary embodiment, the body 20 is typically formed by, for example, an extrusion process, a metal casting process or a machining process where the channel 34 is formed as part of the process used to fabricate the body. The insulation piercing member 100 is typically formed by, for example, a stamping process, a metal casting process or a machining process and hardened using conventional hardening processes, such as heating and rapidly cooling the insulation piercing member.

[0031] It is noted, however, that the insulation piercing members 100 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 100 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires. The insulation piercing members 100 are preferably made of a hardened material that is sufficient to pierce through insulation surrounding the run conductors 400. Non-limiting examples of such hardened material include 6000 series aluminium, stainless steel or hardened brass.

[0032] Referring to Fig. 6, another exemplary embodiment of the body 20 of the connector 10 is shown. In this exemplary embodiment, the body 20 is substantially the same as the body described above except that the body 20 includes one or more insulation piercing members 110 integrally or monolithically formed into one or more walls 26, 28 and 32 of the body. As shown, the insulation piercing member 110 extends from the bottom wall 32 into the opening 30. In this exemplary embodiment, the insulation piercing member 110 includes tip member 112, which is substantially similar to the tip member 104 described above. The tip member 112 is, in this

exemplary embodiment, a triangular shaped member extending from the bottom wall 32 of the body into the opening 30. More specifically, the tip member 112 includes two side walls 112a and 112b extending away from the bottom wall 32 of the body 20 and joined to form a piercing tip 112c. The piercing tip 112c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in the run conductor 700 when the connector 10 is crimped, and to contact the electrical wire within the run conductor 700 to create an electrical path between the connector 10 and the run conductor 700, similar to the connection shown in Fig. 8. The tip member 112 has a length "L2" that is less that the width "W1" of the body 20. The length "L2" of the tip member 112 should be sufficiently less than the width "W1" of the body 20 so that the insulation jacket 120, seen in Fig. 7, applied to the body 20 surrounds the junction between the bottom wall 32 and the insulation piercing member 110. By having the length of the tip member 112 less than the width of the body 20, a seal can form between the connector 10 and the run conductor 700 when the run conductor is crimped to the connector 10. This seal minimizes and possibly prevents water and/or gas from contacting the tip member 112 of the insulation piercing member 110. As a non-limiting example, if the width "W1" of the body 20 is 1 inch, the length "L2" of the tip member 112 would preferably be ½ inch and the tip member would be centered along the width "W1" of the body 20 as shown in Fig. 6. As such, in this exemplary embodiment, the length "L2" of the tip member 112 is ½ the width "W1" of the body 20. In this exemplary embodiment, the body 20 is typically formed by an extrusion process, metal casting process or a machining process where the insulation piercing member 110 is formed as part of the extrusion process, metal casting process or the insulation piercing member is machined as part of the body. In order to harden the insulation piercing member 110, the insulation piercing member is put through a conventional hardening process, such as heating and then rapidly cooling the insulation piercing member.

[0033] It is noted, however, that the insulation piercing members 110 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 110 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires.

[0034] Referring again to Figs. 1-3, the branch connector portion 24 includes one or more branch openings. Each branch opening can be configured and dimensioned to receive one or more branch conductors. In the embodiment shown, the branch conductor portion 24 includes four branch conductor openings 40, 50, 60 and 70, and the branch conductors 702, 704, 706 and 708, seen in Fig. 4, are round cables. However, there may be less than four branch openings or there may be more than four branch openings.

[0035] In the exemplary embodiment shown in Figs. 3 and 6, the branch opening 40 extends along the width "W1" of the body 20 as shown and has a lead-in 42 defined by a rib 44. The rib 44 helps retain a branch conductor within the branch opening 40 until the connector 10 is compressed, e.g., crimped. The branch conductor portion 24 also includes a first hinge portion 46 that enables rib 44 to more easily bend or deflect in a direction toward the bottom wall 32 of the body 20 when being compressed. The branch opening 50 extends along the width "W1" of the body 20 as shown and has a lead-in 52 defined by a rib 54. The rib 54 helps retain a branch conductor within the branch opening 50 until the connector 10 is compressed, e.g., crimped. The branch conductor portion 24 also includes a second hinge portion 56 that enables rib 54 to more easily bend or deflect in a direction toward the bottom wall 32 of the body 20 when being compressed. The branch opening 60 extends along the width "W1" of the body 20 as shown and has a lead-in 62 defined by a rib 64. The rib 64 helps retain a branch conductor within the branch opening 60 until the connector 10 is compressed, e.g., crimped. The branch conductor portion 24 also includes a third hinge portion 66 that enables rib 64 to more easily bend or deflect in a direction toward the bottom wall 32 of the body 20 when being compressed. Branch opening 70 extends along the width "W1" of the body 20 as shown and has a lead-in 72 defined by a rib 74. The rib 74 helps retain a branch conductor within the branch opening 70 until the connector 10 is compressed, e.g., crimped. The branch conductor portion 24 also includes a fourth hinge portion 76 that enables rib 74 to more easily bend or deflect in a direction toward the bottom wall 32 of the body 20 when being compressed. Each branch opening includes an interior wall that is configured to contact an electrical wire within a respective branch conductor to create an electrically conductive path between the branch conductor and the connector body 20.

[0036] When the connector 10 is compressed, using for example a standard hydraulic crimping tool (not shown), the hinge portions 46, 56, 66 and 76 of the branch conductor portion 24 bend or deflect first to prevent the branch conductors or strands of the branch conductors from exiting the respective opening via lead-ins 42, 52, 62 and 72. It is noted that the branch openings 40, 50, 60 and 70 shown are substantially the same size. As a result, the branch openings would be configured to receive branch conductors 702, 704, 706 and 708 having a size or gauge that falls with the same predefined range of, for example, #22 AWG to 4/0 AWG. However, the present disclosure also contemplates that one or more the branch openings 40, 50, 60 and 70 may have different sizes. For example, one or more branch openings could be configured to receive branch conductors having a first size or gauge that falls with a first predefined range of, for example, 1/0 AWG, and one or more branch openings could be configured to receive branch conductors having a second size or gauge that falls with a second predefined range of, for example, 4/0 AWG.

[0037] Referring to Figs. 4 and 5, it is noted that the run conductors 700 are typically greater in size or gauge than the branch conductors 702, 704, 706 and 708. The run conductors 700 and the branch conductors include electrical wires surrounded by an insulating jacket. Further, the electrical wires in the run conductors 700 and the branch conductors 702, 704, 706 and 708 can be solid wires so that the run or branch conductors would be known as solid conductors. Alternatively, the electrical wires in the run conductors 700 and the branch conductors 702, 704, 706 and 708 can be stranded wires so that the run or branch conductors would be known as stranded conductors. Typically, the run conductors and branch conductors are stranded conductors, as shown.

[0038] Once the connector body 20 is formed, the connector body, including the insulation piercing members 100 or 110, is coated with a flexible insulating material to form the insulation jacket 120 around the connector body 20. At the same time, branch conductor portals 122 that are aligned with the branch openings 40, 50, 60 and 70 are formed in the insulation jacket 120 to provide a seal between the insulation jacket surrounding the electrical wire in the branch conductors. This seal minimizes and possibly prevents water and/or gas from entering the

branch conductor openings. Non-limiting examples of the flexible insulating material include Polyvinyl Chloride (PVC), ethylene propylene diene monomer (EPDM) rubber, Santoprene and Plastisol.

[0039] To coat the conductor body 20 with the flexible insulating material and to form the branch conductor portals 122, pegs 124 are first inserted into the branch openings 40, 50, 60 and 70, as seen in Figs. 3 and 6. Each peg 124 includes a first portion 124a and a second portion 124b. In this exemplary embodiment, the first portion 124a is a cylindrical member shaped to conform to the branch openings 40, 50, 60 and 70. The first portion 124a has an outer diameter configured to fit within the respective branch opening. However, the first portion may have other shapes to conform to the shape of the branch openings 40, 50, 60 and 70. Similarly, the second portion 124b is a cylindrical member shaped to conform to the insulation jacket surrounding electrical wire in the branch conductors 702, 704, 706 and/or 708. The second portion 124b of each peg 124 has an outer diameter configured to form the branch conductor portals 122 made of the flexible insulating material. In this configuration, the inner diameter of the branch conductor portals 122 would be the same or slightly less than the outer diameter of the insulation jacket surrounding the electrical wire in the branch conductors 702, 704, 706 and/or 708 so that when the branch conductors are inserted into the branch conductor portals 122 a seal is formed between the branch conductor insulating jacket and the branch conductor portal 122. This seal minimizes and possibly prevents water and/or gas from entering the branch conductor openings. However, the second portion 124b may have other shapes to conform to the shape of the insulation jacket surrounding the electrical wires in branch conductors 702, 704, 706, 708.

[0040] With the pegs 124 inserted into the branch openings 40, 50, 60 and 70, the conductor body 20 is coated with the flexible insulating material, by for example, dipping the conductor body into a vat of liquid insulating material and then allowing the coating of insulating material to harden to form the insulation jacket 120, or by an injection moulding process. Once the coating hardens, the portion of the insulating jacket 120 covering the tip member 104 or 112 of

the insulation piercing member 100 or 110, respectively, is removed to expose the insulation piercing member, as seen in Fig. 7.

[0041] Referring now to Figs. 4, 5 and 8, to secure the run and branch conductors to the connector 10, the connector is placed in a standard crimping tool (not shown), such as a hydraulic 12-ton or 15-ton hand held power tool, that has die surfaces 500 and 502, seen in Figs. 4 and 5, in a working head of the tool. An example of a hydraulic power tool is the PAT46-18V manufactured by Burndy, LLC. When the tool is actuated, the connector 10 would come into contact with the interior surfaces of the dies, such that a compressive force applied to the dies is transferred to the connector 10 causing the connector to compress. As the tool is compressing the connector 10, the hinges 46, 56, 66, and 76 would typically bend or deflect first securing the branch conductors 702, 704, 706 and 708 within their respective branch openings 40, 50, 60 and 70 and preventing strands of the branch conductors from exiting the openings. As additional compressive force is applied to the connector 10, the wall 26 folds and then the wall 28 folds to secure the run conductor 700 to the connector. In addition, the insulation piercing members 100 or 110 would pierce through the run conductor insulation jacket so that an electrical path is formed between the electrical wire in the run conductor and the body 20. The conductors provided in branch openings 30, 40, 50, 60 and 70 will receive direct compressive loads due to the unique geometric relationship between the connector 10 and the dies of the tool. After the crimping process is completed, the conductors 700, 702, 704, 706 and 708 provided in their respective openings would be secured in place, i.e., crimped to the connector 10.

[0042] The body 20 of the connector 10 described in the present disclosure can be manufactured from copper, aluminum or similar metallic materials which would appropriately deform when pressure is applied in standard mechanical, hydraulic and pneumatic crimping tools and devices to crimp the conductors to the connectors. The insulation piercing members described herein are preferably made of a hardened material or hardened so that the insulation piercing members are sufficient to pierce through the insulation jacket surrounding the run conductors. Further, the branch openings disclosed and described herein may also include one or more insulation piercing members, similar to the insulation piercing members described herein,

that are configured and dimensioned to pierce the insulation jacket surrounding electrical wire in the branch conductors.

