

TEST POINT INSERT

FIELD OF INVENTION

[0001] The present invention relates to cable connectors, such as loadbreak connectors and deadbreak connectors, having a voltage test point. Specifically, the voltage test point is molded during the jacket molding process of the cable connector and designed to prevent defects on the voltage test point without the use of a plastic barrier surrounding the test point terminal. The molding process utilized in the present invention is designed to limit variations in the capacitive ratio of test points, from part-to-part, during the manufacturing process.

BACKGROUND OF INVENTION

[0002] Electrical distribution networks are critical for the delivery of electricity to consumers and businesses from the transmission system. Loadbreak and deadbreak connectors are used in conjunction with 15, 25, and 35 kV switchgear in electrical distribution networks. Such connectors typically have an elbow-like design, having one end configured to receive a power cable and another end configured for receiving the bushing of an apparatus, such as switchgear.

[0003] The connector typically includes a grounding eye, affixed along its exterior surface, and a test point. The grounding eye is capable of being connected to an external ground in order to ensure that the semi-conductive outer layer of the connector remains at ground potential.

[0004] In a typical configuration, the semi-conductive outer layer encloses a conductor surrounded by a semi-conducting layer and an insulating layer. A first end of a voltage test point is embedded into the insulating layer and a second end is exposed to accept an indicating device. As a result, a voltage on the conductor capacitively couples a first voltage on the test point terminal and a second voltage on the semi-conductive outer layer.

[0005] Various indicating devices are known in the art that use the voltage test point to determine whether a voltage is present in the conductor of loadbreak and deadbreak connectors. This is of extreme importance to prevent electrical shock hazards to service personnel that maintain the continual operation of electrical distribution networks. Therefore, these indicating devices need to reliably and correctly indicate the presence of voltage in the connector.

[0006] Although there is no official industry standard for the geometry of the voltage test point, it is understood that voltage test points are generally cylindrical. As a result, various voltage sensing devices are designed to mate with this common size and shape. When the voltage test point is not in use, a cap of semi-conductive material is coupled to the test point, such that the cap makes contact with the outer jacket of the connector. Since the outer jacket is grounded via the grounding eye, the coupled cap grounds the voltage test point. However, when the test point is in use the voltage indicating device does not ground the test point.

[0007] Because of the limitations of the geometry of the test point, the outer jacket material of the connector is typically thin in the area surrounding the test point. The thin area allows the semi-conductive cap to make contact with the test point terminal and the outer jacket. Voltage sensing devices must also be able to contact the test point terminal and outer jacket in order to correctly measure the capacitive ratio, which is necessary to indicate the presence of voltage in the conductor of the connector.

[0008] Typically, loadbreak and deadbreak connectors are manufactured by injection molding, specifically by injecting rubber or epoxy into a metal mold comprising either steel or aluminum. The test point terminal is inserted into the mold during the insulation molding process. As a result of the thin material surrounding the test point area, molding defects such as flashing can occur due to excess material in the thin layers of the part. The deformations can be so great that the conductive jacket layer makes contact and grounds the test point terminal, thereby rendering the test point inoperative. One solution to this problem is to trim the excess material -- an inconsistent and time consuming procedure. Improperly trimming the excess material can also lead to contaminants remaining on the test point terminal and preventing the reliable operation of voltage sensing devices. Even when trimming is proper, mold part lines are present, which affects the coupling of the semi-conductive cap and voltage sensing device to the test point.

[0009] Due to the flexible nature of the rubber used during the molding process, deformations can also occur in the thin area of the outer layer where the semi-conductive cap or voltage sensing device coupled to the test point contacts the outer layer. These variations in the distance between the test point

terminal and outer layer result in unwanted variations in the capacitive ratio from part-to-part during manufacturing.

[0010] Such inherent disadvantages in known systems have not been entirely ignored in the industry. Techniques have been developed to prevent the conductive jacket layer material from making unwanted contact with the voltage test point during the molding process, effectively shorting the test point to ground. Typically, an assembly comprising the test point surrounded by a rigid insulating material, such as a plastic ring, is formed prior to the insulation jacket molding process. The test point with the rigid plastic ring is then molded into the body of the elbow during insulation molding, with the plastic ring acting as a barrier to prevent the conductive jacket material from contacting the test point terminal.

