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Roberts

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(54) **ELECTRICAL CONNECTOR HAVING MALE AND FEMALE CONNECTORS**

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H01R 24/38	(2011.01)
H01R 13/05	(2006.01)
H01R 103/00	(2006.01)

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CPC ***H01R 24/38*** (2013.01); ***H01R 13/052*** (2013.01); ***H01R 13/111*** (2013.01); *H01R 24/86* (2013.01); *H01R 2103/00* (2013.01)

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USPC 439/92

See application file for complete search history.

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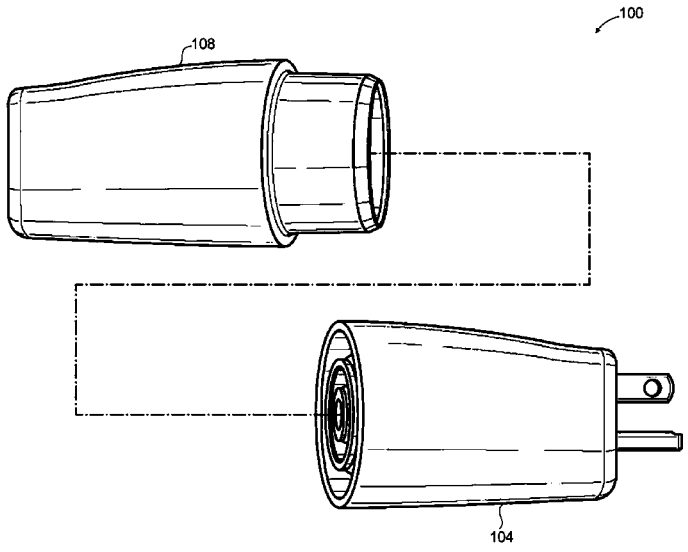
(57) **ABSTRACT**

An electrical connector includes a female connector removably connectable with a male connector. The female connector includes an outer ring shield, and first and second ring insulator. The first ring insulator is spaced inwardly of the outer ring shield to define a first recess with a first female electrical contact provided in the first recess. The second ring insulator is spaced inwardly of the first ring insulator to define a second recess with a second female electrical contact provided in the second recess. The male connector includes first and second. When the male and female connectors are electrically connected, the first and second male electrical contacts are received in the first and second recesses respectively.

17 Claims, 13 Drawing Sheets



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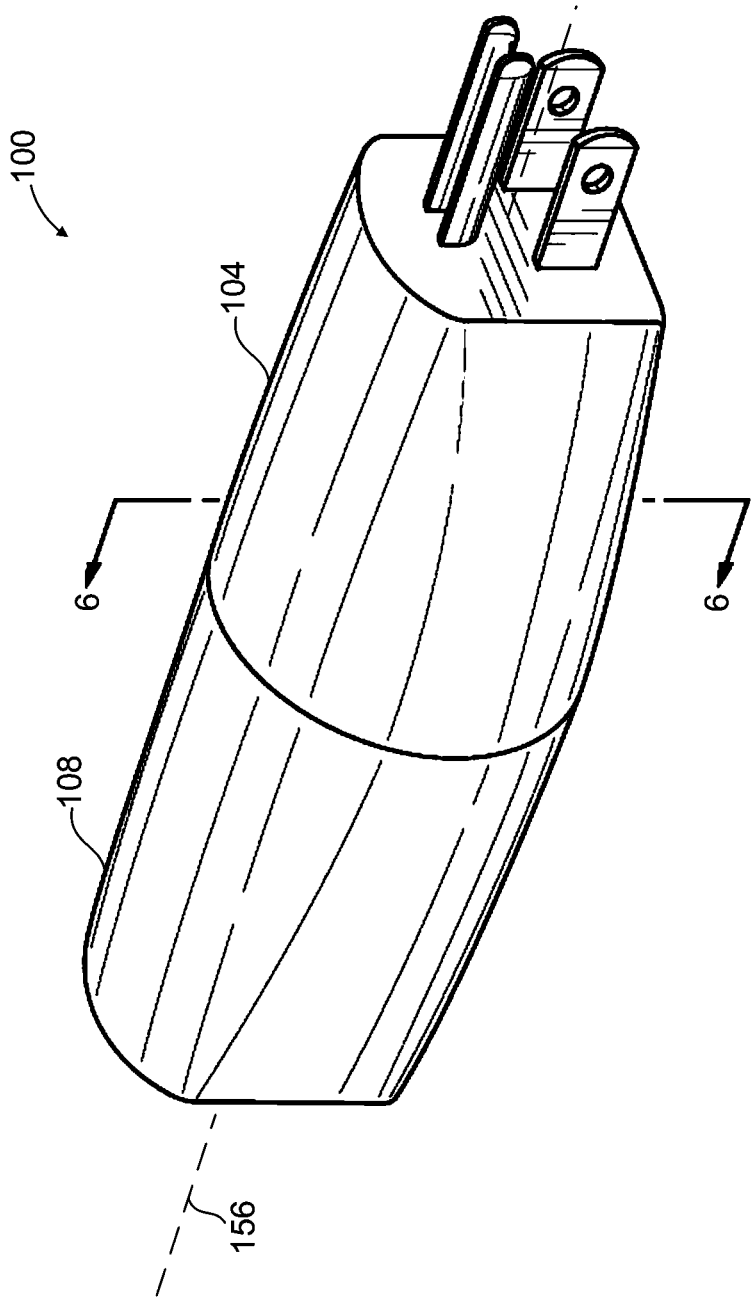

