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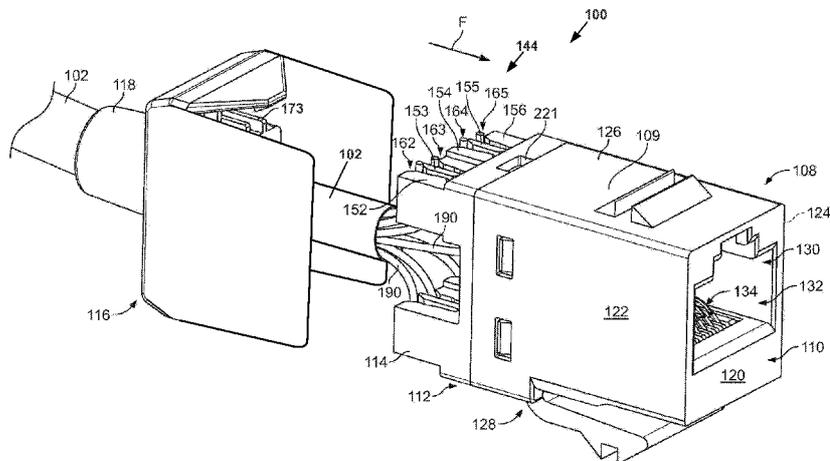
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(54) Title: ELECTRICAL CONNECTOR WITH SHIELD CAP AND SHIELDED TERMINALS

FIG. 2



(57) Abstract: A shield cap is mounted to an electrical connector for reducing crosstalk between adjoining electrical connectors. The shield cap includes a body portion and opposite shield plates. The body portion is configured to engage the electrical connector and is formed from a non-conductive material. The opposite shield plates are connected to opposite sides of the body portion and configured to at least partially cover one or more insulation displacement contacts exposed from the electrical connector. The electrical connector includes a wire termination conductor configured to be connected to a wire conductor of a cable. The wire termination conductor is at least partially coated with a shielding layer.

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ELECTRICAL CONNECTOR WITH SHIELD CAP AND SHIELDED
TERMINALS

Cross-Reference to Related Application(s)

This application is being filed on April 22, 2015, as a PCT International
5 Patent application and claims priority to U.S. Patent Application Serial No. 61/982,958
filed on April 23, 2014, the disclosure of which is incorporated herein by reference in its
entirety.

Background

Electrical connectors, such as modular jacks and modular plugs, are
10 commonly used in telecommunications systems. Such connectors may be used to provide
interfaces between successive runs of cable in telecommunications systems and between
cables and electronic devices. In the field of data communications, communications
networks typically utilize techniques designed to maintain or improve the integrity of
signals being transmitted via the network ("transmission signals"). To protect signal
15 integrity, the communications networks should, at a minimum, satisfy compliance
standards that are established by standards committees, such as the Institute of Electrical
and Electronics Engineers (IEEE). The compliance standards help network designers
provide communications networks that achieve at least minimum levels of signal integrity
as well as some standard of compatibility.

20 To promote high circuit density, communications networks typically
include a plurality of electrical connectors that bring transmission signals in close
proximity to one another. For example, the contacts of multiple sets of jacks and plugs are
positioned fairly closely to one another. However, such a high density configuration is
particularly susceptible to alien crosstalk inference.

25 Alien crosstalk is electromagnetic noise that can occur in a cable that runs
alongside one or more other signal-carrying cables or in a connector that is positioned
proximate to another connector. The term "alien" arises from the fact that this form of
crosstalk occurs between different cables in a bundle or different connectors in a group,
rather than between individual wires or circuits within a single cable or connector. Alien
30 crosstalk affects the performance of a communications system by reducing the signal-to-
noise ratio.

Various arrangements are introduced to reduce alien crosstalk between adjacent connectors. One possible solution is to separate the cables and/or connectors from each other by a predetermined distance so that the likelihood of alien crosstalk is minimized. This solution, however, reduces the density of cables and/or connectors that
5 may be used per unit of area.

The telecommunications industry is constantly striving toward larger signal frequency ranges. As transmission frequency ranges widen, crosstalk becomes more problematic. Thus, there is a need for further development of electrical connectors with high efficiency in reducing the crosstalk between adjacent connectors.

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Summary

This disclosure is generally directed to electrical connectors. In one possible configuration and by non-limiting example, the electrical connectors are jack assemblies configured to reduce crosstalk between adjacent electrical connectors. In another possible configuration and by non-limiting example, the electrical connectors
15 include wire termination conductors with a shielding layer configured to reduce crosstalk between adjacent wire termination conductors and/or adjacent electrical connectors. Various aspects are described in this disclosure, which include, but are not limited to, the following aspects.