[0043] Referring to Figs. 9-12a, another exemplary embodiment of a body 202 of a connector 200 is shown. In this exemplary embodiment, the body 202 is substantially the same as the body 20 described above except that the branch connector portion 24 of the body 202 includes one or more branch openings, e.g., branch openings 40, 50, 60 and 70, and each branch opening includes one or more insulation piercing members 210 integrally or monolithically formed into the branch opening. As shown in Figs. 9 and 10, each insulation piercing member 210 extends from an interior wall of the respective branch opening. In the embodiment shown, the branch conductor portion 24 includes four branch openings 40, 50, 60 and 70, and the branch conductors 702, 704, 706 and 708, seen in Fig. 12, are round cables. However, there may be less than four branch openings or there may be more than four branch openings. The branch opening 40 includes an interior wall 48 and one or more insulation piercing members 210 extending from the interior wall 48 into the branch opening 40. The branch opening 50 includes an interior wall 58 and one or more insulation piercing members 210 extending from the interior wall 58 into the branch opening 50. The branch opening 60 includes an interior wall 68 and one or more insulation piercing members 210 extending from the interior wall 68 into the branch opening 60. The branch opening 70 includes an interior wall 78 and one or more insulation piercing members 210 extending from the interior wall 78 into the branch opening 70. For ease of description, the one or more insulation piercing members 210 extending from the interior wall 78 into the branch conductor opening 70 will be described in more detail. However, this description applies to branch openings 40, 50 and 60 as well.

[0044] Referring to Figs. 9 and 10, one or more insulation piercing members are shown extending from an interior wall of the respective branch opening. As shown in Fig. 9, one insulation piercing member 210 extends from the interior wall 78 into the branch opening 70. The insulation piercing member 210 may have a length that is substantial equal to the width "W1" of the body 202, seen in Fig. 9, or the insulation piercing member 210 may have a length that is less than the width "W1" of the body 202. In other embodiments, the insulation piercing

member 210 extending from the interior wall 78 into the branch opening 70 may be segmented so that more than one insulation piercing members may extend from the interior wall 78 into the branch opening 70.

[0045] Referring again to Figs. 9-12a, in this exemplary embodiment, each insulation piercing member 210 includes tip member 212. The tip member 212 is, in this exemplary embodiment, a triangular shaped member extending from the interior wall of the respective branch opening, e.g. interior wall 78 of branch opening 70. More specifically, the tip member 212 includes two side walls 212a and 212b extending away from the interior wall 78 of the branch conductor opening 70 and are joined to form a piercing tip 212c. The piercing tip 212c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire of the branch conductor, e.g., branch conductor 708, when the connector 200 is crimped, and to contact the electrical wire within the branch conductor 708 to create an electrical path between the connector 200 and the respective branch conductor, similar to the connection shown in Figs. 12 and 12a.

[0046] Although the insulation piercing members 210 are described herein as a triangular shaped member, the insulation piercing members 210 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 210 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires.

[0047] Once the connector body 202 is formed, the connector body is coated with a flexible insulating material to form the insulation jacket 120 around the connector body 202, seen in Fig. 11. At the same time, branch conductor portals 122 that are aligned with the branch openings 40, 50, 60 and 70 are formed in the insulation jacket 120 to provide a seal between the insulation jacket surrounding the electrical wire of the branch conductors and the insulation jacket 120. This seal minimizes and possibly prevents water and/or gas from entering the branch openings. Non-limiting examples of the flexible insulating material include Polyvinyl Chloride (PVC), ethylene propylene diene monomer (EPDM) rubber, Santoprene and Plastisol. The insulation

jacket 120 and the branch conductor portals 122 can be formed in a similar manner as described above, except that the first portion 124a of each peg 124 inserted into a branch opening 40, 50, 60 and/or 70 to facilitate the formation of the branch conductor portals 122 differ slightly. More specifically, the first portion 124a of each peg 124 includes a notch 124c configured to receive the insulation piercing members 210 within the respective branch opening 40, 50, 60 and/or 70.

[0048] Referring now to Figs. 13 and 14, another exemplary embodiment of a connector according to the present disclosure is shown. In this exemplary embodiment, the connector 220 is an H-shape like member having a body 224. The body 224 includes a run conductor portion 226 and a branch conductor portion 228. The run conductor portion 226 includes two side walls 230 and 232, an opening 234 between the side walls 230 and 232, and a bottom wall 236 between the side walls 230 and 232 that define a portion of the opening 234. One of the walls 230 or 232 may include a more rounded shape at its free end than the other wall so that when the connector 220 is compressed, e.g., crimped, the more rounded end can overlay a conductor within the opening 234. The first conductor portion 226 of the connector 220 also includes one or more insulation piercing members 238 integrally or monolithically formed into one or more walls 230, 232 and/or 236 and extending into the opening 234. However, the one or more insulation piercing members 238 may be separate members secured to the connector body 224 using, for example, the above-described sliding dove-tail type connection joint. In the embodiment shown, a single insulation piercing member 238 is monolithically formed in the connector body 224 so that the insulation piercing member extends from the bottom wall 236 into the opening 234.

[0049] The branch conductor portion 228 of the body 224 includes two side walls 250 and 252, an opening 254 between the side walls 250 and 252, and a bottom wall 256 between the side walls 250 and 252 that define a portion of the opening 254. It is noted that the bottom wall 256 is opposite the bottom wall 236. One of the walls 250 or 252 may include a more rounded shape at its free end than the other wall so that when the connector 220 is compressed, e.g., crimped, the more rounded end can overlay a conductor within the opening 254. The second conductor portion 228 of the connector 220 also includes one or more insulation piercing members 238

integrally or monolithically formed into one or more walls 250, 252 and/or 256 and extending into the opening 254. However, the one or more insulation piercing members 238 may be separate members secured to the connector body 224 using, for example, the above-described sliding dove-tail type connection joint. In the embodiment shown, a single insulation piercing member 238 is monolithically formed in the connector body 224 so that the insulation piercing member extends from the bottom wall 256 into the opening 254.

[0050] Each insulation piercing member 238 includes a tip member 240 that is, in this exemplary embodiment, a triangular shaped member extending from the bottom wall 236 or 256 of the body 224 into the opening 234 or 254. More specifically, the tip member 240 includes two side walls 240a and 240b extending away from the bottom wall 236 or 356 of the body 224 and are joined to form a piercing tip 240c. The piercing tip 240c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in a run conductor 700 or a branch conductor 710 when the connector 10 is crimped, and to contact the electrical wire within the run conductor 700 or the branch conductor 710 to create an electrical path between the connector 220 and the conductors 700 and 710, similar to the connection shown in Fig. 18.

[0051] The tip member 240 has a length "L3" that is less that the width "W1" of the body 224. The length "L3" of the tip member 240 should be sufficiently less than the width "W1" of the body 224 so that the insulation jacket 120 applied to the body 224 surrounds the junction between the bottom wall 236 and 256 and the insulation piercing member 238. By having the length of the tip member 240 less than the width "W1" of the body 224, a seal can form between the connector 220 and a run conductor 710 or a branch conductor 712 when the conductor is crimped to the connector 220. This seal minimizes and possibly prevents water and/or gas from contacting the insulation piercing member 238. As a non-limiting example, if the width "W1" of the body 224 is 1 inch, the length "L3" of the tip member 240 would preferably be 1/2 inch and the tip member 238 would be centered along the width "W1" of the body 224 as shown in Fig. 13. As such, in this exemplary embodiment, the length "L3" of the tip member 240 is 1/2 the width "W1" of the body 224. In this exemplary embodiment, the body 224 is typically formed

by an extrusion process, metal casting process or a machining process where each insulation piercing member 238 is formed as part of the extrusion process, metal casting process, or each insulation piercing member is machined as part of the body 224. In order to harden the insulation piercing members 238, the insulation piercing members may be put through a conventional hardening process, such as heating and then rapidly cooling the insulation piercing member.

[0052] Although the insulation piercing members 238 are described above as a triangular shaped member, the insulation piercing members 238 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 238 may include a serrated tip to assist in the piercing through the insulation jacket surrounding the electrical wires.

[0053] Once the connector body 224 is formed, the connector body, including the insulation piercing members 238, are coated with a flexible insulating material to form the insulation jacket 120 around the connector body 224 that permits a seal to form between the connector body 224 and a run conductor 710 or a branch conductor 712 when the conductors are crimped to the connector 220. This seal minimizes and possibly prevents water and/or gas from contacting the insulation piercing members 238. Non-limiting examples of the flexible insulating material include Polyvinyl Chloride (PVC), ethylene propylene diene monomer (EPDM) rubber, Santoprene and Plastisol.

[0054] In one exemplary embodiment, to coat the conductor body 224 with the flexible insulating material, the conductor body 224 is, for example, dipped into a vat of liquid insulating material and then removed allowing the coating of insulating material to harden to form the insulation jacket 120. In another exemplary embodiment, the conductor body 224 may be coated with the flexible insulating material by an injection moulding process. Once the coating hardens, the portion of the insulating jacket 120 covering the tip members 240 of the insulation piercing members 238 is removed to expose the tip members 240, as seen in Fig. 13.

[0055] Referring now to Figs. 15 and 16, another exemplary embodiment of a connector according to the present disclosure is shown. In this exemplary embodiment, the connector 300 includes a body 310 having a run conductor portion 312 and a branch conductor portion 314. The body 310 is a C-shaped like member having a first wall 316, a second wall 318 and a third wall 320 joining the first wall to the second wall. As such, the first wall 316 and a portion of the third wall 320 form the run conductor portion 312, and the second wall 318 and a portion of the third wall 320 form the branch conductor portion 314. The first, second and third walls 316, 318 and 320 may be a unitary or monolithic structure, or the walls 316, 318 and 320 may be separate walls joined together by, for example, welds. The body 310 also includes an opening 322 and a lead-in 324 between the first and second walls 316 and 318. The lead-in 324 is configured and dimensioned to permit a run conductor 710 and a branch conductor 712 to pass into and be received by the opening 322. It is noted that in the exemplary embodiment shown in Figs. 15 and 16, the run conductor portion 312 and the branch conductor portion 314 are configured and dimensioned with inner surfaces 316a and 318a shaped to receive conductors, e.g., a run conductor 710 and a branch conductor 712. The configuration of the openings 322 and the lead-in 324 can vary depending upon the size of the conductor to be crimped. As a non-limiting example, the conductor can range from about 250 Kcmil to about 750 Kcmil.

[0056] The first wall 316, in this exemplary embodiment, is a U-shaped like structure configured such that when a run conductor 710 is passed into the opening 322 via lead-in 324, the connector 300 can rest on the run conductor 710 prior to a crimping operation. The second wall 318, in this exemplary embodiment, is a U-shaped like structure configured to receive at least partially a branch conductor 712 passed into the opening 322 via lead-in 324, as seen in Fig. 19. This permits a technician to set-up and operate a crimping tool without having to hold the connector 300 as well.

[0057] The connector 300 may also include one or more insulation piercing members 330 extending from an inner surface of the one or more walls 316, 318 and/or 320 of the body 310. In the embodiment shown, a single insulation piercing member 330 extends from an inner surface 316a of the first wall 316 into the opening 322, and a single insulation piercing member

330 extends from an inner surface 318a of the second wall 318 into the opening 322. The one or more insulation piercing members 330 may be integrally or monolithically formed into one or more walls 316, 318 and/or 320 and extend into the opening 322. However, the one or more insulation piercing members 330 may be separate members secured to the connector body 310 using, for example, the above-described sliding dove-tail type connection joint. In the embodiment shown, a single insulation piercing member 330 is monolithically formed in the first wall 316 of the connector body 310, and a single insulation piercing member 330 is monolithically into the second wall 318 of the conductor body 310 so that the insulation piercing members 330 extend from the respective walls 316 and 318 into the opening 322.

[0058] Each insulation piercing member 330 includes a tip member 332 that is configured and dimensioned to pierce or cut through the insulation jacket surrounding a run conductor 710 or the branch conductor 712 when the connector 300 is crimped such that the electrical wires within the conductors 710 and 712 contact the respective insulation piercing member 330 to create an electrical path between the connector 300, the run conductor 710 and the branch conductor 712, similar to the connection shown in Fig. 16. Each tip member 332 is, in this exemplary embodiment, a triangular shaped member extending from the respective wall 316 or 318 of the body 310 into the opening 322. More specifically, the tip member 332 includes two side walls 332a and 332b extending away from the wall 316 or 318 of the body 310 and are joined to form a piercing tip 332c. The piercing tip 332c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in a run conductor 710 or a branch conductor 712 as noted above.