[0011] However, the use of a rigid plastic ring to prevent contaminants from entering the test point terminal does not address the deformations of the thin outer layer surrounding the test point, resulting in variations in the capacitive ratio.

[0012] Therefore, there is a need in the art for an electrical connector, such as a loadbreak elbow, with a rigid semi-

conductive section that is integrally molded into the jacket, whereby manufacturing defects are prevented when the insulation layer is molded.

[0013] Furthermore, there is a need for a method of manufacturing an electrical cable connector that reduces the variation in the distance between the test point and outer jacket. Therefore, the capacitive ratio is consistent from part-to-part during the manufacturing process.

SUMMARY OF THE INVENTION

[0014] According to various embodiments of the present invention, a connector is disclosed with a test point that is manufactured during the insulation molding process. This manufacturing is conducted without using a separate rigid insulating material to create a barrier for the test point.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] A further understanding of the present invention and the objectives other than those set forth above can be obtained by reference to the various implementations set forth in the illustrations of the accompanying figures. Although the implementations illustrate certain aspects of the present

invention, the apparatus and method of use of the invention, in general, together with further objectives and advantages thereof, may be more easily understood by reference to the drawings, examples, and the following description. The examples and figures are not intended to limit the scope of this invention, which is set forth with particularity in the claims as appended or as subsequently amended, but merely to clarify and exemplify the invention. The detailed description makes reference to the accompanying figures wherein:

[0016] FIG. 1 is a side view of a prior art loadbreak connector.

[0017] FIG. 2 is a cross-sectional side view of the prior art loadbreak connector shown in FIG. 1.

[0018] FIG. 3 is a cross-sectional side view of a loadbreak connector in accordance with an exemplary embodiment of the present invention.

[0019] FIG. 4 is an enlarged cross-sectional view of the voltage test point in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0020] A detailed description of the various embodiments of the present invention is disclosed herein. However, techniques of manufacture and resulting structures in accordance with the present invention may be embodied in a wide variety of forms and modes, some of which may be quite different from those in the disclosed embodiments. Consequently, the specific structural details disclosed herein are merely representative, yet in that regard, they are deemed to represent suitable implementations for purposes of disclosure and to provide a basis for the claims herein, which define the scope of the present invention. Well known methods, procedures, and substances for both carrying out the objectives of the present invention and illustrating the preferred embodiment are incorporated herein but have not been described in detail as not to unnecessarily obscure novel aspects of the present invention.

[0021] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense, as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to." As

used herein, the terms "connected," "coupled," or any variant thereof, mean any connection or coupling, either direct or indirect, electronic or otherwise, between two or more elements; the coupling of connection between the elements can be physical, logical, or a combination thereof. Additionally, the words "herein," "above," "below," and words of similar import, when used in this application, shall refer to this application as a whole and not to any particular portions of this application. Where the context permits, words in the Detailed Description of the Embodiments using the singular or plural number may also include the plural or singular number respectively. The word "or," in reference to a list of two or more items, covers all of the following interpretations of the word: any of the items in the list, all of the items in the list, and any combination of the items in the list.

[0022] Referring initially to FIG. 1 and FIG. 2, shown are prior art loadbreak connectors. In FIG. 1, a loadbreak connector 100 is illustrated. Loadbreak connector 100 includes an end 102 which can receive a high voltage conductor or prepared cable therein, and a substantially right-angled probe retainer 104. Receiving portion 106 of right-angled probe retainer 104 is configured to couple to the bushing of an

apparatus, such as switchgear. Loadbreak connector 100 further includes grounding eye 108 that can be molded or affixed along the exterior surface of loadbreak connector 100. Grounding eye 108 is capable of receiving and being connected to an external ground in order to ensure that the outer surface of loadbreak connector 100 remains at ground potential.

[0023] The loadbreak connector 100 can further include a test point 110. It is known to one skilled in the art to use a high-impedance voltage sensing device at test point 110 to determine whether a voltage is present within loadbreak connector 100. Test point 110 includes a test point terminal 112, which is formed from a corrosion-resistant, conductive metal or plastic, and can include a cap (not shown) that is capable of being snapped onto and covering test point terminal 112. Therefore, access to test point terminal 112 is prevented from exposure to elements external to loadbreak connector 100, such as dirt, that can cause test point terminal 112 to degrade in quality.