FIG. 1

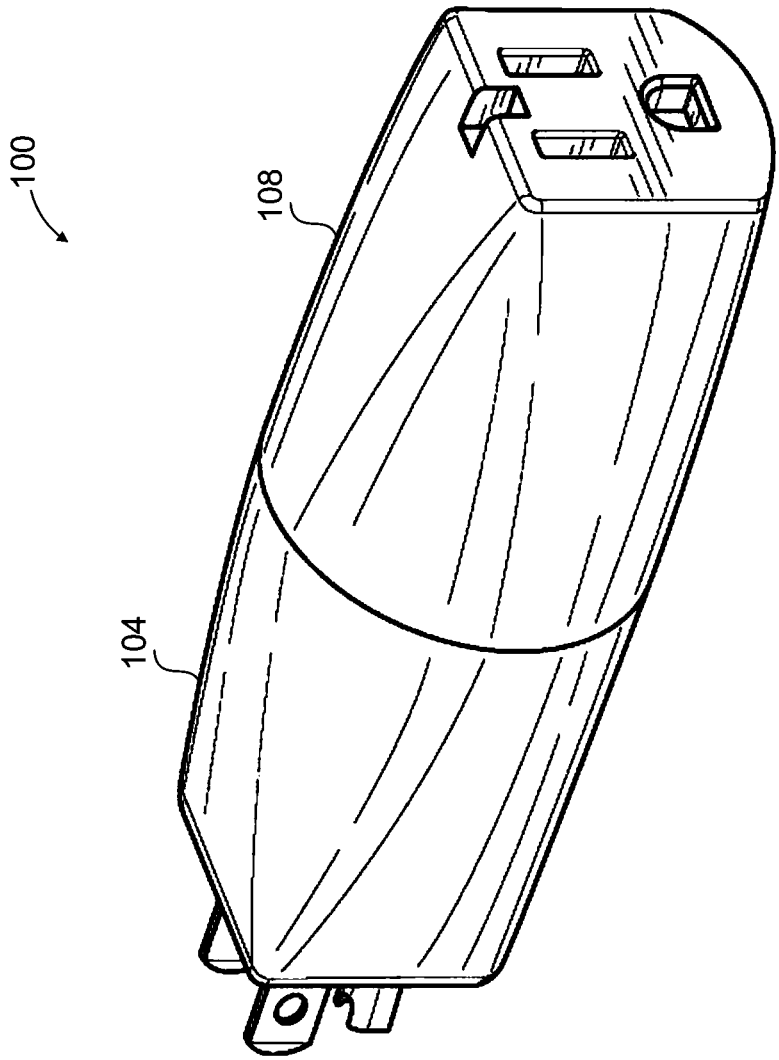

FIG. 2

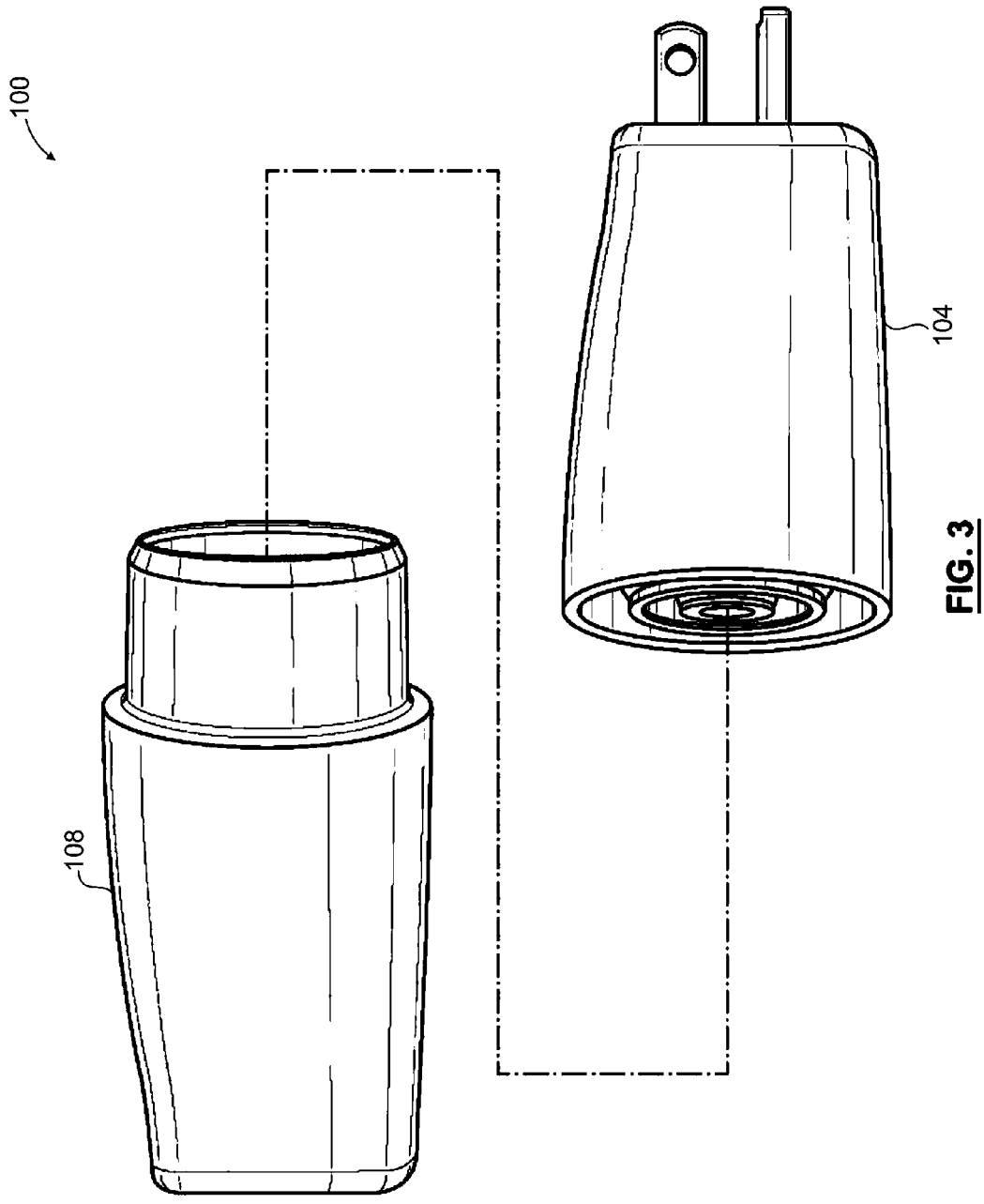

FIG. 3

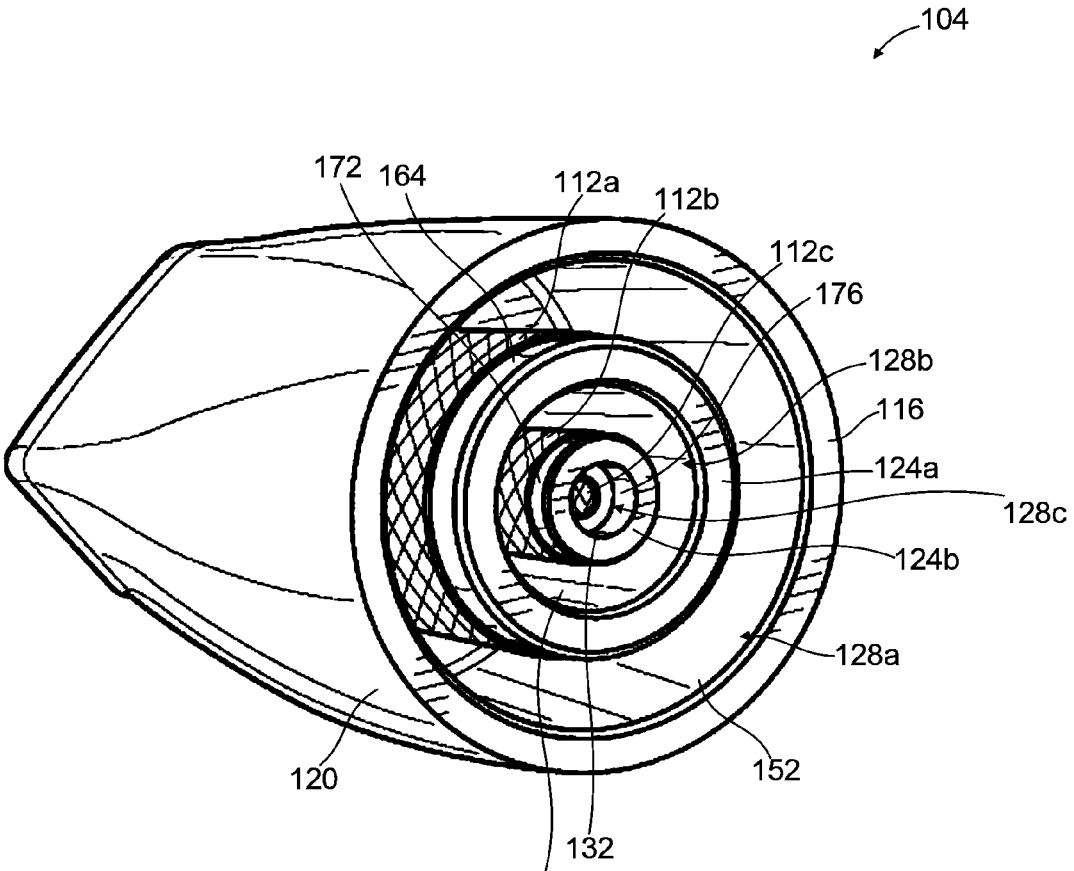
104
172
164
112a
112b
112c
176
128b
116
124a
128c
124b
128a
120
152
132
168