[0059] Each tip member 332 has a length "L3" that is less that the width "W1" of the body 310. The length "L3" of the tip member 332 should be sufficiently less than the width "W1" of the body 310 so that the insulation jacket 120 applied to the body 310 surrounds the junction between the walls 316 and 318 and the insulation piercing members 330. By having the length "L3" of the tip members 332 less than the width of the body 310, a seal can form between the connector 300 and a run conductor 710 or a branch conductor 712 when the conductor is crimped to the connector 300. This seal minimizes and possibly prevents water and/or gas from

contacting each insulation piercing member 330. As a non-limiting example, if the width "W1" of the body 310 is about 1 inch, the length "L3" of the tip member 332 would preferably be about 1/2 inch and the tip member 332 would be centered along the width "W1" of the body 310 as shown in Fig. 15. As such, in this exemplary embodiment, the length "L3" of the tip member 332 is 1/2 the width "W1" of the body 310. In this exemplary embodiment, the body 332 is typically formed by an extrusion process, metal casting process or a machining process where the insulation piercing members 310 are formed as part of the extrusion process, metal casting process or the insulation piercing member is machined as part of the body 310. In order to harden the insulation piercing members 330, the insulation piercing members can be put through a conventional hardening process, such as heating and then rapidly cooling the insulation piercing member.

[0060] Although the insulation piercing members 330 are described above as a triangular shaped members, the insulation piercing members 330 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 330 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires.

[0061] Once the connector body 310 is formed, the connector body, including the insulation piercing members 330, are coated with a flexible insulating material to form the insulation jacket 120 around the connector body 310 that permits a seal to form between the connector body 310 and a run conductor 700 or a branch conductor 710 when the conductors are crimped to the connector 300. This seal minimizes and possibly prevents water and/or gas from contacting the insulation piercing members 330. Non-limiting examples of the flexible insulating material include Polyvinyl Chloride (PVC), ethylene propylene diene monomer (EPDM) rubber, Santoprene and Plastisol.

[0062] In one exemplary embodiment, to coat the conductor body 310 with the flexible insulating material, the conductor body 310 is, for example, dipped into a vat of liquid insulating material and then removed allowing the coating of insulating material to harden to form the

insulation jacket 120. In another exemplary embodiment, the conductor body 310 may be coated with the flexible insulating material by an injection moulding process. Once the coating hardens, the portion of the insulating jacket 120 covering the tip members 332 of the insulation piercing members 330 is removed to expose the tip members 332, as seen in Fig. 15.

[0063] Referring now to Figs. 17 and 18, another exemplary embodiment of a connector according to the present disclosure is shown. In this exemplary embodiment, the connector 350 includes a body 360 having a run conductor portion 362 and a branch conductor portion 364. The body 360 is an S-shaped like member having a first wall 366, a second wall 368 and a third wall 370 joining the first wall to the second wall. As such, the first wall 366 and a portion of the third wall 370 form the run conductor portion 362, and the second wall 368 and a portion of the third wall 370 form the branch conductor portion 364. The first, second and third walls 366, 368 and 370 may be a unitary or monolithic structure, or the walls 366, 368 and 370 may be separate walls joined together by, for example, welds. The body 360 includes a run opening 372 and a first lead-in 374 between the first wall 366 and a portion of the third wall 370. The first lead-in 374 is configured and dimensioned to permit a run conductor 710 pass into and be received within the run opening 372. The body 360 also includes a branch opening 376 and a second lead-in 378 between the second wall 368 and a portion of the third wall 370. The second lead-in 378 is configured and dimensioned to permit a branch conductor 712 pass into and be within the branch opening 376.

[0064] The first wall 366, in this exemplary embodiment, is a U-shaped like structure configured such that when a run conductor 710 is passed into the opening 372 via lead-in 374, the connector 350 can rest on the run conductor 710 prior to a crimping operation. The second wall 368, in this exemplary embodiment, is a U-shaped like structure configured to receive at least partially a branch conductor 712 passed into the opening 376 via lead-in 378, as seen in Fig. 17. This permits a technician to set-up and operate a crimping tool without having to hold the connector 350 as well.

[0065] The connector 350 may also include one or more insulation piercing members 380 extending from an inner surface of the one or more walls 366, 368 and/or 370 of the body 360.

In the embodiment shown, a single insulation piercing member 380 extends from an inner surface 366a of the first wall 366 into the first opening 372, and a single insulation piercing member 380 extends from an inner surface 368a of the second wall 368 into the second opening 376. Each insulation piercing member 380 may be integrally or monolithically formed into one or more walls 366, 368 and/or 370 and extend into the first opening 372 and/or the second opening 376. Each insulation piercing member 380 includes a tip member 382 that is configured and dimensioned to pierce or cut through insulation surrounding a run conductor 710 or the branch conductor 712 when the connector 350 is crimped such that the electrical wires within the conductors 710 and 712 contact the respective insulation piercing member 380 to create an electrical path between the connector 350, the run conductor 710 and the branch conductor 712. Each tip member 382 is, in this exemplary embodiment, a triangular shaped member extending from the respective wall 366 or 368 of the body 360 into the respective opening 372 or 376. More specifically, each tip member 382 includes two side walls 382a and 382b extending away from the wall of the body 360 and are joined to form a piercing tip 382c. The piercing tip 382c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in a run conductor 710 or a branch conductor 712 when the connector 350 is crimped, and to contact the electrical wire within the run conductor 710 or the branch conductor 712 to create the electrical path between the connector 350 and the conductors 710 and 712, similar to the connection shown in Fig. 18.

[0066] Each tip member 382 has a length "L3" that is less that the width "W1" of the body 360. The length "L3" of the tip member 382 should be sufficiently less than the width "W1" of the body 360 so that the insulation jacket 120 applied to the body 360 surrounds the junction between the walls 366 and 368 and the insulation piercing members 380. By having the length "L3" of the tip members 382 less than the width of the body 360, a seal can form between the connector 350 and a run conductor 710 or a branch conductor 712 when the conductor is crimped to the connector 350. This seal minimizes and possibly prevents water and/or gas from contacting each insulation piercing member 380. As a non-limiting example, if the width "W1" of the body 360 is about 1 inch, the length "L3" of the tip member 382 would preferably be about 1/2 inch and the tip member 382 would be centered along the width "W1" of the body 360

as shown in Fig. 21. As such, in this exemplary embodiment, the length "L3" of the tip member 382 is about 1/2 the width "W1" of the body 360. In this exemplary embodiment, the body 360 is typically formed by an extrusion process, metal casting process or a machining process where the insulation piercing members 380 are formed as part of the extrusion process, metal casting process or the insulation piercing member is machined as part of the body 360. In order to harden the insulation piercing members 380, the insulation piercing members can be put through a conventional hardening process, such as heating and then rapidly cooling the insulation piercing member.

[0067] Although the insulation piercing members 380 are described above as a triangular shaped member, the insulation piercing members 380 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 380 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires.

[0068] It is noted that in the exemplary embodiment shown in Figs. 17 and 18, the first conductor portion 362 and the second conductor portion 364 are configured and dimensioned with inner surfaces 366a and 368a shaped to receive conductors, e.g., a run conductor 710 or a branch conductor 712. The configuration of the first opening 372 and the first lead-in 374 and the configuration of the second opening 376 and the second lead-in 378 can vary depending upon the size of the conductor to be crimped. As a non-limiting example, the conductor can range from about 250 Kcmil to about 750 Kcmil.

[0069] Referring now to Figs. 19 and 20, another exemplary embodiment of the connector of the present disclosure is shown. In this exemplary embodiment, the connector 400 includes a body 410 having a run conductor portion 412 and a branch conductor portion 414. The run conductor portion 412 of the body 410 is a C-shaped like member having a first wall 416, a common wall 418 and a third wall 420 joining the first wall 416 to the common wall 418. The branch conductor portion 414 of the body 410 is a circular, oval or other shaped member having a second wall 422, the common wall 418, a side walls 424 and 426 joining the second wall 422

to the common wall 418. The walls 416, 418, 420, 422, 424 and 426 may be a unitary or monolithic structure, or the walls 416, 418, 420, 422, 424 and 426 may be separate walls joined together by, for example, welds. The run conductor portion 412 of the body 410 also includes a first opening 428 and a first lead-in 430 between the first wall 416 and a portion of the common wall 418. The lead-in 430 is configured and dimensioned to permit a run conductor 710 to pass through the lead-in 430 into the opening 428. The branch conductor portion 414 of the body 410 also includes a second opening 432 between the second wall 422 and a portion of the common wall 418.

[0070] The first wall 416, in this exemplary embodiment, is a U-shaped like structure configured such that when a run conductor 710 is passed into the opening 428 via the lead-in 430, the connector 400 can rest on the run conductor 710 prior to a crimping operation, as seen in Fig. 19.

[0071] Continuing to refer to Figs. 19 and 20, the run conductor portion 412 of the body 410 may also include one or more insulation piercing members 440 extending from an inner surface of the one or more walls 416, 418 and/or 420 toward the first opening 428. Each insulation piercing member 440 may be integrally or monolithically formed into the one or more walls 416, 418 and/or 420, or each insulation piercing member may be a separate structure secured to the one or more walls 416, 418 and/or 420 using, for example, a friction fit or welds. In the embodiment shown, a single insulation piercing member 440 extends from an inner surface 416a of the first wall 416 into the first opening 428. The branch conductor portion 412 of the body 410 may also include one or more insulation piercing members 440 extending from an inner surface of the one or more walls 418, 420 and/or 422 toward the second opening 432. Each insulation piercing member 440 may be integrally or monolithically formed into the one or more walls 418, 420 and/or 422, or each insulation piercing member may be a separate structure secured to the one or more walls 418, 420 and/or 422 using, for example, a friction fit or welds. In the embodiment shown, a single insulation piercing member 440 extends from an inner surface 418a of the common wall 418 into the second opening 432.

[0072] Each insulation piercing member 440 includes a tip member 442 that is configured and dimensioned to pierce or cut through insulation surrounding a run conductor 710 or the branch conductor 712 when the connector 400 is crimped such that the electrical wires within the conductors 710 and 712 contact the respective insulation piercing member 440 to create an electrical path between the connector 400, the run conductor 710 and the branch conductor 712. Each tip member 442 is, in this exemplary embodiment, a triangular shaped member extending from the respective wall 416 or 418 of the body 410 into the respective opening 428 or 432. More specifically, each tip member 442 includes two side walls 442a and 442b extending away from the wall of the body 410 and are joined to form a piercing tip 442c. The piercing tip 442c is configured and dimensioned to pierce or cut through the insulation jacket surrounding the electrical wire in a run conductor 710 or a branch conductor 712 when the connector 400 is crimped, and to contact the electrical wire within the run conductor 710 or the branch conductor 712 to create the electrical path between the connector 400 and the conductors 710 and 712, similar to the connection shown in Fig. 20.

[0073] Each tip member 442 has a length "L3" that is less that the width "W1" of the body 360. The length "L3" of the tip member 442 should be sufficiently less than the width "W1" of the body 410 so that the insulation jacket 120 applied to the body 410 surrounds the junction between the walls 416 and 418 and the insulation piercing members 440. By having the length "L3" of the tip members 442 less than the width of the body 410, a seal can form between the connector 400 and a run conductor 710 or a branch conductor 712 when the conductor is crimped to the connector 400. This seal minimizes and possibly prevents water and/or gas from contacting each insulation piercing member 440. As a non-limiting example, if the width "W1" of the body 410 is about 1 inch, the length "L3" of the tip member 442 would preferably be about 1/2 inch and the tip member 442 would be centered along the width "W1" of the body 410 as shown in Fig. 19. As such, in this exemplary embodiment, the length "L3" of the tip member 442 is about 1/2 the width "W1" of the body 410. In this exemplary embodiment, the body 410 is typically formed by an extrusion process, metal casting process or a machining process where the insulation piercing members 440 are formed as part of the extrusion process, metal casting process or the insulation piercing member is machined as part of the body 410. In order to

harden the insulation piercing members 440, the insulation piercing members can be put through a conventional hardening process, such as heating and then rapidly cooling the insulation piercing member.