[0024] FIG. 2 is a cross-sectional view of the prior art loadbreak connector 100 depicted in FIG. 1. A prepared cable is slidably inserted into end 102 of loadbreak connector 100. The prepared cable mates with cable connector 118 to form an

interference fit. On the other end of loadbreak connector 100, receiving portion 106 of right-angled probe retainer 104 forms an aperture with a substantially conical shape. Positioned within the center of receiving portion 106 is a probe or energized electrode 116. The probe 116 is electrically connected to a prepared cable inserted into end 102 via cable connector 118. Loadbreak connector 100 includes a semi-conductive outer layer 120 formed from semi-conductive rubber, silicone, EPDM, or other suitable materials known to those of ordinary skill in the art. Within outer layer 120, loadbreak connector 100 includes an insulation layer 122. Insulation layer 122 is typically molded from an insulating rubber or epoxy material. Further, within insulation layer 122, cable connector 118 is surrounded by a semi-conductive inner layer 124.

[0025] A pre-assembly, comprising a pre-molded plastic insulation ring 126 and test point terminal 112, is embedded in a portion 130 of insulation layer 122 that extends through an aperture 128 within outer layer 120. Test point terminal 112 is separated from outer layer 120 by plastic insulation ring 126 and insulation layer 122. Therefore, test point terminal 112 is capacitively coupled to the electrical conductor elements within loadbreak conductor 100. The pre-molded plastic insulation ring

126 is pre-assembled to surround a portion of test-point terminal 112. In the prior art, plastic insulation ring 126 is an angular ring formed by injection molding, blow molding, or spin molding of an insulating material, such as glass-filled nylon.

[0026] During the molding procedure of loadbreak connector 100, the conductive components (probe 116, receiving portion 106, and cable connector 118) and outer layer 120 are first secured within a rubber or epoxy mold in their respective positions. Plastic insulation ring 126 and test point terminal 112 are pre-assembled in a separate procedure and positioned within the mold of aperture 128 of outer layer 120. Next, an insulating material is injected within outer layer 120 to form insulation layer 122. Plastic insulation ring 126 contacts the injected insulating material through aperture 128 formed within outer layer 120, thereby holding plastic insulation ring 126 and test point terminal 112 in position. Further, plastic insulation ring 126 provides a surface for the electrical voltage detection test point to rest on when coupled to test point terminal 112.

[0027] A frequent problem not addressed by the prior art is

manufacturing deformations within the thin area of outer layer 120 where test point 110 is embedded into aperture 128. The defects are caused by the flexible EPDM rubber used to form outer layer 120. Such defects vary from part-to-part and result in variations in the distance between the exposed end of test point terminal 112 and outer layer 120. These deformations can produce variations in the capacitive ratio between test point terminal 112 and outer layer 120.

[0028] Referring now to FIG. 3 and FIG. 4, the preferred embodiment of the present invention eliminates the need for a pre-molded plastic insulation ring surrounding the test point terminal. In addition, the present invention eliminates the possibility of outer layer 120 from coming in contact with test point terminal 202 during the manufacturing process of the jacket body. Further, the present invention decreases the deformation in the thin area of outer layer 120 where test point 210 is embedded, thereby decreasing the variation in the capacitance ratio from part-to-part.

[0029] In FIG. 3 a cross-sectional side view of loadbreak connector 200 is illustrated. In the preferred embodiment of the present invention, test point 210 comprises test point

terminal 202, which is formed from a rigid, corrosion-resistant, and conductive nylon. Test point terminal 202 is molded into a portion 204 of insulation layer 122, that extends through an aperture 206. As shown, a rigid portion 208 is molded over a portion of outer layer 120 in the thin area surrounding test point 210 to separate portion 204 of insulation layer from outer layer 120. Rigid portion 208 provides an electrical interface surface for voltage detection devices or a semi-conductive cap. Rigid portion 208 is formed from a rigid corrosion-resistant, conductive nylon or high durometer EPDM material. Therefore, during the manufacturing process the thin area surrounding test point 210 does not deform, providing for less capacitive variation from part-to-part.