FIG.4

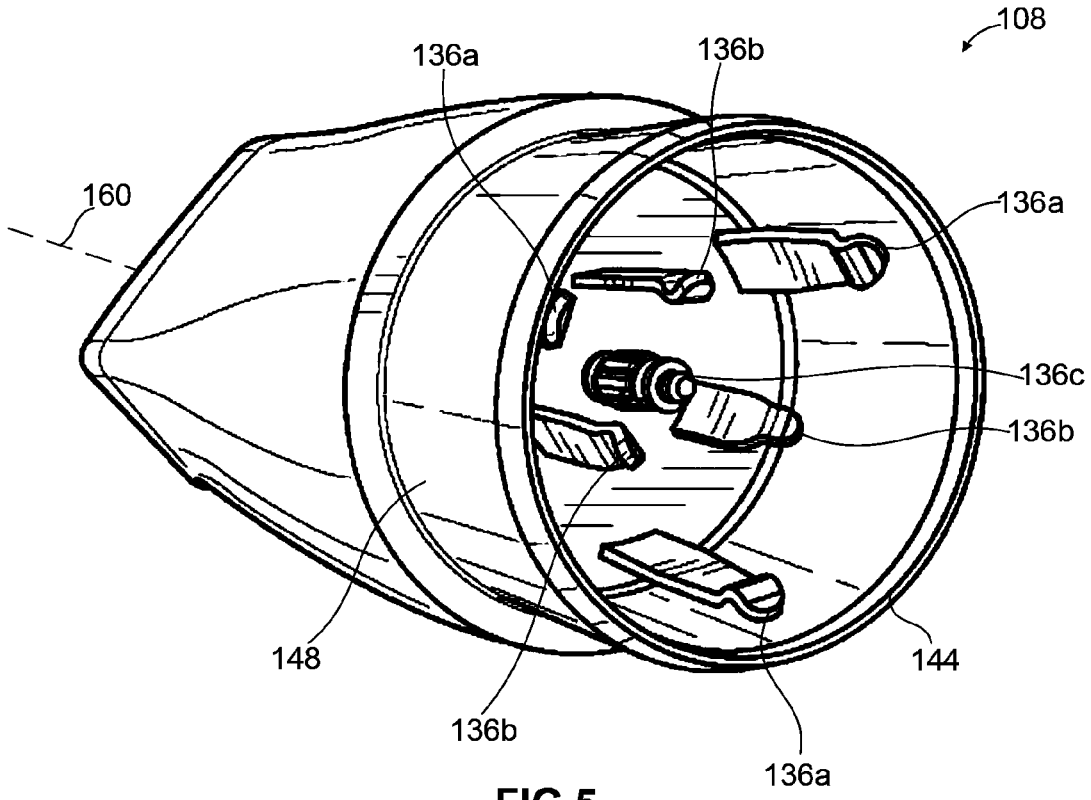

FIG.5

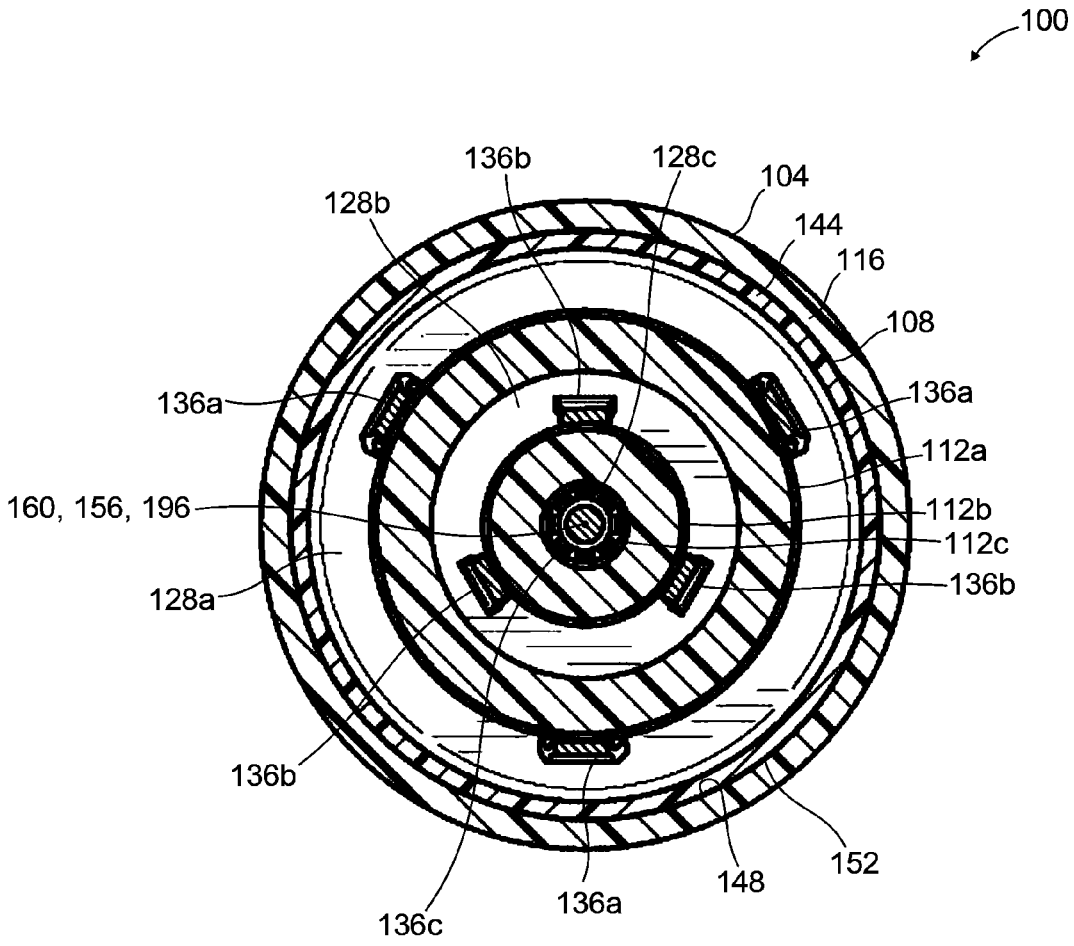
100
136b
128c
104
128b
144
116
108
136a
136a
112a
160, 156, 196
112b
112c
128a
136b
136b
152
148
136a
136c