[0074] Although the insulation piercing members 440 are described above as a triangular shaped member, the insulation piercing members 440 may come in different shapes and sizes configured and dimensioned to pierce or cut through insultation surrounding electrical wires, such as a cone-shaped member or a member with a pointed tip. Further, the insulation piercing members 440 may include a serrated tip to assist in the piercing through insulation surrounding the electrical wires.

[0075] It is noted that in the exemplary embodiment shown in Figs. 19 and 20, the first conductor portion 412 and the second conductor portion 414 are configured and dimensioned with inner surfaces shaped to receive conductors, e.g., a run conductor 710 or a branch conductor 712. The configuration of the first opening 428 and the first lead-in 430 and the configuration of the second opening 432 can vary depending upon the size of the conductor to be crimped. As a non-limiting example, the conductor can range from about 250 Kcmil to about 750 Kcmil.

[0076] As shown throughout the drawings, like reference numerals designate like or corresponding parts. While illustrative embodiments of the present disclosure have been described and illustrated above, it should be understood that these are exemplary of the disclosure and are not to be considered as limiting. Additions, deletions, substitutions, and other modifications can be made without departing from the spirit or scope of the present disclosure. Accordingly, the present disclosure is not to be considered as limited by the foregoing description.

CLAIMS

What is claimed is:

1. An electrical compression connector for connecting a plurality of conductors, the compression connector comprising:

a connector body made of compressible material and adapted to be inserted into a crimping tool, the connector body having a run conductor portion and a branch conductor portion;

the run conductor portion includes a pair of side walls joined by a bottom wall, a run conductor opening between the pair of side walls and the bottom wall, and at least one insulation piercing member extending from at least one of the pair of side walls and the bottom wall into the run conductor opening;

the branch conductor portion includes at least one branch conductor opening having a lead-in with a rib adjacent the lead-in, and a hinge portion between the branch conductor opening and the connector body; and

an insulation coating surrounding the connector body such that an interior wall of the at least one branch conductor opening and the at least one insulation piercing member are not covered by the insulation coating.

2. The compression connector according to claim 1, wherein the at least one insulation piercing member comprises a base and a tip member, wherein the base is attached to the at least one of the pair of side walls or the bottom wall and the tip member extends from the at least one of the pair of side walls or the bottom wall into the run conductor opening.

3. The compression connector according to claim 1, wherein a length of the at least one insulation piercing member is less than a width of the at least one of the pair of side walls or the bottom wall.

4. The compression connector according to claim 1, wherein the at least one insulation piercing member is integrally or monolithically formed into the at least one of the pair of side

walls or the bottom wall and extends from the at least one of the pair of side walls or the bottom wall into the run conductor opening.

5. The compression connector according to claim 1, wherein the at least one insulation piercing member is removably attached to the bottom wall.

6. The compression connector according to claim 1, wherein the at least one insulation piercing member is removably attached to one of the pair of side walls.

7. The compression connector according to claim 1, wherein the branch conductor portion includes a plurality of branch conductor openings each having a lead-in with a rib adjacent the lead-in, and a hinge portion between the branch conductor opening and the connector body.

8. The compression connector according to claim 1, wherein each of the at least one branch conductor opening includes at least one insulation piercing member extending into the branch conductor opening.

9. The compression connector according to claim 8, wherein the at least one insulation piercing member in each branch conductor opening is integrally or monolithically formed into the connector body.

10. An electrical compression connector for connecting a plurality of conductors, the compression connector comprising:

a connector body made of compressible material and adapted to be inserted into a crimping tool, the connector body having a run conductor portion and a branch conductor portion;

the run conductor portion includes at least one wall forming a run conductor receiving opening, and at least one insulation piercing member extending from the at least one wall into the run conductor opening; and

the branch conductor portion includes at least one wall forming a branch conductor receiving opening and at least one insulation piercing member extending from the at least one wall into the branch conductor opening; and

an insulation coating surrounding the connector body such that each at least one insulation piercing member is not covered by the insulation coating.

11. The compression connector according to claim 10, wherein the at least one insulation piercing member in the run conductor portion comprises a base and a tip member, wherein the base is attached to the at least one wall of the run conductor portion and the tip member extends from the at least one wall of the run conductor portion into the run conductor opening, and wherein the at least one insulation piercing member in the branch conductor portion comprises a base and a tip member, wherein the base is attached to the at least one wall of the branch conductor portion and the tip member extends from the at least one wall of the branch conductor portion into the branch conductor opening.

12. The compression connector according to claim 10, wherein a length of the at least one insulation piercing member in the run conductor portion is less than a width of the at least one wall of the run conductor portion, and wherein a length of the at least one insulation piercing member in the branch conductor portion is less than a width of the at least one wall of the branch conductor portion .

13. The compression connector according to claim 10, wherein the at least one insulation piercing member in the run conductor portion is integrally or monolithically formed into the at least one wall of the run conductor portion and extends from the at least one wall of the run conductor portion into the run conductor opening, and wherein the at least one insulation piercing member in the branch conductor portion is integrally or monolithically formed into the at least one wall of the branch conductor portion and extends from the at least one wall of the run conductor portion into the branch conductor opening.

14. The compression connector according to claim 10, wherein the at least one insulation piercing member in the run conductor portion is removably attached to the at least one wall of the run conductor portion and extends from the at least one wall of the run conductor portion into the run conductor opening, and wherein the at least one insulation piercing member in the branch conductor portion is removably attached to the at least one wall of the branch conductor portion and extends from the at least one wall of the run conductor portion into the branch conductor opening.

15. An electrical compression connector for connecting a plurality of conductors, the compression connector comprising:

a connector body made of compressible material and adapted to be inserted into a crimping tool, the connector body having a run conductor portion and a branch conductor portion;

the run conductor portion having a run conductor opening and at least one insulation piercing member extending from the connector body into the run conductor opening;

the branch conductor portion having a plurality of branch conductor openings each having at least one insulation piercing member extending from the connector body into the run conductor opening; and

an insulation coating surrounding the connector body such that the at least one insulation piercing member in the run conductor portion and the at least one insulation piercing member in the branch conductor portion are not covered by the insulation coating.

16. The compression connector according to claim 15, wherein the at least one insulation piercing member in the run conductor portion comprises a base and a tip member, wherein the base is attached to the conductor body and the tip member extends from the conductor body into the run conductor opening, and wherein the at least one insulation piercing member in the branch conductor portion comprises a base and a tip member, wherein the base is attached to the

conductor body and the tip member extends from the conductor body into the branch conductor opening.

17. The compression connector according to claim 15, wherein a length of the at least one insulation piercing member in the run conductor portion is less than a width of the conductor body, and wherein a length of the at least one insulation piercing member in the branch conductor portion is less than a width of the conductor body.

18. The compression connector according to claim 15, wherein the at least one insulation piercing member in the run conductor portion is integrally or monolithically formed into the conductor body, and wherein the at least one insulation piercing member in the branch conductor portion is integrally or monolithically formed into the conductor body.

19. The compression connector according to claim 15, wherein the at least one insulation piercing member in the run conductor portion is removably attached to the conductor body, and wherein the at least one insulation piercing member in the branch conductor portion is removably attached to the conductor body.

20. The compression connector according to claim 15, wherein the connector body comprises one of a U-shaped body, an H-shaped body, an S-shaped body, and a C-shaped body.

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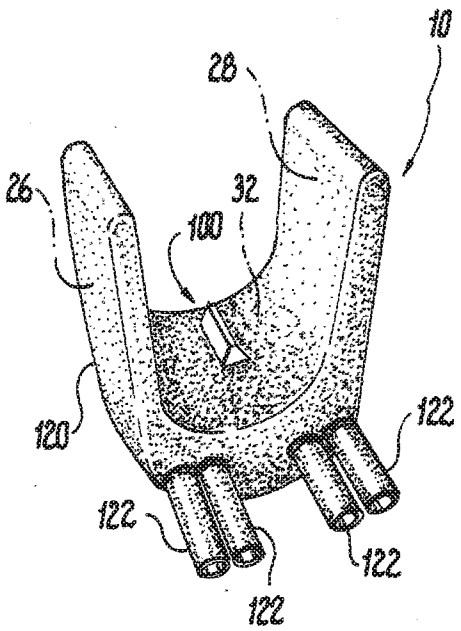