[0030] FIG. 4 is an enlarged cross-sectional view of the voltage test point in accordance with an exemplary embodiment of the present invention. During the molding procedure of loadbreak connector 200, rigid portion 208 is first molded either from a rigid corrosion-resistant conductive nylon, or a high durometer rubber (EPDM). Next, outer layer 120 is overmolded and bonds onto rigid portion 208. The molding of outer layer 120 onto rigid portion 208 forms aperture 206. Thereafter, the conductive components and outer layer 120 --

which is bonded with rigid portion 208 -- are secured within a rubber or epoxy mold in their respective positions. Testpoint terminal 202 is positioned within the mold of aperture 206. Next, an insulating material is injected within outer layer 120 to form insulation layer 122 which extends into aperture 206 to form portion 204 and hold test point terminal 202 in place. This keeps the geometry of test point 210 and portion 204 controlled and consistent.

[0031] While the present invention has been described with reference to the preferred embodiment, which has been set forth in considerable detail for the purposes of making a complete disclosure of the invention, the preferred embodiment is merely exemplary and is not intended to be limiting or represent an exhaustive enumeration of all aspects of the invention. The scope of the invention, therefore, shall be defined solely by the claims. Further, it will be apparent to those of skill in the art that numerous changes can be made in such details without departing from the spirit and the principles of the invention. It should be appreciated that the present invention is capable of being embodied in other forms without departing from its essential characteristics.

[0032] While certain aspects of the device and methods are presented below in certain claim forms, the inventor contemplates the various aspects of the device and methods in any number of claim forms. Accordingly, the inventor reserves the right to add additional claims after filing the application to pursue such additional claim forms for other aspects of the device and methods.

CLAIMS

I CLAIM:

1. An electrical connector having a voltage test point, the connector comprising:
 - an internal conductor;
 - an inner insulating sheath surrounding the conductor;
 - a semi-conductive outer shield surrounding the insulating sheath, the conductive outer shield having an aperture formed therethrough;
 - a conductive voltage detection test point terminal molded within the aperture, wherein the test point terminal is capacitively coupled to the internal conductor for external testing of a voltage of the connector; and
 - a portion adjacent to the aperture consisting a rigid material.