FIG.6

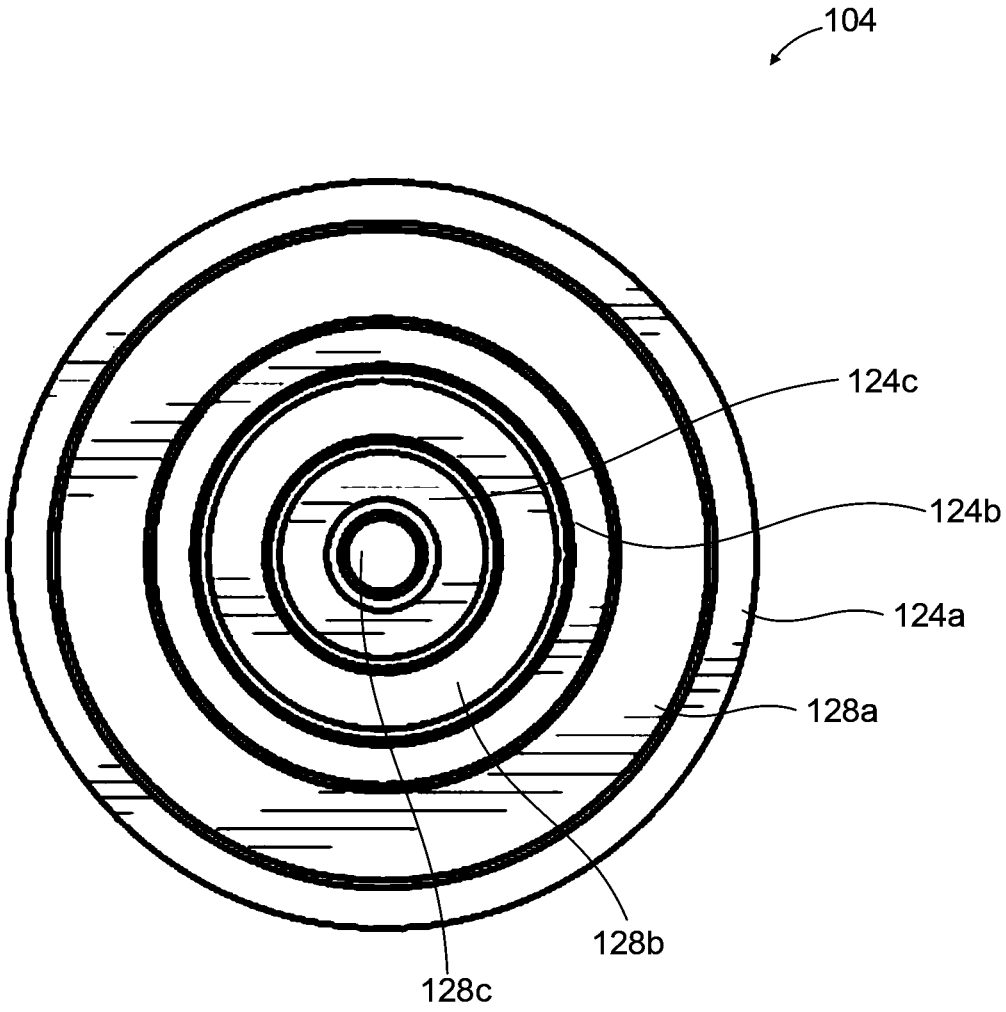

FIG.7

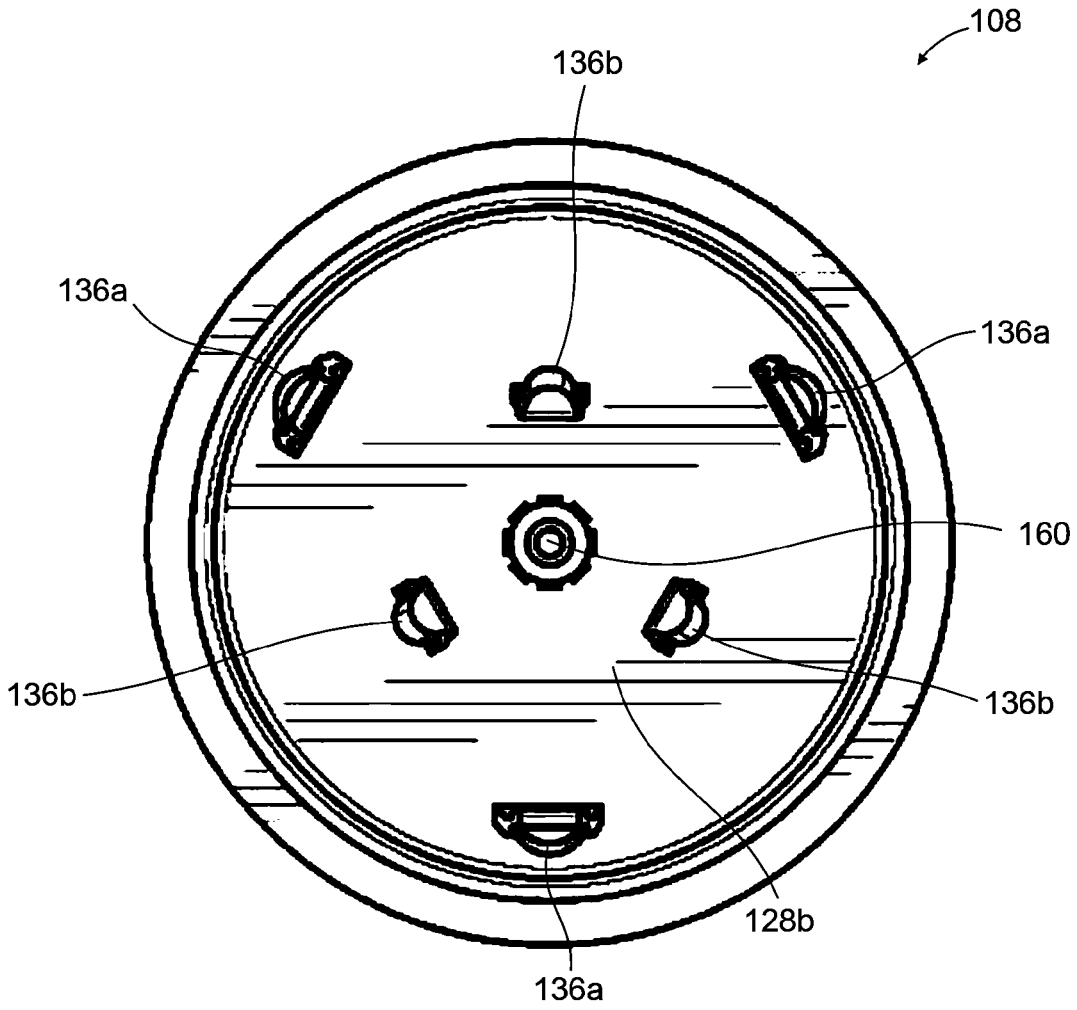

FIG.8

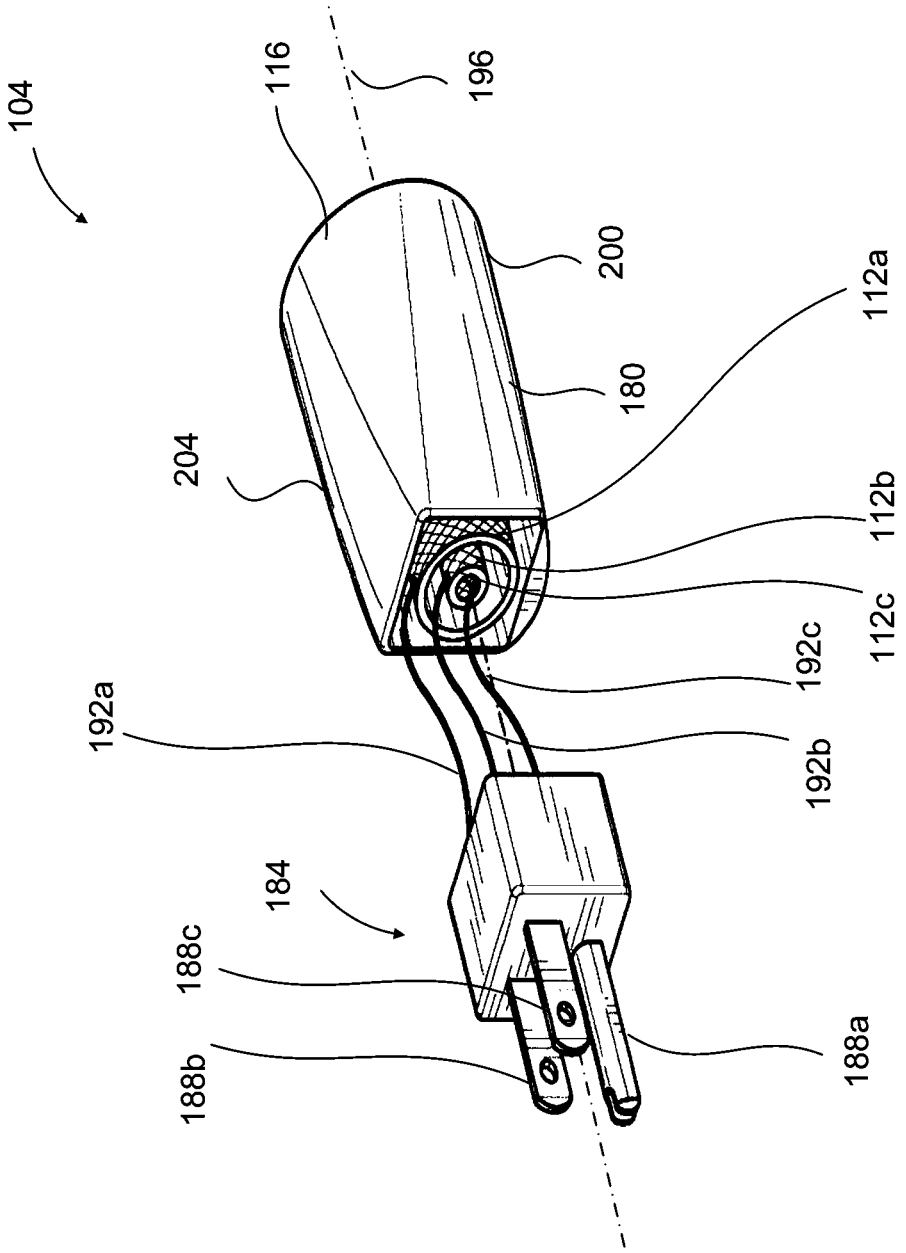
104
116
196
200
112a
180
204
112b
112c
192c
192a
192b
184
188c
188b
188a

FIG.9

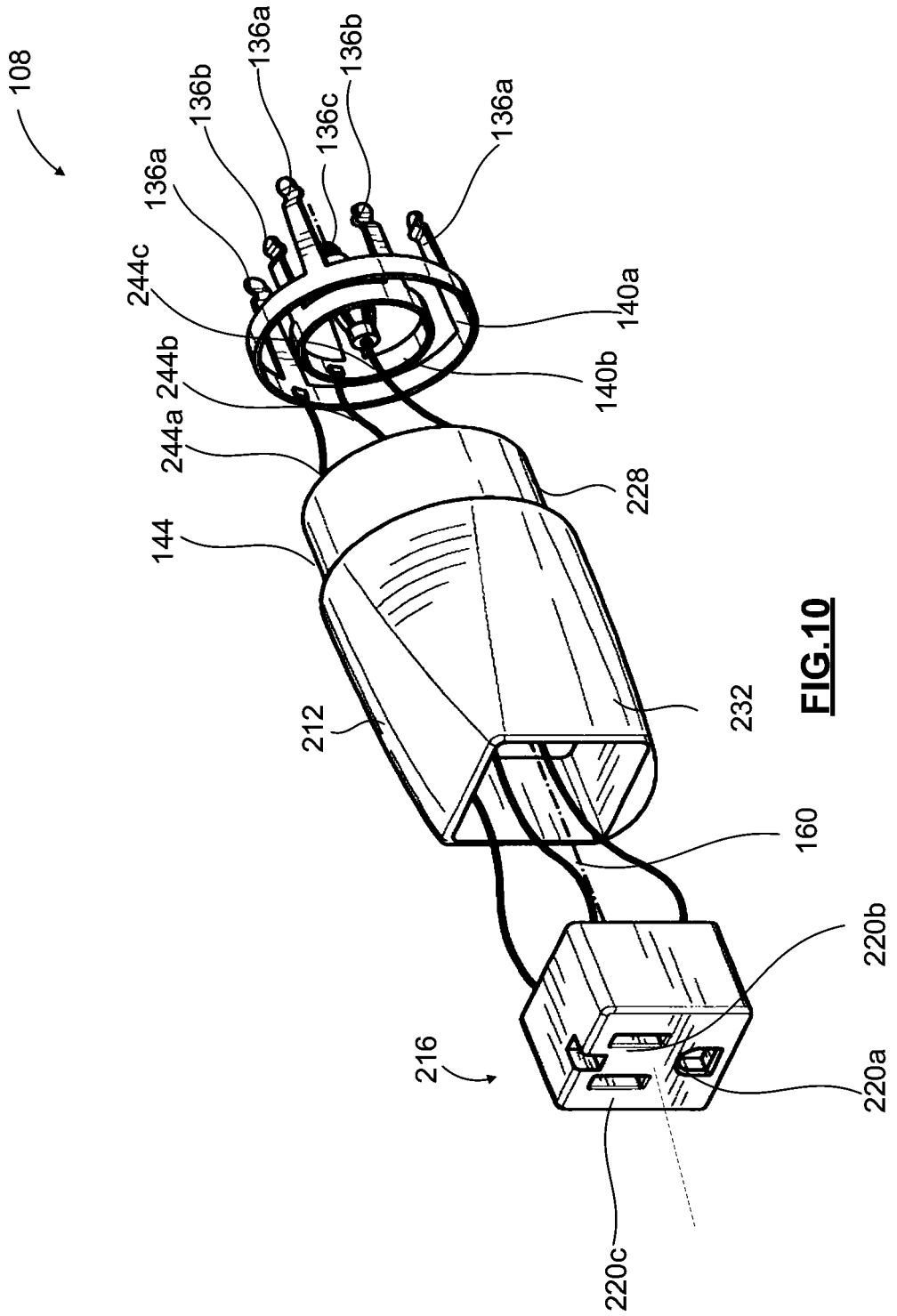
108
136a
136b
136c
136b
136a
136a
244c
244b
244a
140a
140b
228
144
212
232
160
216
220b
220a
220c