Fig. 1

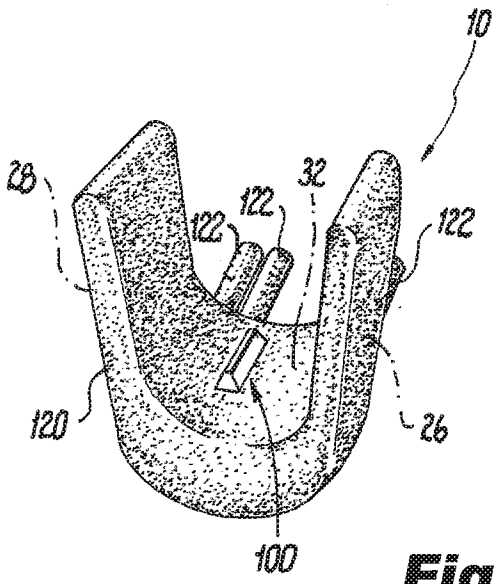


Fig. 2

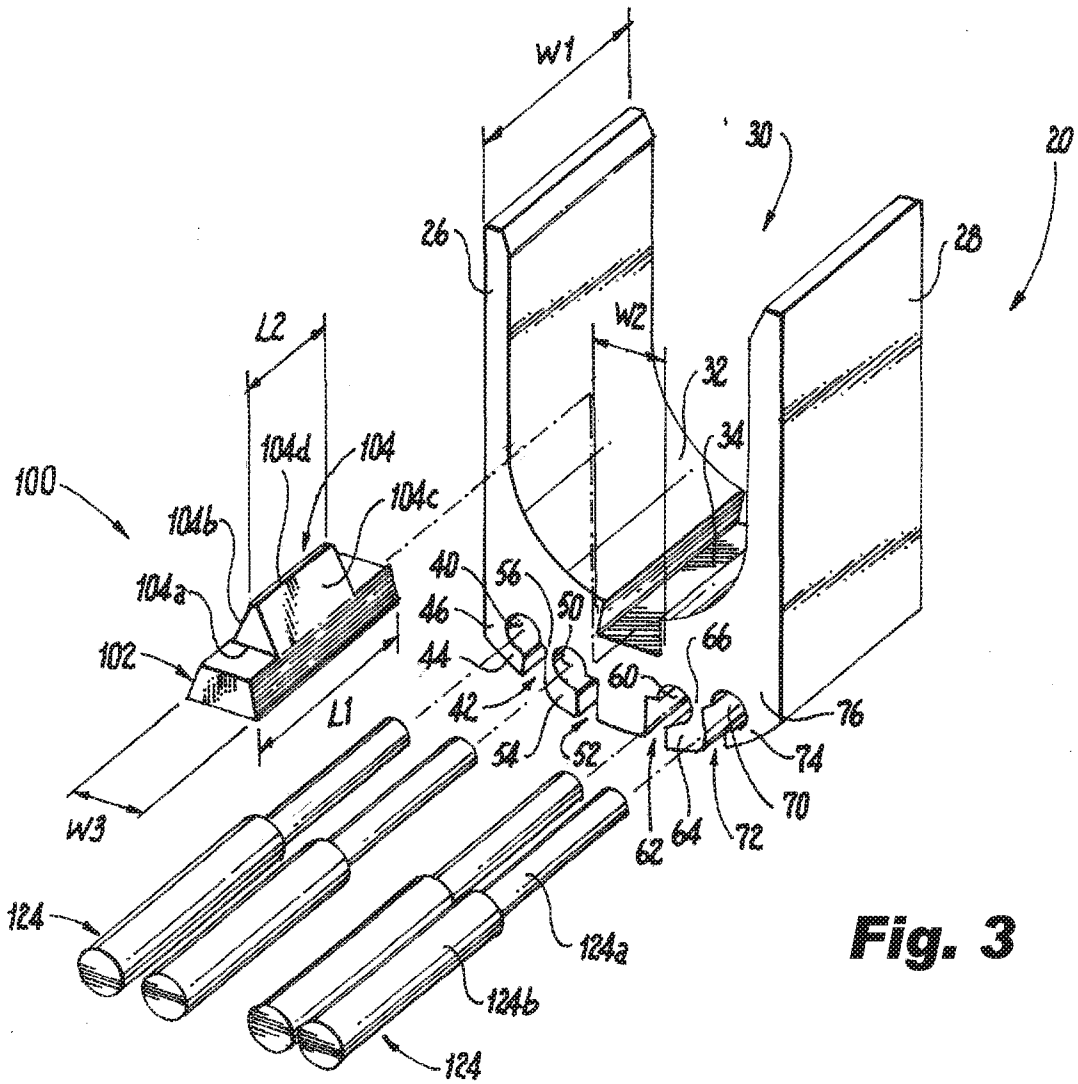


Fig. 3

Fig. 4

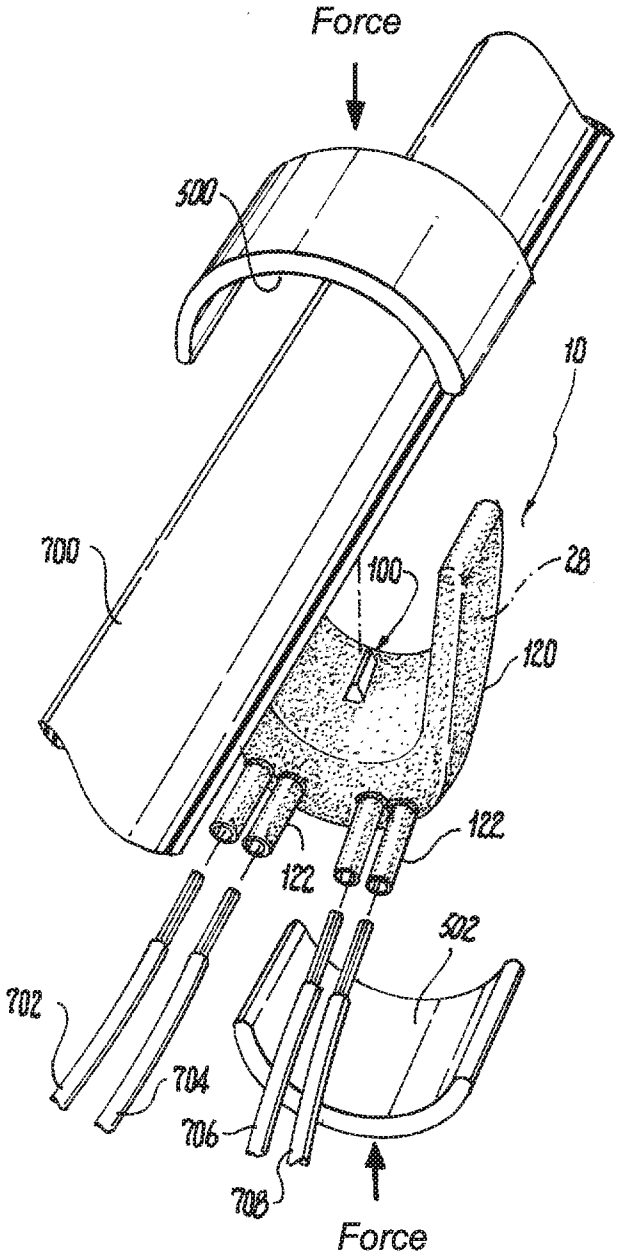
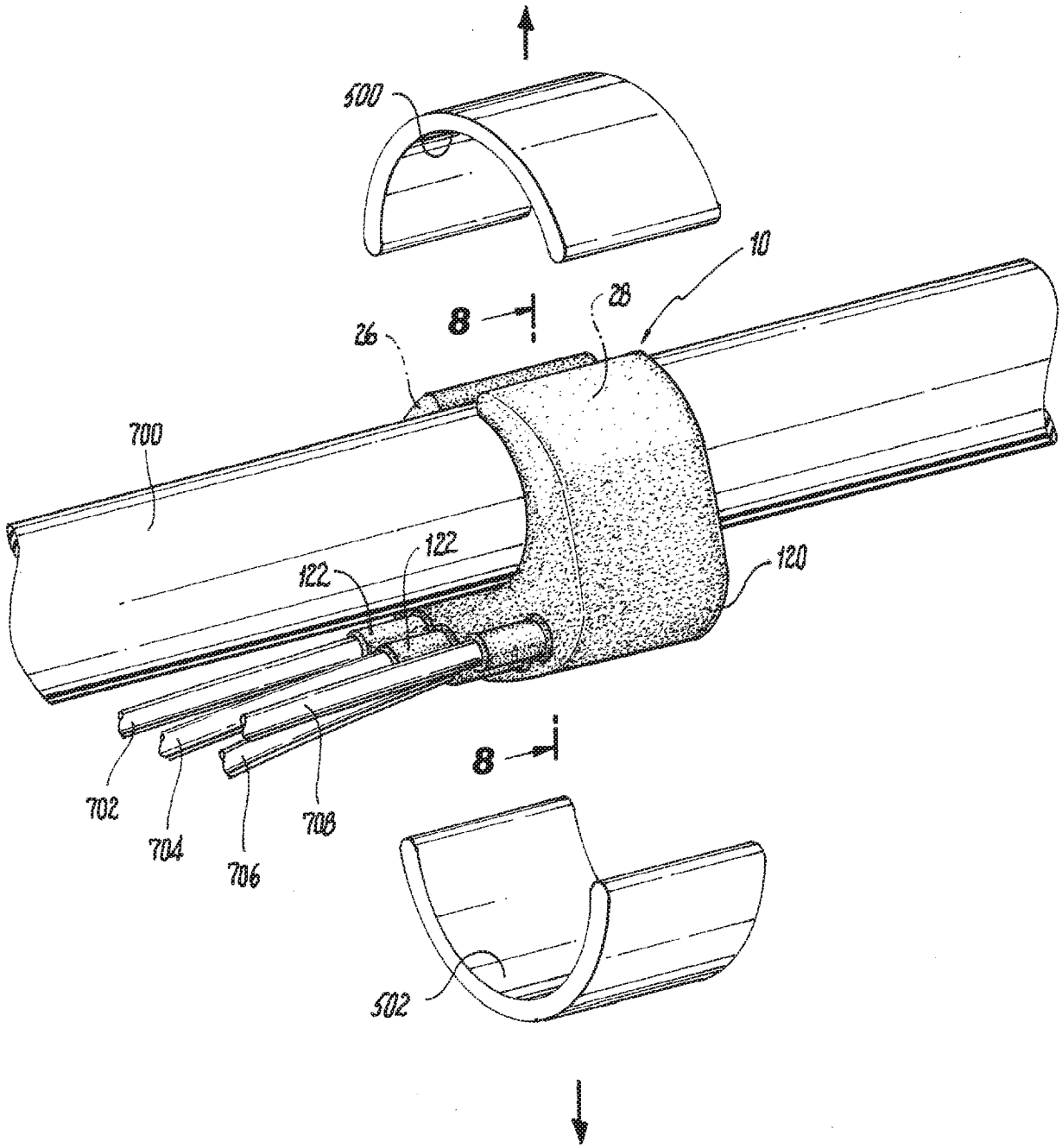


Fig. 5



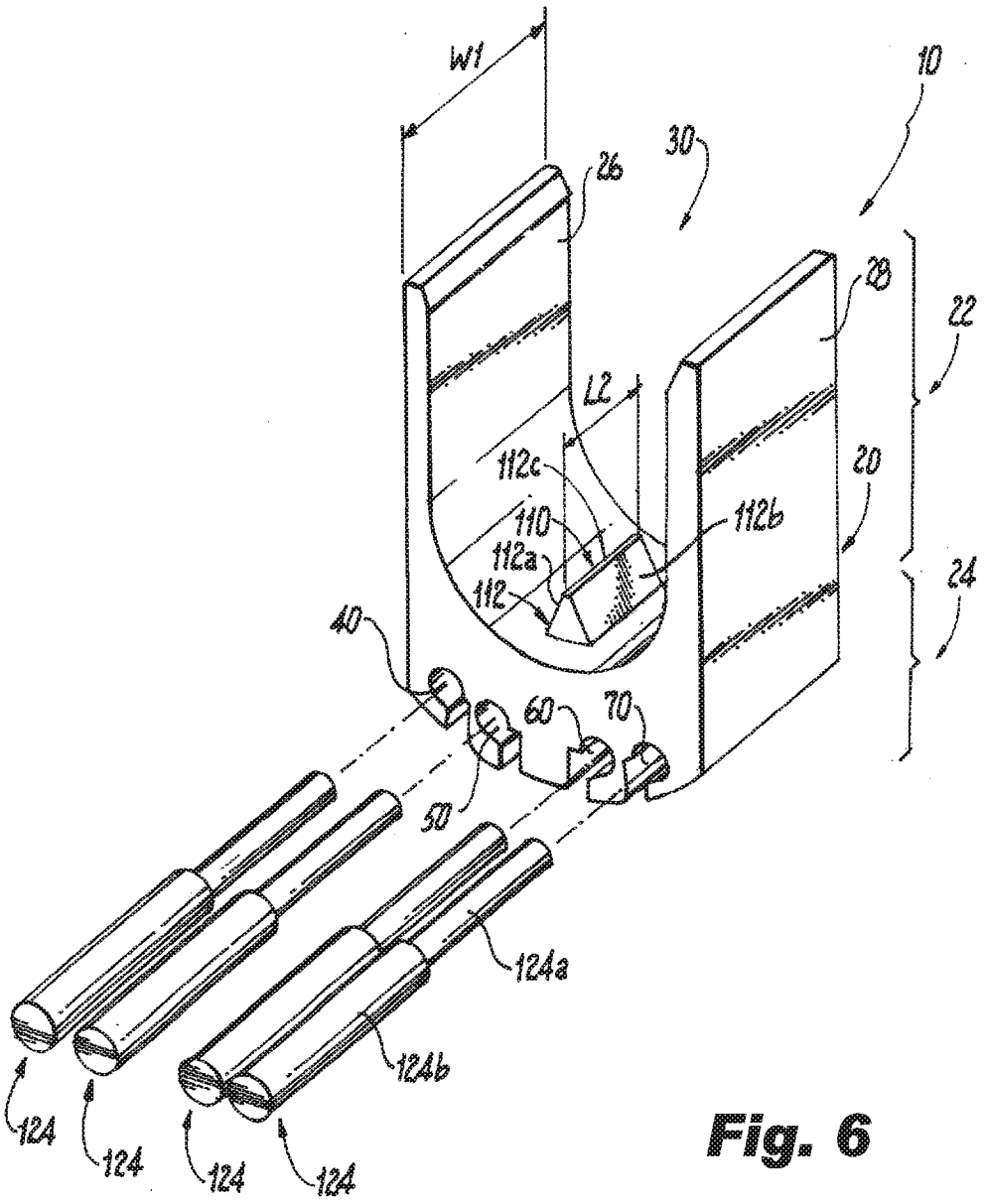
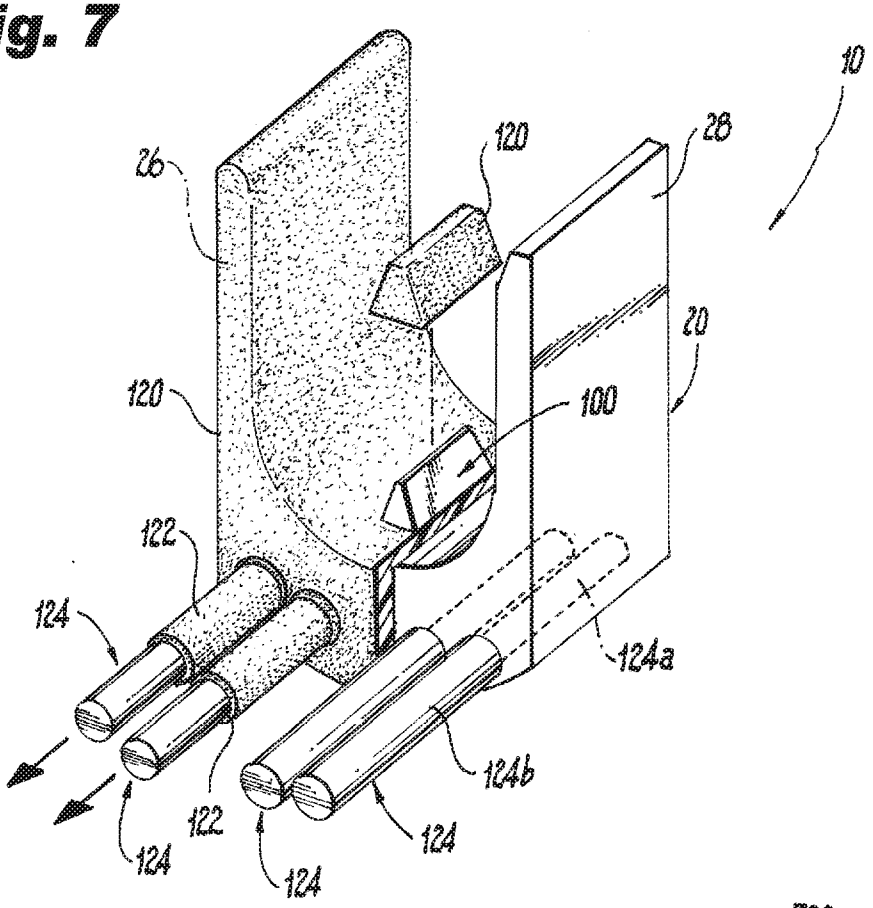