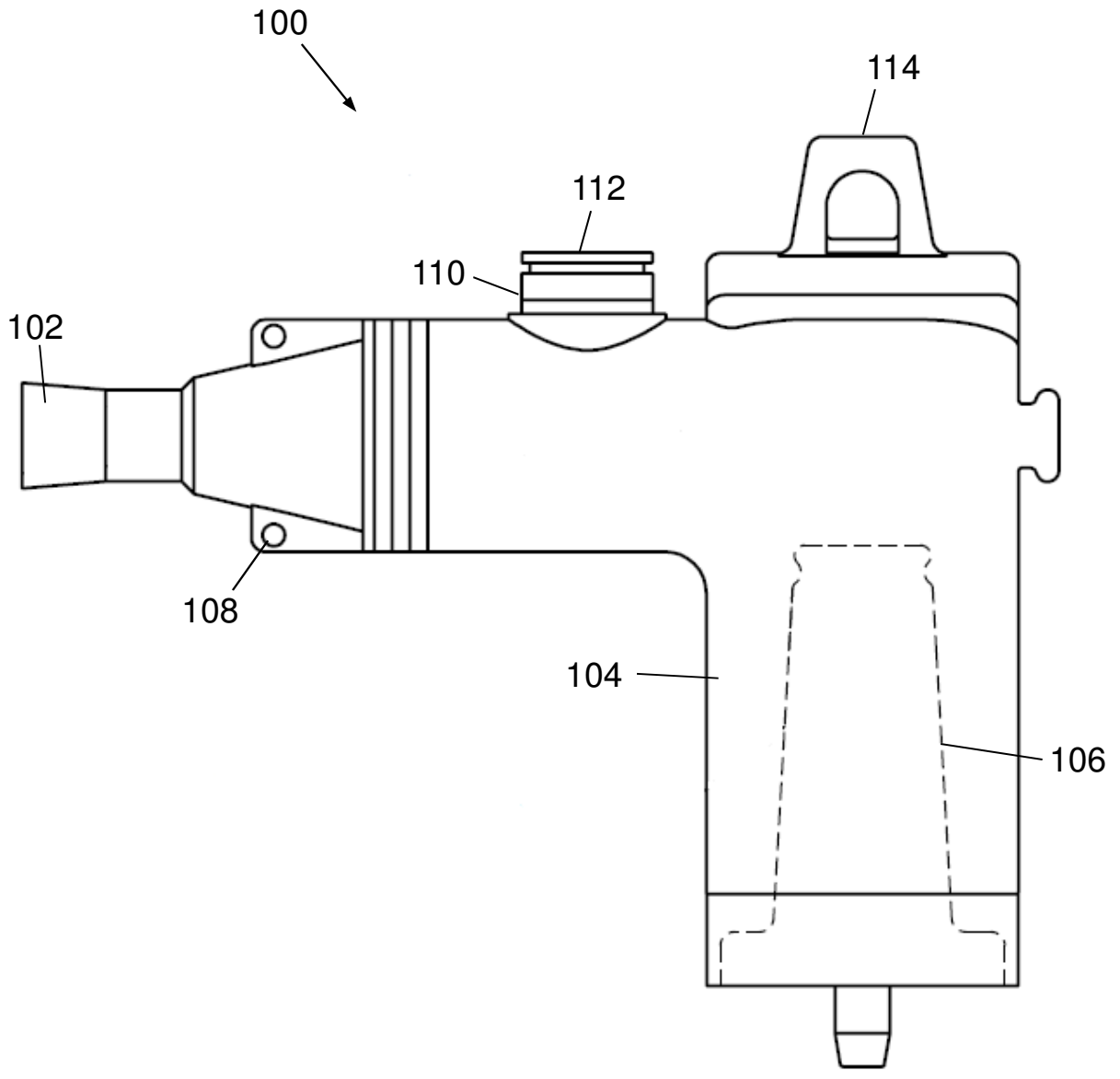


FIG. 1
(Prior Art)