FIG.10

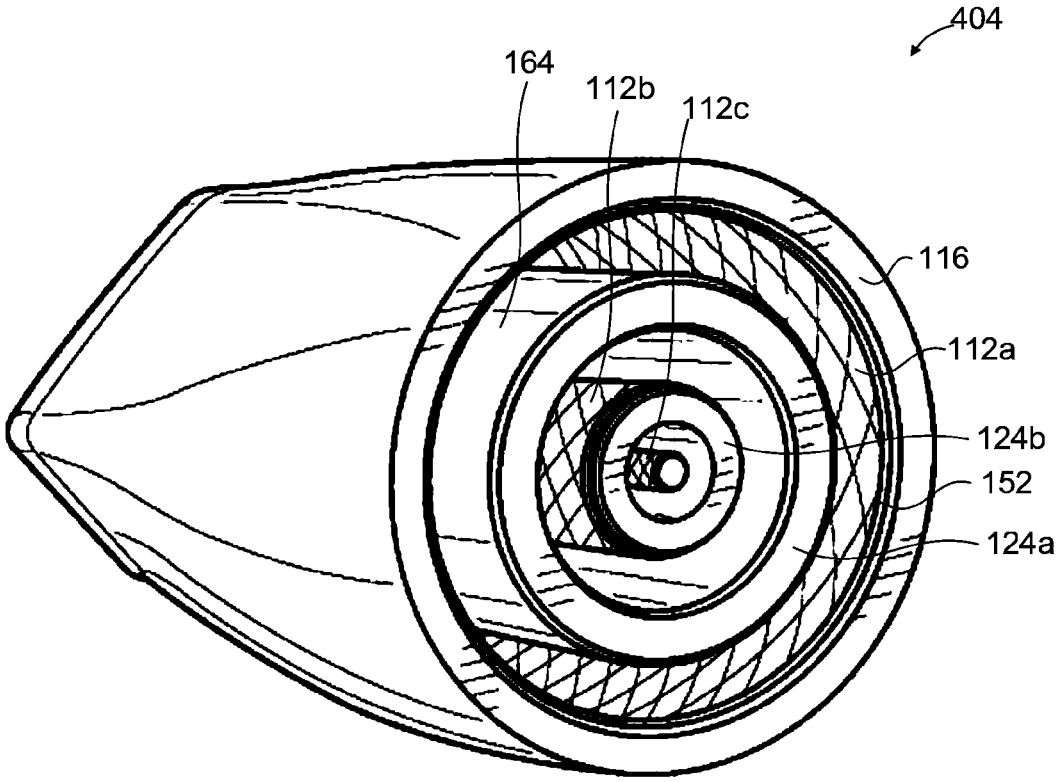

FIG.11

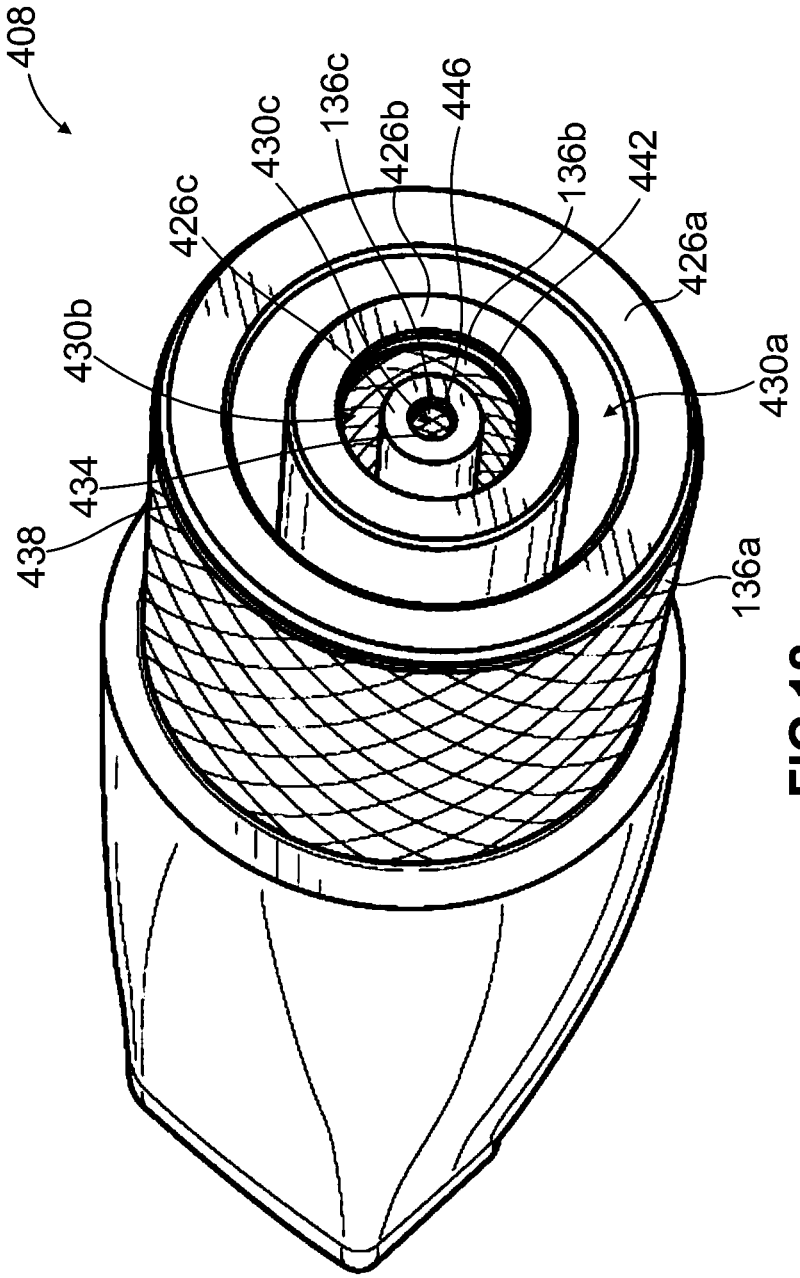
408
430c
136c
426b
446
136b
442
426c
426a
430b
430a
434
438
136a

FIG.12

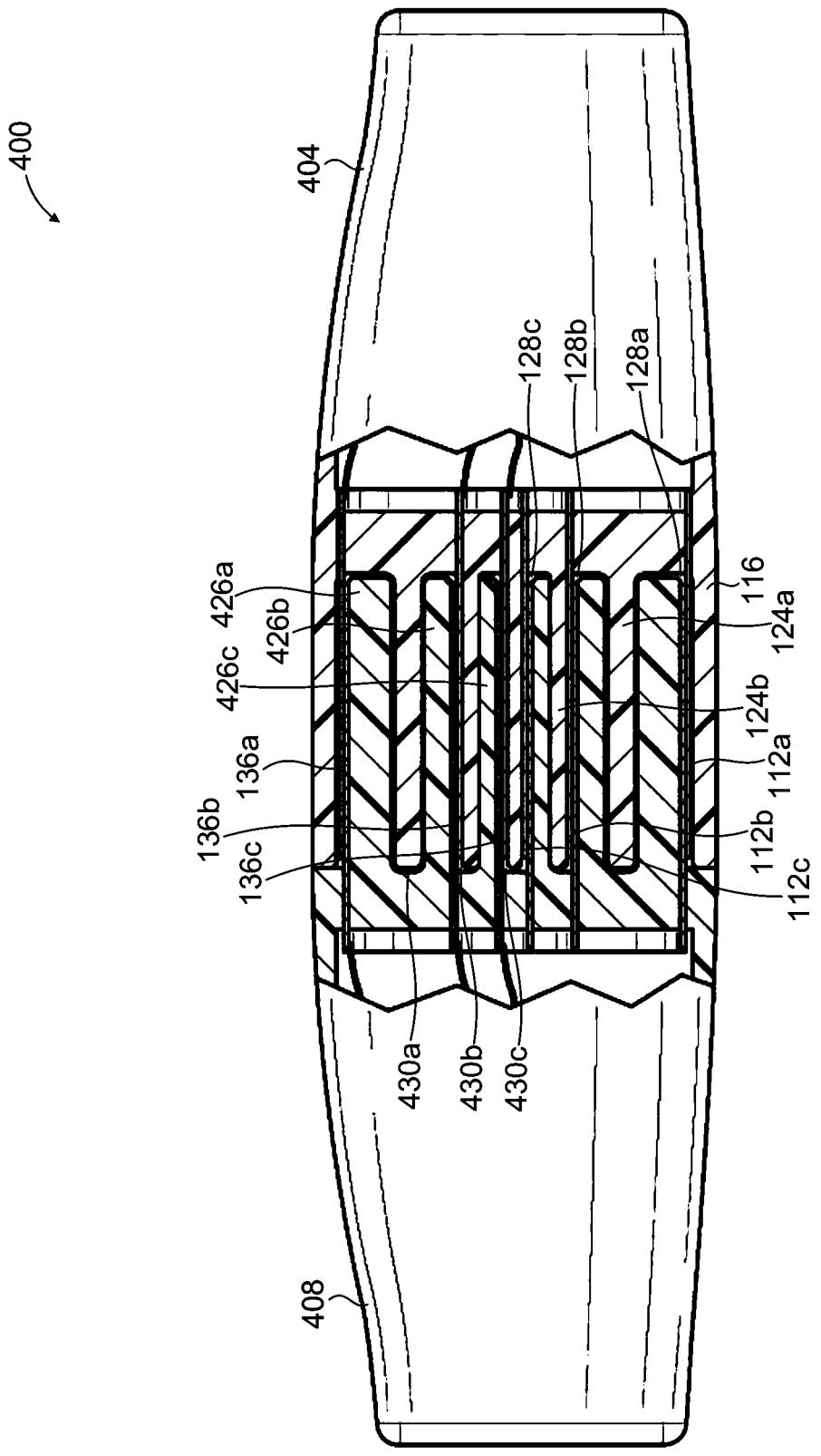
400
404
128c
128b
128a
426a
426b
426c
116
124a
124b
112a
136a
136b
136c
112b
112c
430a
430b
430c
408

FIG. 13

ELECTRICAL CONNECTOR HAVING MALE AND FEMALE CONNECTORS

FIELD

This disclosure relates to the field of electrical connectors, and more particularly to electrical connectors having a male connector removably electrically connectable with a female connector.

INTRODUCTION

Electrical connectors are devices that provide a disconnectable electrical connection along an electrical pathway. Typically, an electrical connector includes a male connector that is removably connectable to a female connector. When the male and female connectors are connected, the electrical connector defines one or more electrical pathways across the juncture of the male and female connectors.

SUMMARY

In accordance with one aspect of this disclosure, an electrical connector is provided that utilizes a male connector releasably engageable with a female connector wherein each of the male and female connectors utilize a plurality of axially extending contact members that are arranged concentrically. For example, if the connector is for use with a wire that includes a ground, then each of the male and female connectors may be provided with three concentrically arranged contact members (hot, neutral and ground). However, if the connector is for use with a wire that does not include a ground, then each of the male and female connectors may be provided with two concentrically arranged contact members (hot and neutral). The contact members are preferably separated from each other by insulators and accordingly, a plurality of concentrically arranged insulators may be provided. An advantage of arranging the contact members in annular bands is that the male and female connectors may be connected by only axially aligning the male and female connectors. Accordingly, a user need not rotate, e.g., the male connector about is axis so as to align it with the female connector prior to inserting the male connector into the female connector.

Each contact member may be configured as a continuous annular member. Alternately, a contact member may comprise a plurality of discrete members that are arranged in an annular band. Similarly, each insulator may be a continuous annular band or a plurality of discrete members arranged in an annular band.

The outer surface of the outer annular member of the male connector may be an insulator. For example, the outer annular member may be an annular insulator with a conductive member provided on the inner surface thereof. An advantage of this embodiment is that the conductive members may be provided internal of an outer annular insulator so that the likelihood of a user touching a conductive member is reduced. Further, it will be appreciated that the insulators of the male and female connectors may extend axially further outwardly from a main body of the connector than the conductive members. Accordingly, in such an embodiment, the likelihood of a user touching a conductive member may be further reduced.

Alternately, or in addition, it will also be appreciated that the ground contact member may be positioned as the outermost conductive member. In such an embodiment, the likelihood of a user touching the hot or neutral conductive members is reduced.

In any embodiment, the annular members or bands of the male and female connectors may be sized so as to frictionally engage each other to thereby secure the male and female connectors in an engaged position.