W1
10
30
26
28
22
L2
112c
110
112a
112
112b
20
24
40
60
70
50
124a
124b
124
124
124
124

Fig. 6

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5/11

Fig. 7



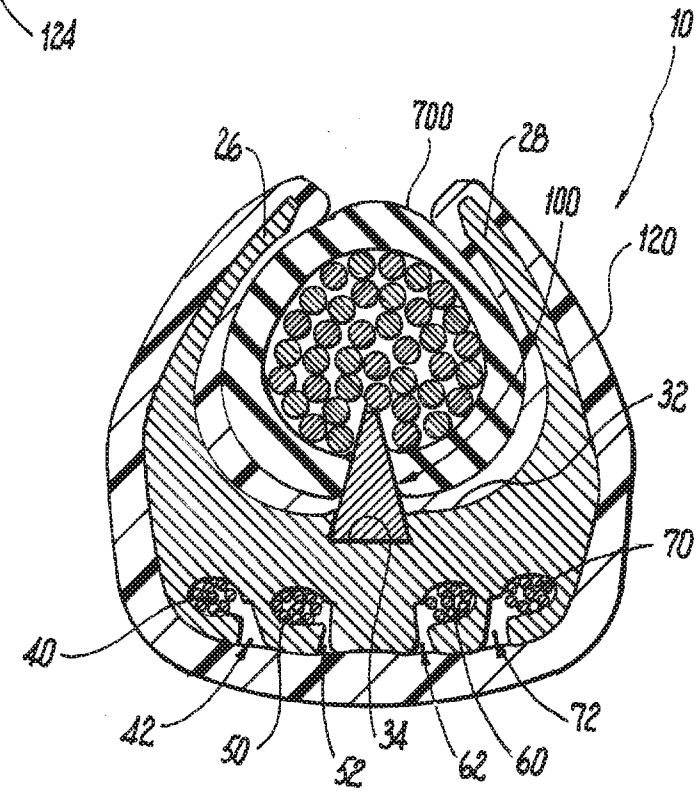
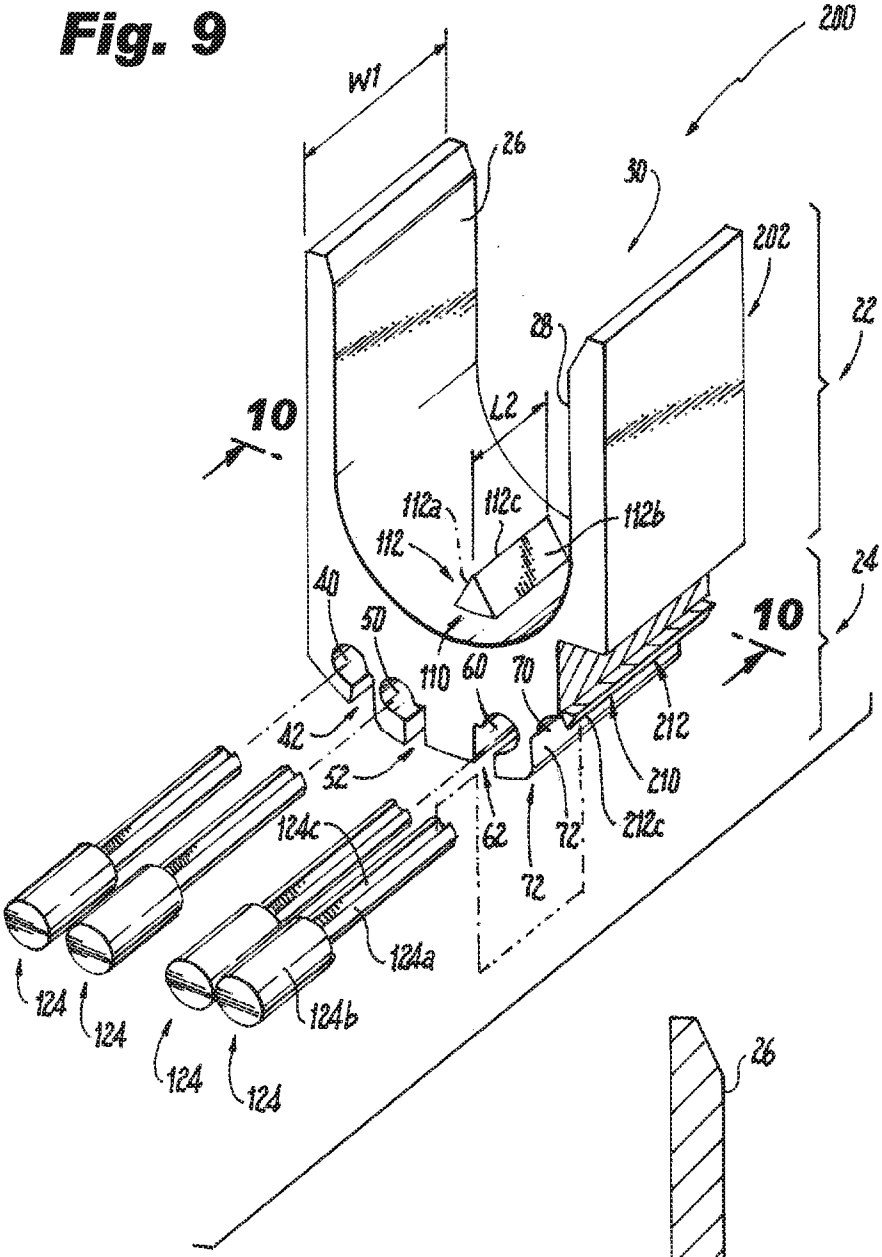