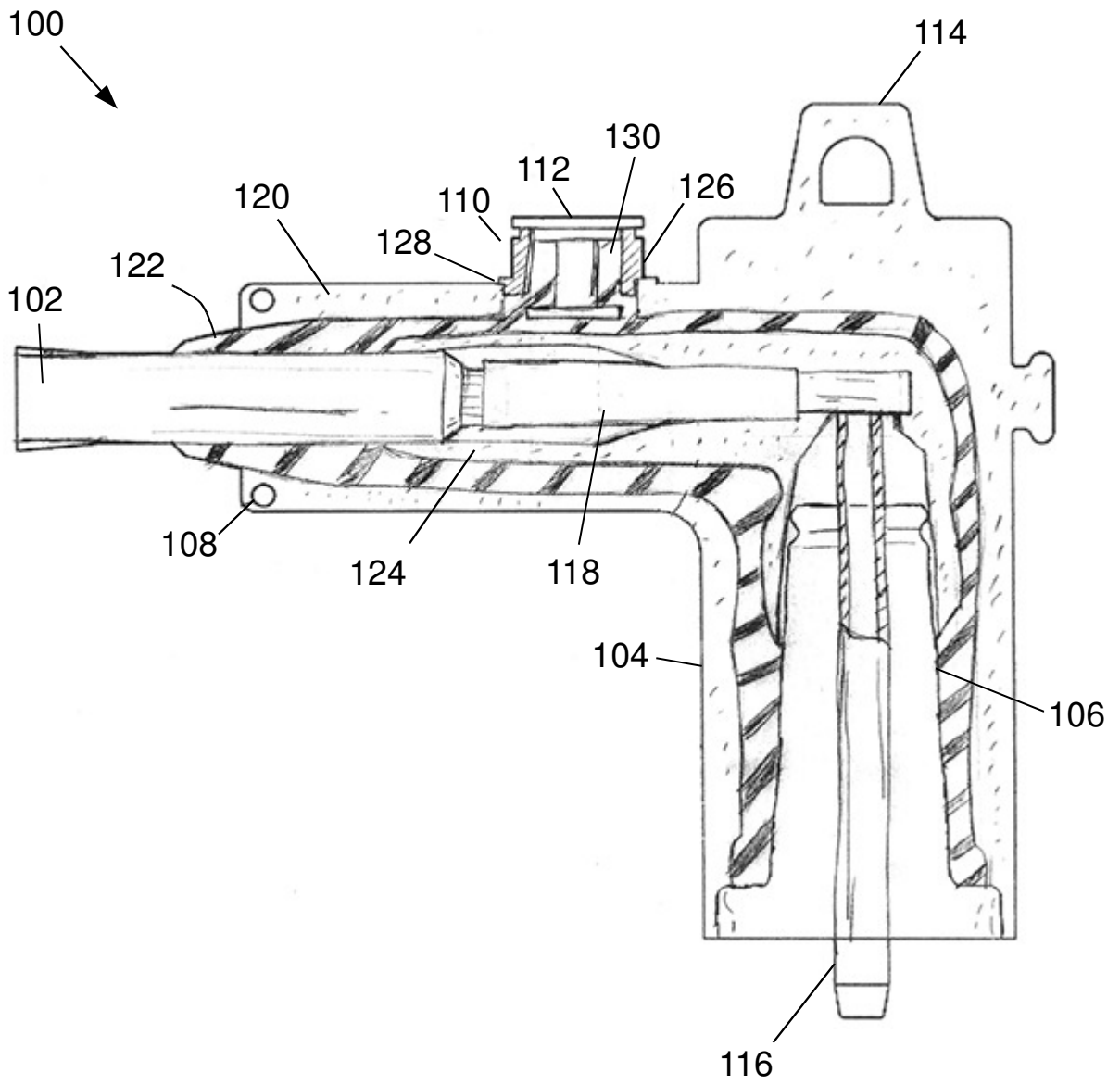


FIG. 2
(Prior Art)