In accordance with this aspect, there is provided an electrical connector is provided. The electrical connect may comprise a female connector removably connectable with a male connector. The female connector may include an outer ring shield, a first ring insulator, and a second ring insulator. The first ring insulator may be spaced inwardly of the outer ring shield to define a first recess between the outer ring shield and the first ring insulator with a first female electrical contact provided in the first recess. The second ring insulator may be spaced inwardly of the first ring insulator to define a second recess between the first and second ring insulators with a second female electrical contact provided in the second recess. The male connector may include at least one first male electrical contact and at least one second male electrical contact, and at least one third male electrical contact. When the male and female connectors are electrically connected together, the first male electrical contact is received in the first recess and the second male electrical contact is received in the second recess.

In any embodiment, the second ring insulator may have an inner cavity defining a third recess with a third female electrical contact provided in the third recess and the male connector may include at least one third male electrical contact wherein, when the male and female connectors are electrically connected together, the third male electrical contact is received in the third recess.

In any embodiment, the outer ring shield may comprise an outer ring shield outer surface that is free of electrical contacts.

In any embodiment, the first and second ring recesses may be concentric annular recesses.

In any embodiment, the first ring insulator may have a first ring insulator outer surface, the outer ring shield may have an outer ring shield inner surface, and the first male connector electrical contact may be a sleeve-type contact that at least substantially lines at least one of the first ring insulator outer surface and the outer ring shield inner surface.

In any embodiment, the first ring insulator may have a first ring insulator inner surface, the second ring insulator may have a second ring insulator outer surface, and the second male connector electrical contact may be a sleeve-type contact that at least substantially lines at least one of the first ring insulator inner surface and the first ring insulator outer surface.

In any embodiment, the third male connector electrical contact may be a sleeve-type contact that at least substantially lines the third ring insulator inner surface.

In any embodiment, the third male connector electrical contact may be a pin-type contact.

In any embodiment, the third female connector electrical contact may be a pin-type contact.

In any embodiment, the third male connector electrical contact may be a sleeve-type contact.

In any embodiment, the male connector may further comprise a body having the first, second and third male connector electrical contacts provided at one end and one of a plug or a socket provided at a longitudinally spaced apart second end of the body. In any such embodiment, the plug or socket may be an AC plug or socket comprising a hot

contact, a neutral contact, and a ground contact, and each contact may be electrically connected to a different one of the first, second and third male connector electrical contacts respectively.

In any embodiment, the female connector may further comprise a body having the outer ring shield and the first and second ring insulators may be provided at one end and one of a plug or a socket may be provided at a longitudinally spaced apart second end of the body. In any such embodiment, the plug or socket may be an AC plug or socket comprising a hot contact, a neutral contact, and a ground contact, and each contact is electrically connected to a different one of the first, second and third female connector electrical contacts respectively. Alternately, or in addition, in any such embodiment, the male connector may further comprise a male body having the first, second and third male connector electrical contacts provided at one end and the other of a plug or a socket provided at a longitudinally spaced apart second end of the male body.

In any embodiment, the first female connector electrical contact may comprise a ground.

In any embodiment, the male and female connectors may be secured together by a press fit.

Other aspects and features of the present specification will become apparent, to those ordinarily skilled in the art, upon review of the following description of the specific examples of the specification.

DRAWINGS

The drawings included herewith are for illustrating various examples of articles, methods, and apparatuses of the teaching of the present specification and are not intended to limit the scope of what is taught in any way.

FIG. **1** is a front perspective view of an electrical connector including a male connector and a female connector in accordance with an embodiment;

FIG. **2** is a rear perspective view of the electrical connector of FIG. **1**;

FIG. **3** is a perspective view of the electrical connector of FIG. **1** showing the male connector disconnected from the female connector;

FIG. **4** is a front perspective view of the female connector of FIG. **1**;

FIG. **5** is a front perspective view of the male connector of FIG. **1**;

FIG. **6** is a cross-sectional view taken along line **6-6** in FIG. **1**;

FIG. **7** is a front plan view of the female connector of FIG. **1**;

FIG. **8** is a front plan view of the male connector of FIG. **1**;

FIG. **9** is an exploded view of the female connector of FIG. **1**;

FIG. **10** is an exploded view of the male connector of FIG. **1**;

FIG. **11** is a front perspective view a female connector in accordance with another embodiment;

FIG. **12** is a front perspective view of a male connector in accordance with another embodiment; and,

FIG. **13** is a side elevation view of an electrical connector including the male and female connectors of FIGS. **11** and **12**, partially cut-away to show the internal connection therebetween.

DESCRIPTION OF VARIOUS EMBODIMENTS

Numerous embodiments are described in this application, and are presented for illustrative purposes only. The described embodiments are not intended to be limiting in any sense. The invention is widely applicable to numerous embodiments, as is readily apparent from the disclosure herein. Those skilled in the art will recognize that the present invention may be practiced with modification and alteration without departing from the teachings disclosed herein. Although particular features of the present invention may be described with reference to one or more particular embodiments or figures, it should be understood that such features are not limited to usage in the one or more particular embodiments or figures with reference to which they are described.

The terms "an embodiment," "embodiment," "embodiments," "the embodiment," "the embodiments," "one or more embodiments," "some embodiments," and "one embodiment" mean "one or more (but not all) embodiments of the present invention(s)," unless expressly specified otherwise.

The terms "including," "comprising" and variations thereof mean "including but not limited to," unless expressly specified otherwise. A listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms "a," "an" and "the" mean "one or more," unless expressly specified otherwise.

As used herein and in the claims, two or more parts are said to be "coupled", "connected", "attached", or "fastened" where the parts are joined or operate together either directly or indirectly (i.e., through one or more intermediate parts), so long as a link occurs. As used herein and in the claims, two or more parts are said to be "directly coupled", "directly connected", "directly attached", or "directly fastened" where the parts are connected in physical contact with each other. As used herein, two or more parts are said to be "rigidly coupled", "rigidly connected", "rigidly attached", or "rigidly fastened" where the parts are coupled so as to move as one while maintaining a constant orientation relative to each other. None of the terms "coupled", "connected", "attached", and "fastened" distinguish the manner in which two or more parts are joined together.

As used herein and in the claims, a first element is said to be "received" in a second element where at least a portion of the first element is received in the second element unless specifically stated otherwise.

Referring to FIGS. **1-3**, an electrical connector **100** is shown in accordance with an embodiment. As shown, electrical connector **100** includes a female connector **104** and a male connector **108** that are removably connectable. When the male connector **108** is inserted into the female connector **104**, electrical pathway is completed. Different electrical pathways may correspond to different electrical poles. For example, electrical connector **100** may connect to form electrical pathways for hot, neutral, and ground poles of an AC electrical line.

Referring to FIG. **4**, female connector **104** includes a plurality of electrical contacts **112** surrounded by an outer shield **116**. Outer shield **116** is made of electrically insulating material. As shown, outer surface **120** of outer shield **116** is free of electrical contacts. By surrounding electrical contacts **112**, outer shield **116** mitigates the risk of electrical shock to a user, and provides electrical contacts **112** with protection against weather, dirt, and damage both when connected and disconnected from male connector **108** (FIG. **3**).

The electrically insulating material may be any insulating material known in the electrical arts, such as plastic (e.g. acrylic, polyvinyl chloride), rubber and carbon fiber. In some embodiments, the insulating material may be ceramic.

The insulating material may be a selected so as to maintain its shape when pressure is applied thereto. Therefore, if the insulating material is more pliable, such as rubber, then the thickness of the insulating material may be increased. Alternately, if the insulating material is rigid, such as ceramic, then the then the thickness of the insulating material may be reduced.

A material may be referred to as "electrically insulating" if that material has an electrical conductivity of less than 1.0 (S/m) at 20° C. For example, PET plastic has an electrical conductivity of 1.0×10^{-21} S/m at 20° C., whereas most metals which have electrical conductivities exceeding 1×10^{6} S/m at 20° C.

Within female connector **104**, electrical contacts **112** may be spaced apart by electrical insulators **124**. As exemplified, electrical insulators **124** are configured as annular bands of electrically insulating material. The electrically insulating material may be the same or different to the electrically insulating material from which outer shield **116** is constructed. It will be appreciated that each electrical insulator **124** may be made as a single unitary body or may be made from a plurality of discrete members arranged in an annular band. As exemplified, each electrical insulator **124** may extend axially from the main body further than electrical contacts **112**. An advantage of this design is that this helps to mitigate the risk of two electrical contacts **112** being inadvertently short circuited. For example, outer shield **116** and insulators **124** may collectively define a plurality of spaced apart recesses **128**, and each electrical contact **112** may be positioned in a different recess **128**. This allows male connector **108** (FIG. **3**) to be received in the recesses **128** to electrically connect with female connector contacts **112**, and to form a secure press fit connection with female connector **104**.

As exemplified, female connector **104** includes two insulators **124***a*, and **124***b* and three electrical contacts **112***a*, **112***b*, and **112***c*. First insulator **124***a* is spaced radially inwardly of outer shield **116** to define a first recess **128***a*, and first electrical contact **112***a* is positioned in the first recess **128***a*. Second insulator **124***b* is spaced radially inwardly of first insulator **124***a* to define a second recess **128***b*, and second electrical contact **112***b* is positioned in the second recess **128***b*. Second insulator **124***b* also includes a radial inner cavity **132** defining a third recess **128***c*, and third electrical contact **112***c* is positioned in the third recess **128***c*.