Fig. 8

Docket: 117-0192PCT
6/11

Fig. 9



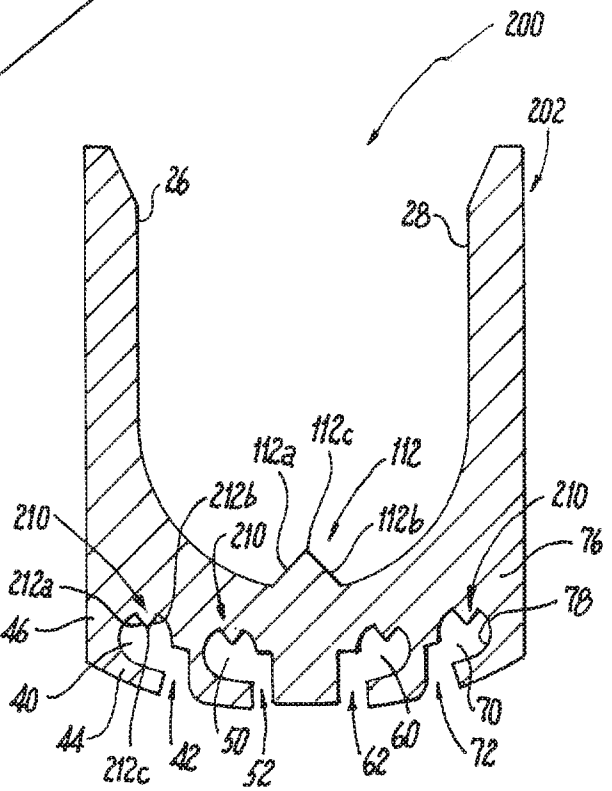


Fig. 10

Docket: 117-0192PCT
7/11

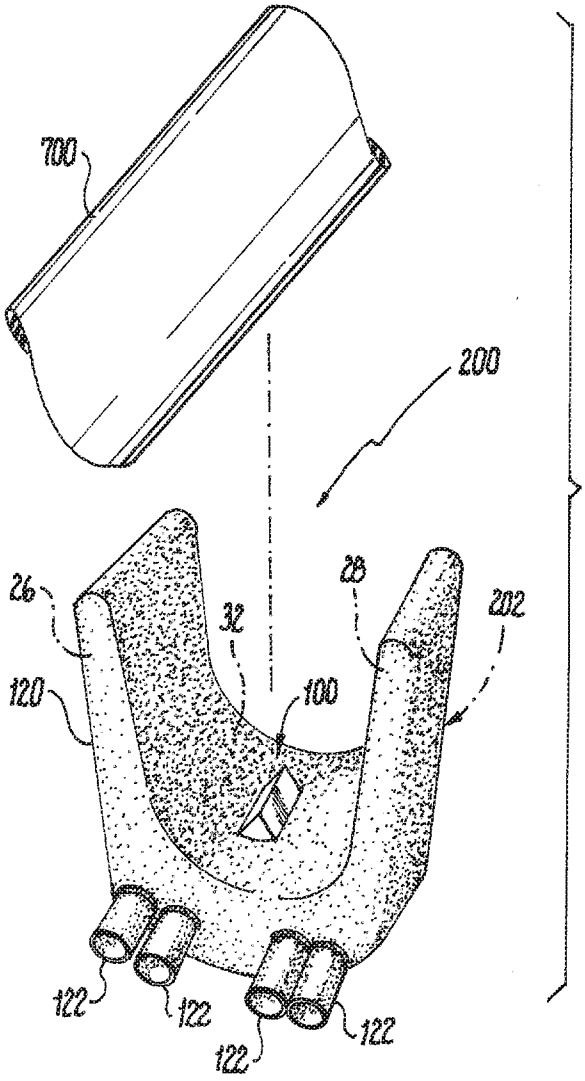


Fig. 11

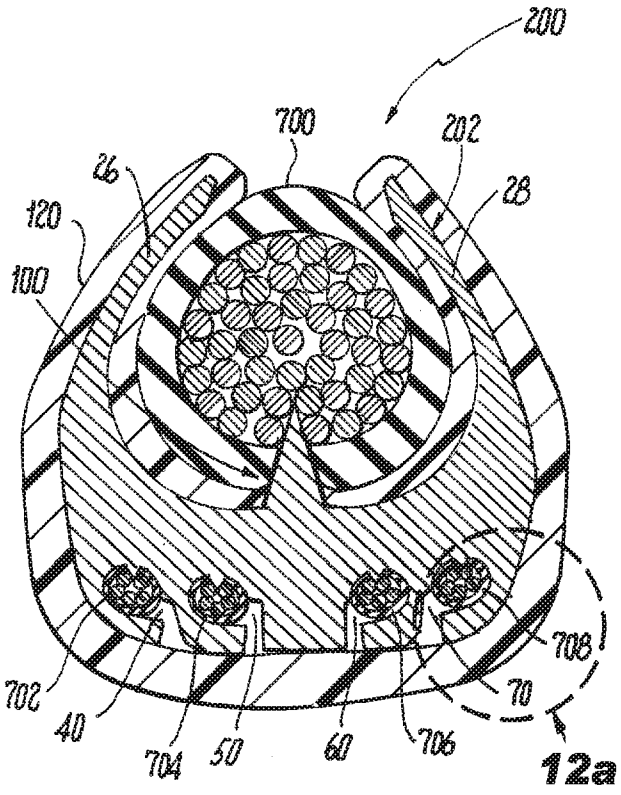


Fig. 12

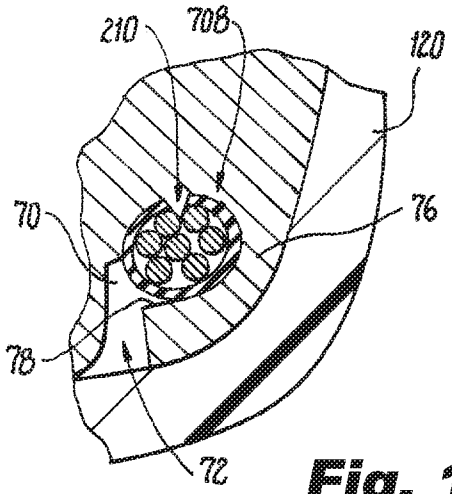


Fig. 12a

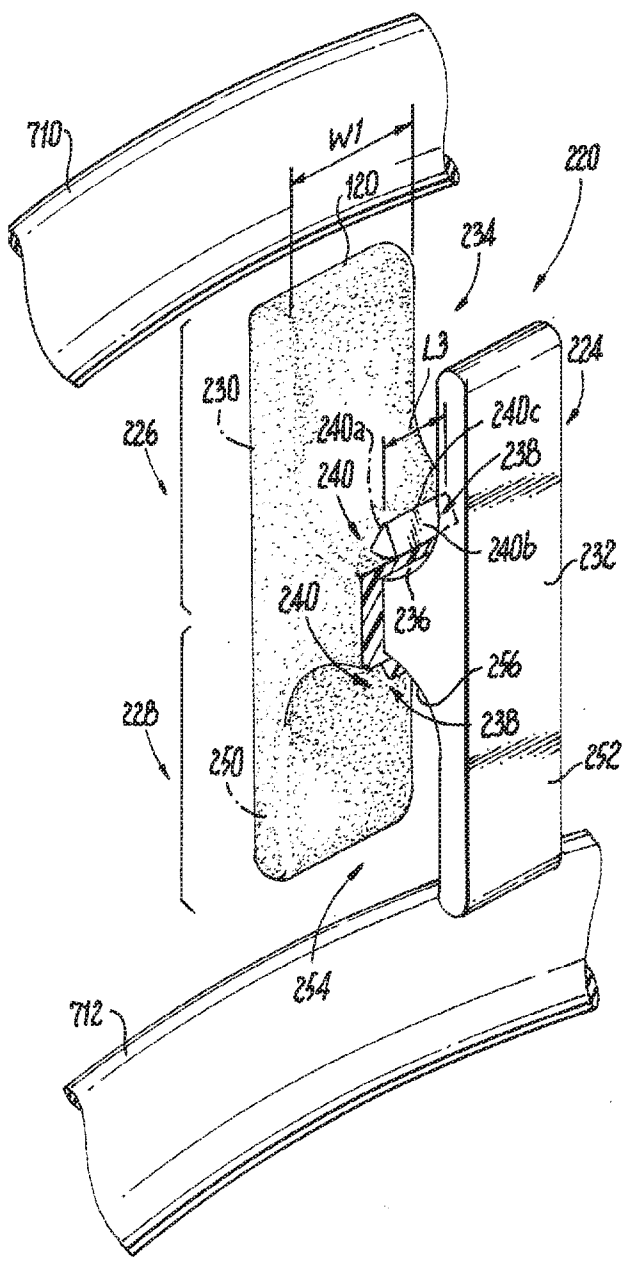

710
W1
120
220
234
L3
224
230
240a
240c
226
240
238
240b
232
240
236
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228
238
250
252
254
712

Fig. 13

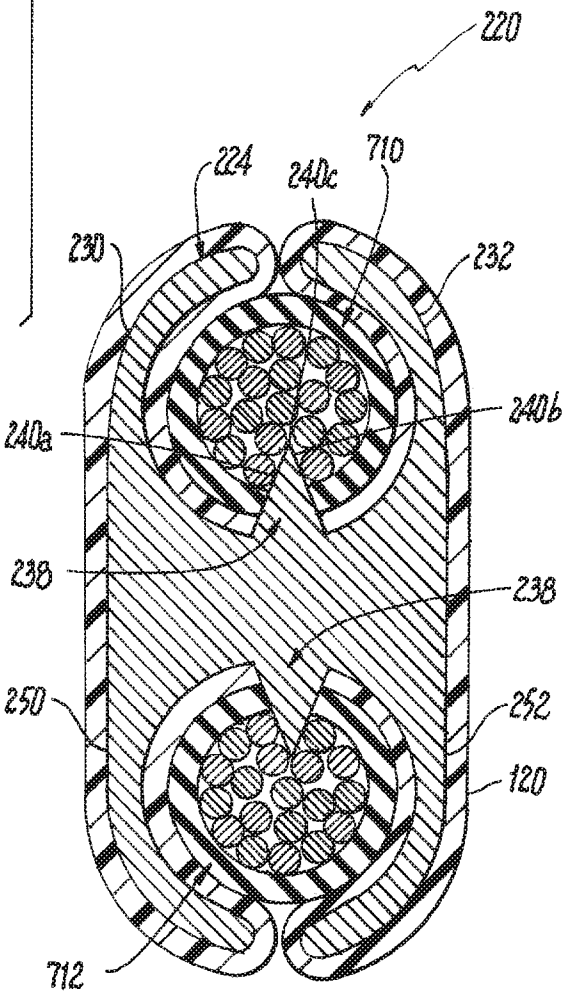

220
224
240c
710
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232
240b
240a
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238
250
252
120
712