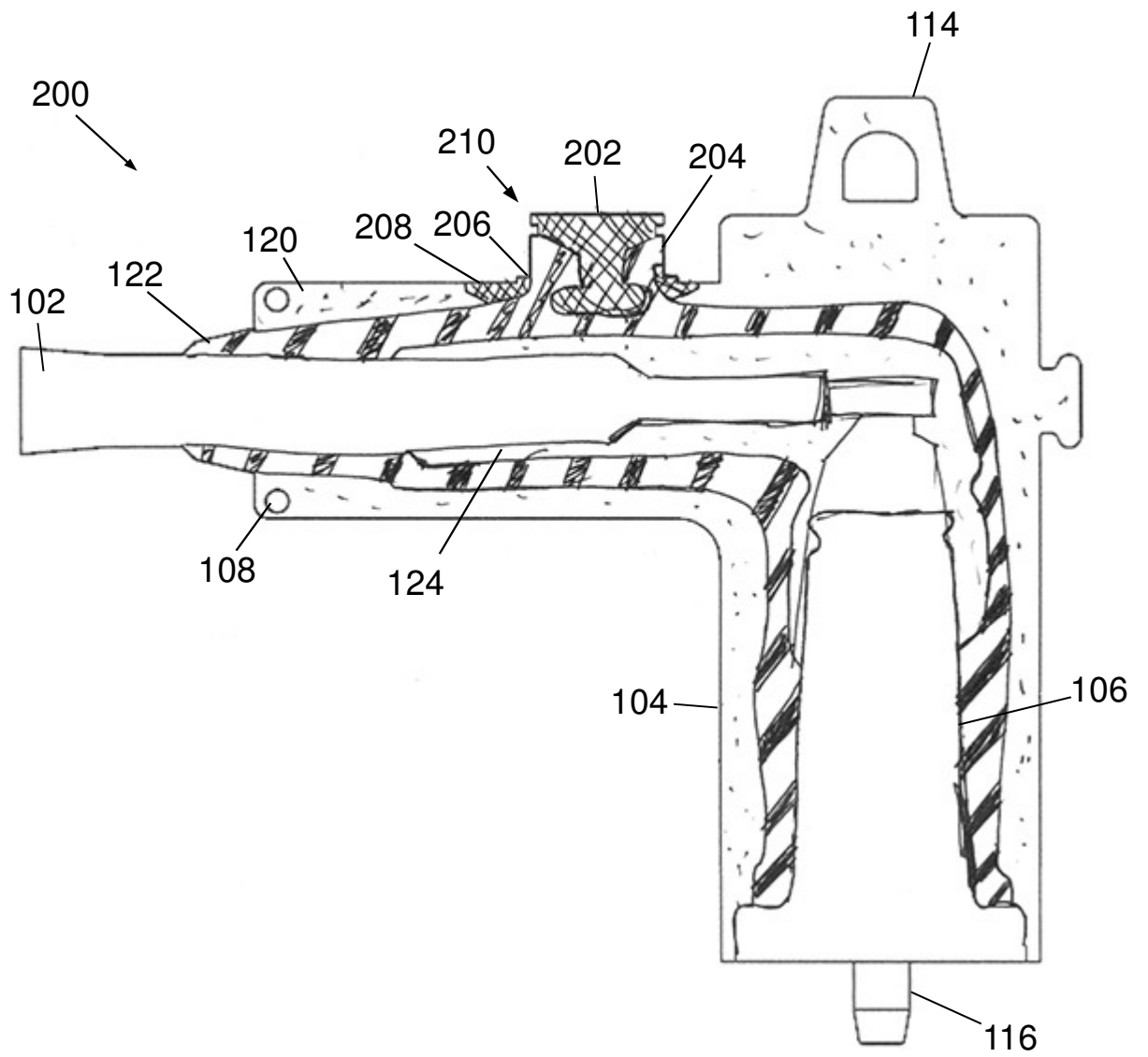


FIG. 3

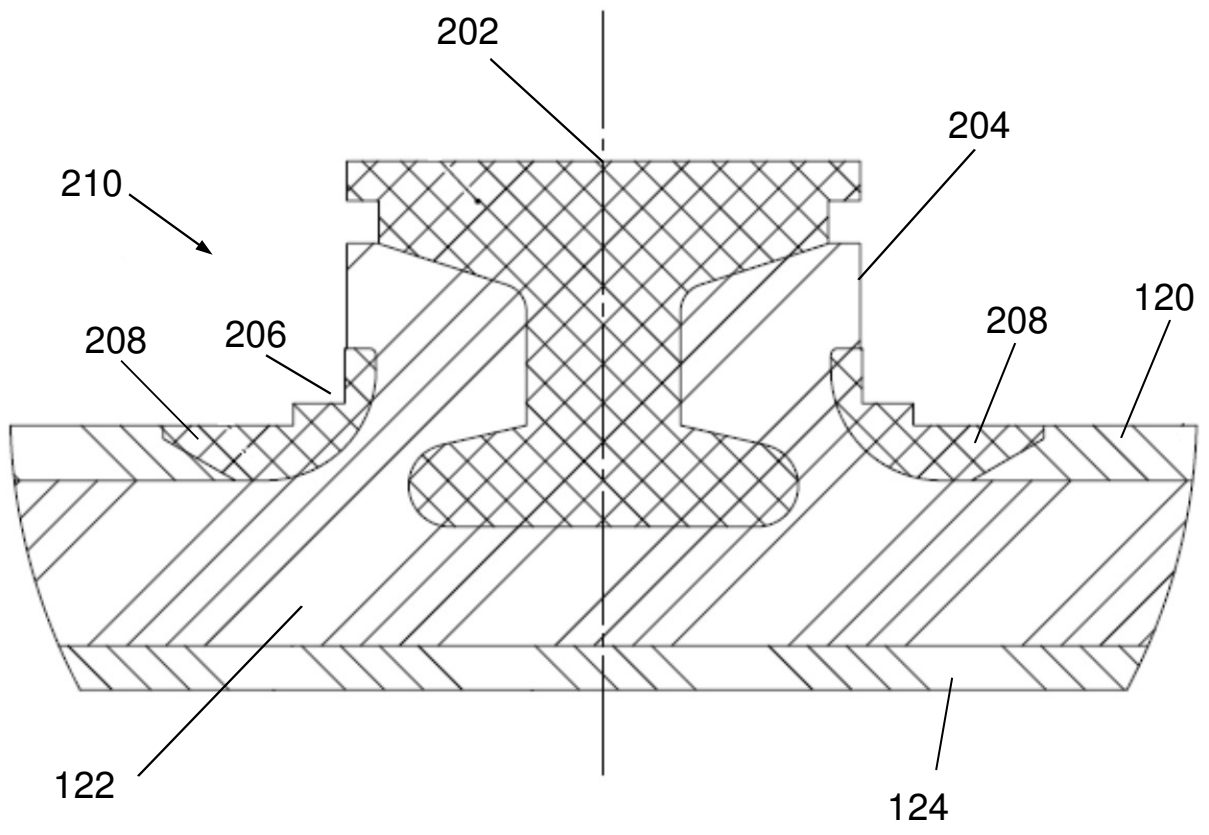


FIG. 4