As exemplified in FIGS. **4** and **5**, male connector **108** includes a plurality of electrical contacts **136** for forming an electrical connection with respective female connector contacts **112** (FIG. **4**) when male connector **108** is connected with female connector **104** (FIG. **4**). As female connector **104** is exemplified with three electrical contacts then male connector **108** may include at least one first male connector contact **136***a*, at least one second male connector contact **136***b*, and at least one third male connector contact **136***c*. As shown in FIG. **6**, first, second, and third male connector contacts **136***a*, **136***b*, and **136***c* are sized and positioned to be received in first, second, and third female connector recesses **128***a*, **128***b*, and **128***c* for electrically connecting with first, second, and third female connector contacts **112***a*, **112***b*, and **112***c* respectively when male connector **108** is connected to female connector **104**.

Referring to FIG. **8**, male connector **108** each of first, second, and third connector contacts **136** may comprise a single member (which may be configured as an annular band) or as a plurality of discrete members. In the illustrated example, male connector **108** includes three first contacts **136***a*, three second contacts **136***b*, and one third contact **136***c*. As shown in FIG. **6**, when female and male connectors **104** and **108** are connected, first female and male connector contacts **112***a* and **136***a* collectively form a first electrical pathway, second female and male connector contacts **112***b* and **136***b* collectively form a second electrical pathway, and third female and male connector contacts **112***c* and **136***b* collectively form a third electrical pathway. Turning to FIG. **10**, all of the first male connector contacts **136***a* may be electrically connected by a first contact base **140***a*, and all of the second male connector contacts **136***b* may be electrically connected by a second contact base **140***b*. This allows the plurality of first male connector contacts **136***a* to cooperatively define a first electrical pathway, and allows the plurality of second male connector contacts **136***b* to cooperatively define a second electrical pathway. Similarly, if male connector **108** included a plurality of third contacts **136***c*, then all of the third electrical contacts **136***c* may be electrically connected by a third contact base, so that they cooperatively form a third electrical pathway.

As exemplified in FIGS. **4** and **5**, male connector **108** may include an outer shield **144** that surrounds male connector contacts **136**. Outer shield **144** is made of electrically insulating material, which may be the same or different as outer shield **116**. As shown, outer surface **148** of outer shield **144** is free of electrical contacts. By surrounding electrical contacts **136**, outer shield **144** mitigates the risk of electrical shock to a user, and provides electrical contacts **136** with protection against weather, dirt, and damage both when connected and disconnected from female connector **104**.

As shown in FIG. **6**, male connector outer shield **144** may be sized and positioned for receipt in first female connector recess **128***a* when female and male connectors **104** and **108** are connected. This allows female connector outer shield **116** and male connector outer shield **144** to cooperatively form a double wall shield for electrical connector **100**. This provides enhanced safety against electrical shock, and protection against weather, dirt, and damage to the electrical contacts **112** and **136** inside. Furthermore, outer shields **116** and **144** may be sized and shaped to mate with a secure press fit, enhancing the rigidity and robustness of electrical connector **100** when assembled. As shown, male connector outer shield outer surface **148** may frictionally engage female connector outer shield inner surface **152** when female and male connectors **104** and **108** are connected. Alternately, or in addition, it will be appreciated that a locking member may comprise male and female releasable engagement members that may be provided on male and female connectors **104**, **108** to releasably secure male and female connectors **104**, **108** together.

Referring to FIG. **4**, female connector insulators **124** may have any shape. Preferably, female connector insulators **124** are shaped to allow female connector **104** to receive male connector **108** regardless of the relative orientation of the connectors **104** and **108** about longitudinal axis **156** of electrical connector **100** (FIG. **1**). This makes connecting female and male connectors **104** and **108** simpler and easier for the user. As shown in FIGS. **6-8**, female connector insulators **124** may be concentric ring (annular) insulators that define concentric annular recesses **128**. As exemplified, male connector contacts **136***a* may be equidistantly arranged from male connector longitudinal axis **160** for insertion into first annular recess **128***a*, and male connector contacts **136***b* may be equidistantly arranged from male connector longitudinal axis **160** for insertion into second annular recess **128***b*. As exemplified, male connector contact **136***c* may be positioned along male connector longitudinal axis **160** for

insertion into central recess **128***c*. It will be appreciated that male connector contacts **136***a*, **136***b* may not be equidistantly spaced apart.

Contacts **112** and **136** may be any one or more types of electrical contacts. For example, contacts **112** and **136** may be one or more of sleeve-type contacts, prong-type contacts, and pin-type contacts. Referring to FIGS. **4** and **5**, the illustrated example shows female connector contacts **112** as sleeve-type contacts, male connector contacts **136***a* and **136***b* as prong-type contacts, and male connector contact **136***c* as a pin-type contact. As exemplified, female connector contact **112***a* may at least substantially line a surface of first recess **128***a*, female connector contact **112***b* may at least substantially line a surface of second recess **128***b*, and female connector contact **112***c* may at least substantially line a surface of third recess **128***c*. This allows the prong and pin type male connector contacts **136** to be received in recesses **128** to make physical contact (and thereby electrical connection) with the female connector contacts **112** that line a surface thereof.

As exemplified, first recess **128***a* may be bounded by female connector outer shield inner surface **152** and first ring insulator outer surface **164**, second recess **128***b* may be bounded by first ring insulator inner surface **168** and second ring insulator outer surface **172**, and third recess **128***c* may be bounded by second ring insulator inner surface **176**. As exemplified, first female connector contact **112***a* may line surface **164**, second female connector contact **112***b* may line surface **172**, and second female connector contact **112***c* may line surface **176**. Alternatively, first female connector contact **112***a* may line surface **152** or both of surfaces **152** and **164**. Alternatively, or in addition, second female connector contact **112***b* may line surface **168** or both of surfaces **168** and **172**.

Electrical connector **100** provides a disconnectable connection for a continuous electrical pathway. For example, electrical connector **100** may include or accommodate a connection to one or more of electrical cables, plugs, and sockets. When female and male connectors **104** and **108** of electrical connector **100** are connected, electricity may flow between those electrical cables, plugs, and/or sockets if the circuit is closed.

It will be appreciated that male and female connectors may be used in place of existing male and female connectors. Accordingly female connector **104** may be used in a socket and male connector **108** may be used as the end of an electrical cord. Alternately, as exemplified in FIGS. **9** and **10**, female and male connectors **104**, **108** may be connectable to existing electrical cords or the like. Therefore, for example, electrical connector **100** may provide a disconnectable junction between two typical power cords. Accordingly, female connector **104** may include one of a plug or socket (e.g. an AC type plug or socket), and the male connector **108** may include the other of the plug or socket. This allows electrical connector **100** to bridge a connection between existing male and female connectors.

As exemplified in FIG. **9**, female connector **104** includes a female main connector body **180**, which includes female connector outer shield **116**, and which houses female connector contacts **112** in addition to an electrical plug **184**. Alternatively, female connector body **180** may house an electrical socket **216** (see FIG. **10**) instead of electrical plug **184**. As shown, the electrical plug **184** may be an AC type electrical plug, such as any known international variety of AC type electrical plug. For example, electrical plug **184** may be rated for use with power over 100V, such as 120V or 220V power. In the illustrated example, electrical plug **184** includes three electrical plug contacts **188**. Electrical plug contacts **188** may include a ground contact **188***a*, a hot contact **188***b*, and a neutral contact **188***c*. Each female connector contact **112** may be electrically connected to a different one of electrical plug contacts **188**. The electrical connection may be formed by direct contact between the female connector, or by electrical wires **192** as shown. In the illustrated example, female connector contact **112***a* is electrically connected to ground contact **188***a* by electrical wire **192***a*, female connector contact **112***b* is electrically connected to hot contact **188***b* by electrical wire **192***b*, and female connector contact **112***c* is electrically connected to neutral contact **188***c* by electrical wire **192***c*. It will be appreciated that in alternative embodiment, there can be different pairings of the electrical socket contacts **188** and the female connector contacts **112**. It will also be appreciated that the plug or socket provided in connector body **180** may be configured to receive any plug or socket known in the electrical arts.

Female connector contacts **112** and electrical plug **184** are provided in different portions of female connector body **180**. This can allow female connector contacts **112** and electrical plug **184** to face different directions, as shown. In turn, this allows a male connector **108** and another electrical appliance (e.g. power cord) to simultaneously connect with female connector **104** in different directions without mutually interfering. Female connector **104** has a longitudinal axis **196**. In the illustrated example, connector contacts **112** and electrical plug **184** are longitudinally spaced apart. Connector contacts **112** are provided at a first longitudinal end **200** of female connector body **180**, and electrical plug **184** is provided at a second longitudinal end **204** of female connector body **180**. Female connector contacts **112** and electrical plug **184** may be oriented in parallel (e.g. with longitudinal axis **196**) as shown, or electrical plug **184** may be oriented non-parallel with longitudinal axis **196** and female connector contacts **112**. In an alternate embodiment, it will be appreciated that the plug **184** or socket **216** may be provided elsewhere on body **180**, such as a longitudinally extending sidewall thereof.

As exemplified in FIG. **10**, male connector **108** includes a male main connector body **212**, which includes male connector outer shield **144**, and which houses male connector contacts **136** in addition to an electrical socket **216**. Alternatively male connector body **212** may house an electrical plug **184** instead of electrical socket **216**. As shown, the electrical socket **216** may be an AC type electrical socket, such any known international variety of AC type electrical socket. For example, electrical socket **216** may be rated for use with power over 100V, such as 120V or 220V power. In the illustrated example, electrical socket **216** includes three electrical socket contacts **220**. Electrical socket contacts **220** may include a ground contact **220***a*, a hot contact **220***b*, and a neutral contact **220***c*. Each male connector contact **136** may be electrically connected to a different one of electrical socket contacts **220**. The electrical connection may be formed by direct contact between the male connector, or by electrical wires **224** as shown. In the illustrated example, male connector contact **136***a* is electrically connected to ground contact **220***a* by electrical wire **224***a*, male connector contact **136***b* is electrically connected to hot contact **220***b* by electrical wire **224***b*, and male connector contact **136***c* is electrically connected to neutral contact **220***c* by electrical wire **224***c*. It will be appreciated that in alternative embodiment, there can be different pairings of the electrical socket contacts **220** and the male connector contacts **136**. It will also be appreciated that the

plug or socket provided in connector body **212** may be configured to receive any plug or socket known in the electrical arts.