Fig. 14

Docket: 117-0192PCT
9/11

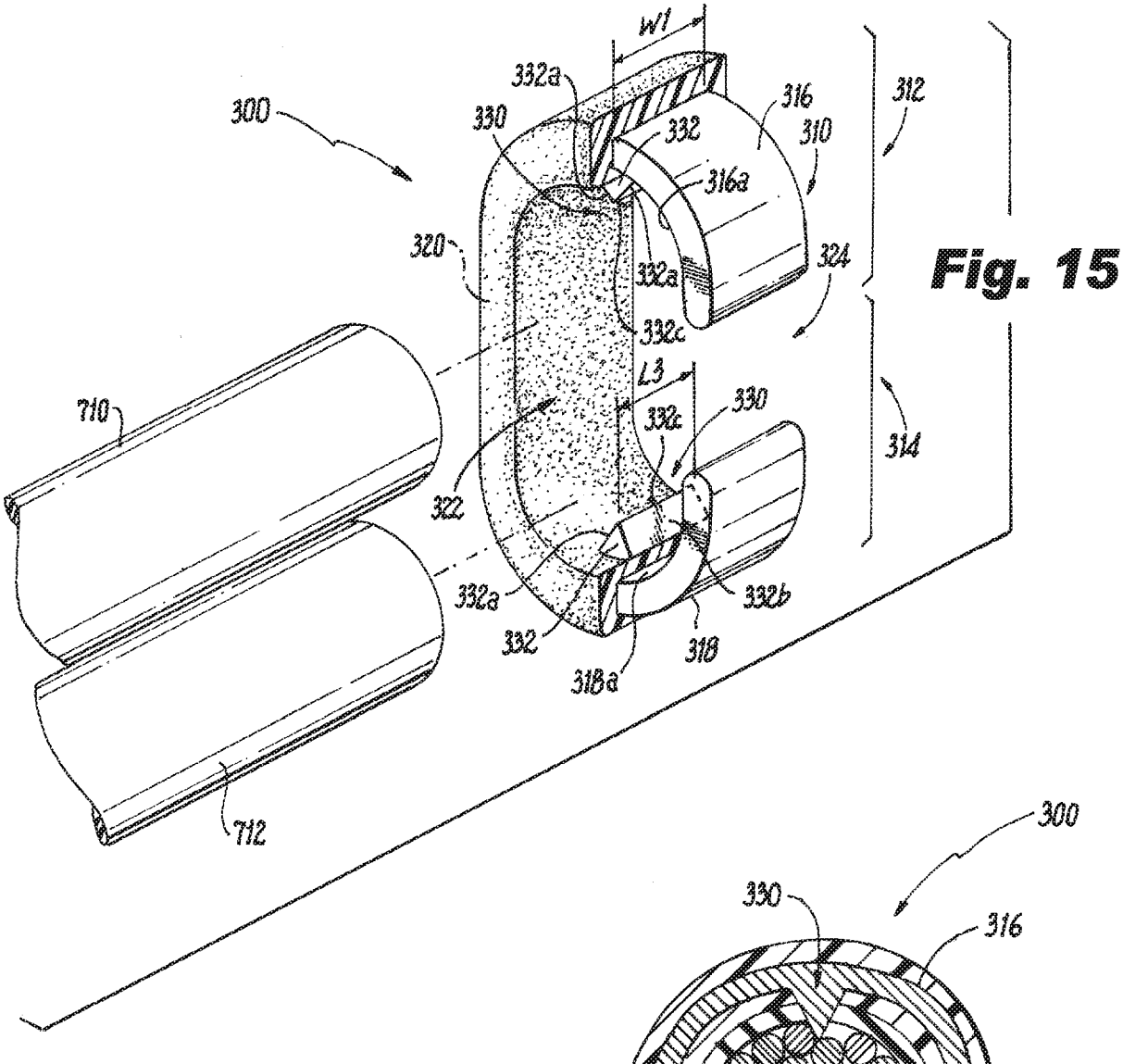


Fig. 15

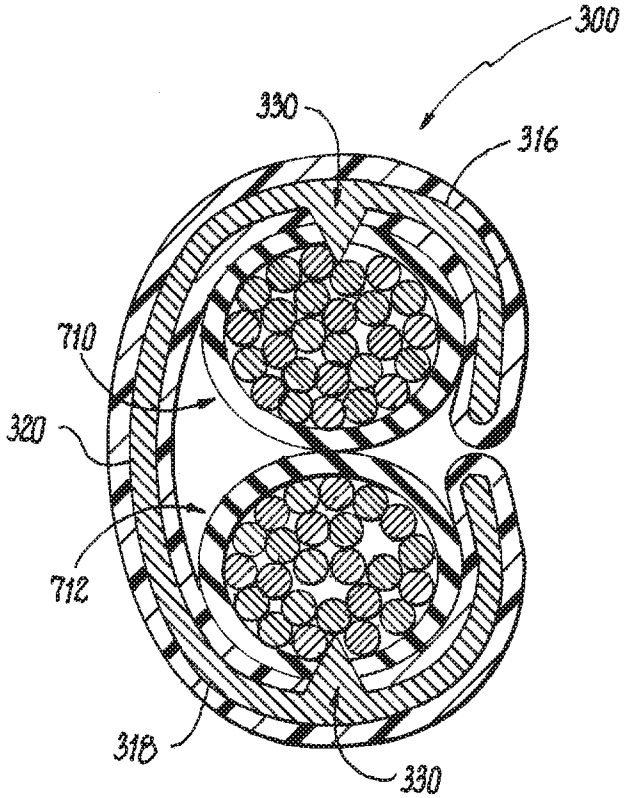


Fig. 16

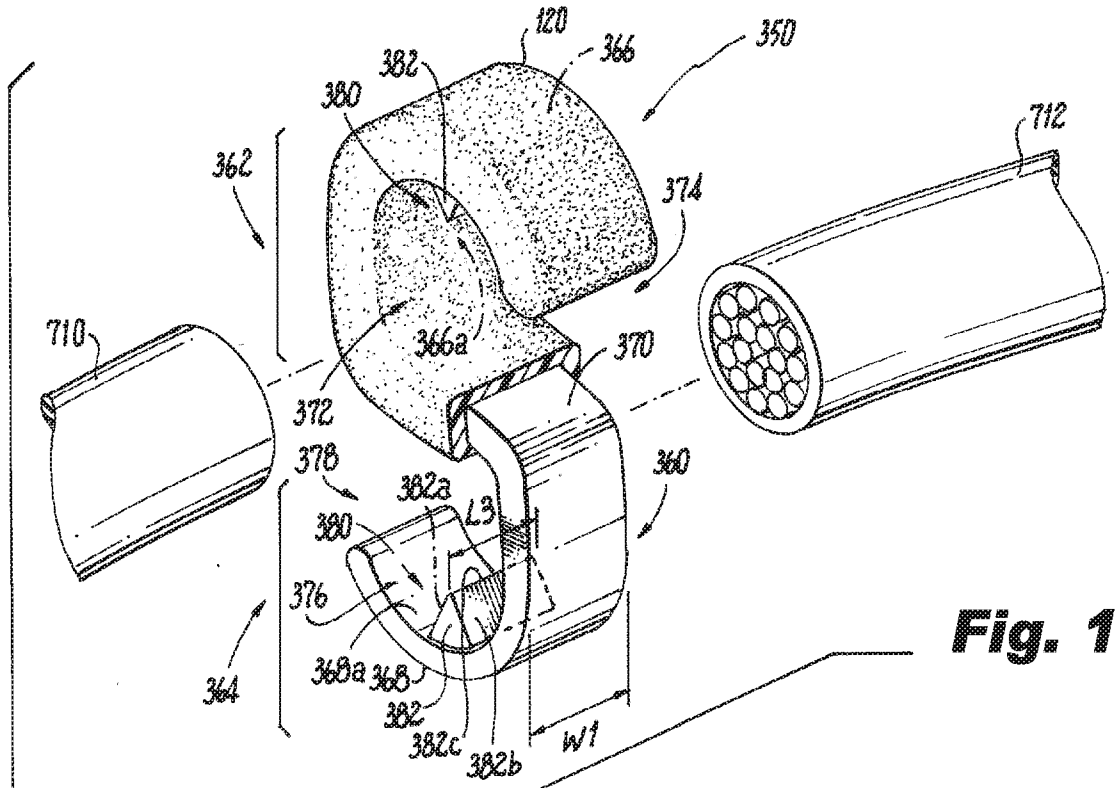

120
366
350
382
380
362
712
374
710
366a
370
372
378
382a
360
L3
380
376
368a
368
382
382c
382b
w1
364

Fig. 17

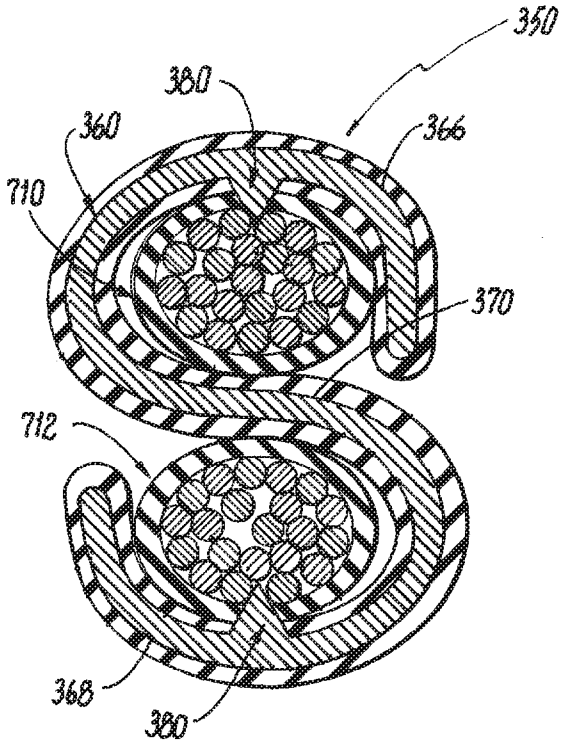

350
380
360
366
710
370
712
368
380

Fig. 18

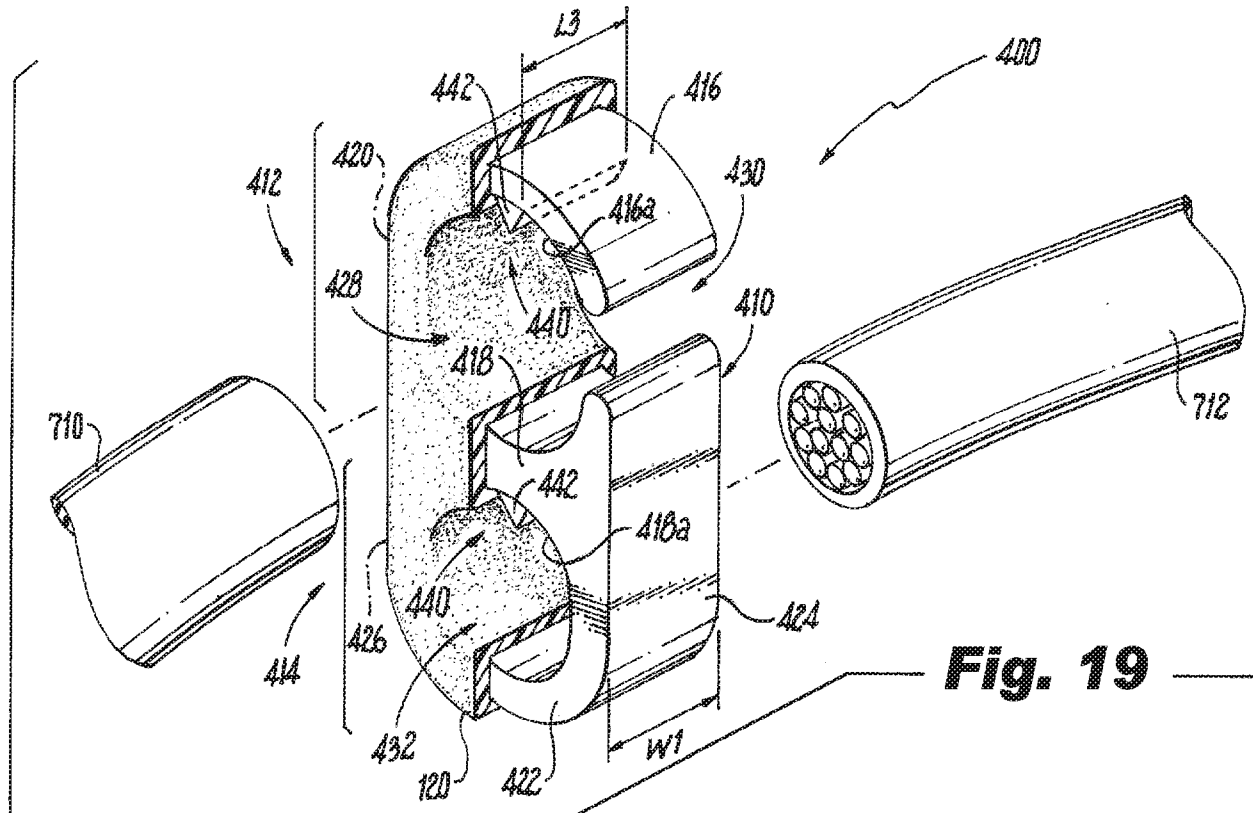

L3
400
442
416
420
412
430
416a
428
440
410
418
710
712
442
418a
440
424
426
414
432
120
422
W1

Fig. 19

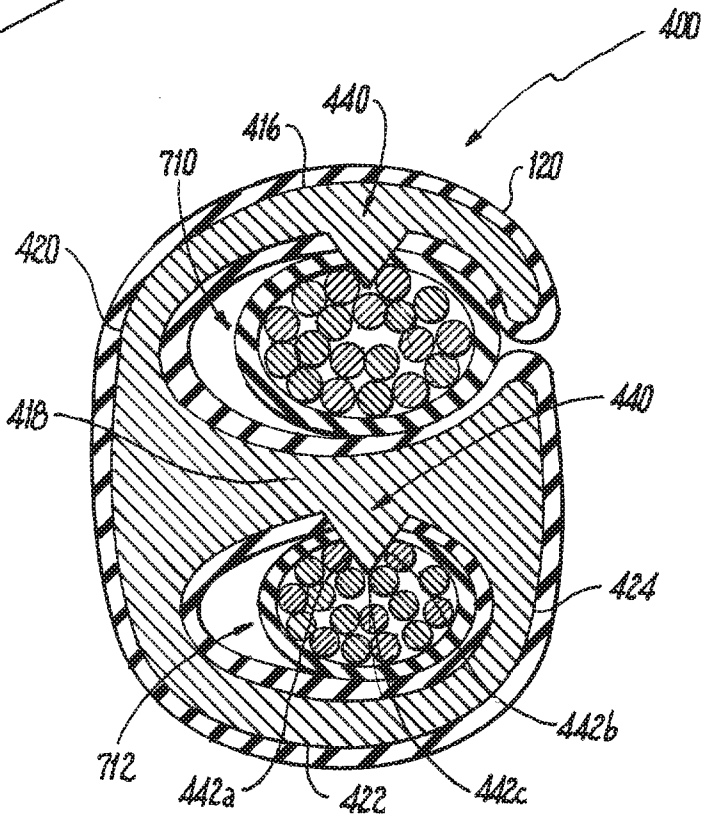

400
440
416
710
120
420
418
440
424
442b
712
442a
422
442c

Fig. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/013951

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01R 4/2404; H01R 4/2407; H01R 4/2495; H01R 4/26; H01R 9/03; H01R 11/09 (2020.01)

CPC - H01R 4/2404; H01R 4/18; H01R 4/183; H01R 4/184; H01R 4/185; H01R 4/186; H01R 4/24; H01R 4/2407; H01R 4/2458; H01R 4/2495; H01R 4/26; H01R 9/03; H01R 9/031; H01R 11/05; H01R 11/07; H01R 11/09 (2020.02)

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)

See Search History document

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

USPC - 174/71R; 174/70R; 174/84C; 439/387; 439/389; 439/391; 439/413; 439/421; 439/430; 439/442; 439/879 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,194,877 A (COLLIER) 13 July 1965 (13.07.1965) entire document	1-20
A	US 2003/0010524 A1 (CONNOR) 16 January 2003 (16.01.2003) entire document	1-20
P, X	US 2019/0058265 A1 (HUBBELL INCORPORATED) 21 February 2019 (21.02.2019) entire document	1-20
A	US 3,668,613 A (KLOSIN) 06 June 1972 (06.06.1972) entire document	1-20
A	US 2008/0113553 A1 (LEGRADY et al) 15 May 2008 (15.05.2008) entire document	1-20
A	US 2015/0229037 A1 (YAZAKI CORPORATION) 13 August 2015 (13.08.2015) entire document	1-20

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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

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"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
03 March 2020	23 MAR 2020
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774