Male connector contacts **136** and electrical socket **216** are provided in different portions of male connector body **212**. This can allow male connector contacts **136** and electrical socket **216** to face different directions, as shown. In turn, this allows a female connector **104** and another electrical appliance (e.g. power cord) to connect with male connector **108** in different directions without interference. In the illustrated example, male connector contacts **136** and electrical socket **216** are longitudinally spaced apart. Connector contacts **136** are provided at a first longitudinal end **228** of male connector body **212**, and electrical socket **216** is provided at a second longitudinal end **232** of male connector body **212**. Male connector contacts **136** and electrical socket **216** may be oriented in parallel (e.g. with longitudinal axis **160**) as shown, or electrical socket **216** may be oriented non-parallel with longitudinal axis **160** and male connector contacts **136**. In an alternate embodiment, it will be appreciated that the plug **184** or socket **216** may be provided elsewhere on body **212**, such as a longitudinally extending sidewall thereof.

Reference is now made to FIGS. **11-13**, which show an electrical connector **400** including a female connector **404** and a male connector **408**, in accordance with another embodiment. Electrical connector **400** is similar to electrical connector **100** in many respects, except for example the configuration of the electrical contacts of the female and male connectors **404** and **408**.

As exemplified in FIG. **11**, female connector **404** may comprise a plurality of female connector contacts **112** spaced apart by a plurality of female connector insulators **124** and surrounded by a female connector outer shield **116**. In contrast with female connector **104** (FIG. **4**), female connector contact **112***a* lines female connector outer shield inner surface **152** instead of first female connector insulator outer surface **164**, and female connector contact **112***c* is a pin-type contact instead of a sleeve-type contact.

As exemplified in FIG. **12**, male connector **408** may comprise male connector contacts **136** spaced apart by a plurality of male connector insulators **426**. Similar to female connector insulators **124**, male insulators **426** are made of electrically insulating material, may have any shape and configuration suitable for mating with female connector **404**, and may be spaced apart from each other to define male connector recesses **430**. Referring to FIGS. **11-13**, when female and male connectors **404** and **408** are connected, male connector insulators **426** are received in female connector recesses **128**, and female connector insulators **124** are received in male connector recesses **430**, whereby male connector contacts **136** physically contact female connector contacts **112** forming electrical connection therebetween. The mutual reception of male and female connector insulators **426** and **124** into female and male connector recesses **128** and **430** can provide greater contact surface area between connectors **404** and **408** for a more secure and robust connection.

As exemplified in FIG. **12**, male connector **408** includes three insulators **426** and three electrical contacts **136**. Second insulator **426***b* is spaced inwardly of first insulator **426***a* to define a first recess **430***a*, third insulator **426***c* is spaced inwardly of second insulator **426***b* to define a second recess **430***b*, and second insulator **426***b* includes an inner cavity **434** defining a third recess **430***c*. Referring to FIGS. **11-12**, Male connector insulators **426***a*, **426***b*, and **426***c* are sized and shape for receipt in female connector recesses **128***a*, **128***b*, and **128***c* respectively. Similarly, male connector recesses and **430***a* and **430***b* are sized and shaped to receive female connector insulators **124***a* and **124***b* respectively. In the illustrated example, male connector insulators **426** are concentric ring shaped insulators which define annular male connector recesses **430** therebetween.

Referring to FIGS. **11-13**, male connector contacts **136** are sized and positioned to make physical contact with respective female connector contacts **112** when female and male connectors **404** and **408** are connected. As shown, male connector contact **136***a* is positioned outside of male connector insulator **426***a*, male connector contact **136***b* is positioned within second male connector recess **430***b*, and male connector contact **136***c* is positioned within third male connector recess **430***c*. Male connector contacts **136** can have any configuration suitable for forming an electrical connection with respective female connector contacts **112**. In the illustrated example, male connector contact **136***a* is a sleeve-type contact that lines first male connector insulator outer surface **438**, second male connector contact **136***b* is a sleeve-type contact that lines second male connector insulator inner surface **442**, and third male connector contact **136***c* is a sleeve-type contact that line third male connector insulator inner surface **446**. In this example, the mating female and male connector contacts **112***a*/**136***a*, and **112***b*/**136***b* are both sleeve-type contacts, which provide large contact surface areas for robust electrical connections with lower electrical resistance (and therefore less heat generation).

While the above description provides examples of the embodiments, it will be appreciated that some features and/or functions of the described embodiments are susceptible to modification without departing from the spirit and principles of operation of the described embodiments. Accordingly, what has been described above has been intended to be illustrative of the invention and non-limiting and it will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto. The scope of the claims should not be limited by the preferred embodiments and examples, but should be given the broadest interpretation consistent with the description as a whole.

The invention claimed is:

1. An electrical connector comprising:

a) a female connector comprising:

i) an outer ring shield, wherein the outer ring shield comprises an outer ring shield outer surface and an outer ring shield inner surface that are both free of electrical contacts;

ii) a first ring insulator spaced inwardly of the outer ring shield to define a first recess between the outer ring shield and the first ring insulator with a first female connector electrical contact provided in the first recess;

iii) a second ring insulator spaced inwardly of the first ring insulator to define a second recess between the first and second ring insulators with a second female connector electrical contact provided in the second recess, and,

b) a male connector removably connectable with the female connector, the male connector comprising at least one first male connector electrical contact and at least one second male connector electrical contact,

wherein when the male and female connectors are electrically connected together, the first male connector electrical

contact is received in the first recess and the second male connector electrical contact is received in the second recess, and

wherein the first ring insulator has a first ring insulator outer surface, and the first female connector electrical contact is a sleeve contact that at least substantially lines the first ring insulator outer surface.

2. The electrical connector of claim **1**, wherein the second ring insulator has an inner cavity defining a third recess with a third female connector electrical contact provided in the third recess and the male connector comprises at least one third male connector electrical contact, wherein when the male and female connectors are electrically connected together, the third male connector electrical contact is received in the third recess.

3. The electrical connector of claim **2**, wherein the second ring insulator has a second ring insulator inner surface, and the third female connector electrical contact is a sleeve contact that at least substantially lines the second ring insulator inner surface.

4. The electrical connector of claim **2**, wherein the third male connector electrical contact is a pin contact.

5. The electrical connector of claim **2**, wherein the third female connector electrical contact is a pin contact.

6. The electrical connector of claim **2**, wherein the third male connector electrical contact is a sleeve contact.

7. The electrical connector of claim **2**, wherein the male connector further comprises a body having the first, second and third male connector electrical contacts provided at one end and one of a plug or a socket provided at a longitudinally spaced apart second end of the body.

8. The electrical connector of claim **7**, wherein the plug or socket is an AC plug or socket comprising a hot contact, a neutral contact, and a ground contact, and each contact is electrically connected to a different one of the first, second and third male connector electrical contacts respectively.

9. The electrical connector of claim **2**, wherein the female connector further comprises a body having the outer ring shield and the first and second ring insulators provided at one end and one of a plug or a socket provided at a longitudinally spaced apart second end of the body.

10. The electrical connector of claim **9**, wherein the plug or socket is an AC plug or socket comprising a hot contact, a neutral contact, and a ground contact, and each contact is electrically connected to a different one of the first, second and third female connector electrical contacts respectively.

11. The electrical connector of claim **9**, wherein the male connector further comprises a male body having the first, second and third male connector electrical contacts provided at one end and the other of a plug or a socket provided at a longitudinally spaced apart second end of the male body.

12. The electrical connector of claim **2**, wherein the first female connector electrical contact comprises a ground.

13. The electrical connector of claim **1**, wherein the first and second ring recesses are concentric annular recesses.

14. The electrical connector of claim **1**, wherein the first ring insulator has a first ring insulator inner surface, the second ring insulator has a second ring insulator outer surface, and the second female connector electrical contact is a sleeve contact that at least substantially lines at least one of the first ring insulator inner surface and the first ring insulator outer surface.

15. The electrical connector of claim **1**, wherein the male and female connectors are secured together by a press fit.

16. The electrical connector of claim **1**, wherein the male connector comprises a male connector outer ring shield that surrounds the first and second male connector electrical contacts, wherein the male connector outer ring shield has an outer surface that is free of electrical contacts.

17. An electrical connector comprising:

a) a female connector comprising:

i) an outer ring shield, wherein the outer ring shield comprises an outer ring shield outer surface and an outer ring shield inner surface that are both free of electrical contacts;

ii) a first ring insulator spaced inwardly of the outer ring shield to define a first recess between the outer ring shield and the first ring insulator with a first female connector electrical contact provided in the first recess;

iii) a second ring insulator spaced inwardly of the first ring insulator to define a second recess between the first and second ring insulators with a second female connector electrical contact provided in the second recess, and,

b) a male connector removably connectable with the female connector, the male connector comprising at least one first male connector electrical contact and at least one second male connector electrical contact,

wherein when the male and female connectors are electrically connected together, the first male connector electrical contact is received in the first recess and the second male connector electrical contact is received in the second recess, wherein the male connector comprises a male connector outer ring shield that surrounds the first and second male connector electrical contacts, wherein the male connector outer ring shield has an outer surface that is free of electrical contacts, and

wherein the male connector outer ring shield is received in the first recess when the male and female connectors are electrically connected together.

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