One aspect of the present disclosure relates to an electrical connector
20 including a connector housing and a shield cap. The connector housing has front and rear ends and a cavity opened at the front end for receiving a plug. The connector further includes one or more insulation displacement contacts supported by the connector housing and extending from the connector housing at the rear end. The shield cap may be mounted to the connector housing at the rear end. The shield cap may include a body portion
25 configured to engage the connector housing, and opposite shield plates connected to opposite sides of the body and configured to at least partially cover the insulation displacement contact.

Another aspect of the present disclosure is directed to a shield cap configured to be mounted to an electrical connector. The shield cap may include a body
30 portion and opposite shield plates. The body portion is configured to engage the electrical connector. The body portion may be formed from a non-conductive material. The opposite shield plates may be connected to opposite sides of the body portion and

configured **to** at least partially cover one or more insulation displacement contacts exposed from the electrical connector.

Still another aspect of the present disclosure relates to a jack assembly for terminating a plurality of line wires of a communications cable. The jack assembly may include a dielectric jack housing and a shield cap. The jack housing has front and rear ends, and includes a cavity opened at the front end for receiving a plug. The jack housing may further include a contact subassembly joined **to** the rear end. **The** contact subassembly may include a plurality of arms extending from the contact **subassembly** against the rear end of the jack housing and spaced part to define a plurality of **conductor** channels. A plurality of insulation displacement contacts are provided in the contact subassembly so that each insulation displacement contact is held within each of the plurality of conductor channels. The jack housing also includes a plurality of electrical contacts configured and positioned in the cavity for engaging corresponding contacts of the plug. The jack housing may include a circuit board configured to electrically connect the plurality of electrical contacts and the plurality **of insulation** displacement contacts. The shield cap is configured to be mounted to the jack housing at the rear end to cover at least partially the contact subassembly. The shield cap may include a body portion, a cable sleeve, opposite sidewalk, and opposite shield plates. The body portion has an inner **surface** and an outer surface and is made from a non-conductive material. The cable sleeve extends outwardly from the outer surface of the body and configured to receive a cable having a plurality of conductors. The cable is inserted through the cable sleeve so that each **of the** plurality of conductors **of the** cable **is** connected to each of the **plurality of** insulation displacement contacts. The opposite sidewalks may be configured to extend from the inner surface and have one or more latch projections configured to engage the jack housing. The opposite shield plates may be configured to extend from the inner **surface** so **as to** at least **partially** cover the **contact** subassembly. The opposite shield plates are made from a conductive material.

Still another aspect of the present disclosure relates to an electrical connector. The electrical connector includes a connector housing, an electrical contact, and a wire termination conductor. The connector housing has front and rear ends and receives a plug at the front end. The electrical contact engages a corresponding electrical contact of the plug. The wire termination conductor is connected to the electrical contact and extends from the connector housing at the rear end. The wire termination conductor is configured to be connected to a wire conductor of a cable. The wire termination

conductor is at least partially coated with a shielding layer. The shielding layer is adapted for reducing crosstalk between adjacent electrical connectors, and between adjacent wire termination conductors.

5 Still another aspect of the present disclosure is a wire termination conductor used for an electrical connector. The wire termination conductor includes a support head supported by the electrical connector, and a wire engaging body extending from the electrical connector and connected to a wire conductor of a cable. The wire engaging body is at least partially coated with a shielding layer. The wire engaging body has a first surface, a second surface opposite to the first surface, and a third surface extending
10 between the first and second surfaces. The wire contact portion may be provided on the third surface. The shielding layer may be coated on the first and second surfaces, but not on the third surface.

The shielding layer may include a first layer and a second layer formed above the second layer. The first layer may be formed with a dielectric material, and the
15 second layer may be formed with a conductive material. The dielectric material may be a polymer. The conductive material may be a conductive ink, such as a silver ink.

Still another aspect of the present disclosure is directed to a method of forming a shielding layer on a wire termination conductor used for an electrical connector. The method may include forming a first layer on at least a portion of the wire termination
20 conductor, and forming a second layer on at least a portion of the first layer. The first layer may include a dielectric material, and the second layer may include a conductive material.

Brief Description of the Drawings

25 FIG. 1 is a rear perspective view of an exemplary electrical connector assembly.

FIG. 2 is a front perspective view of a jack assembly of FIG. 1 before a shield cap engages a contact sub-assembly.

FIG. 3 is a front perspective view of the contact subassembly of FIG. 2.

30 FIG. 4 is a perspective view of an exemplary shield cap of FIGS. 1 and 2.

FIG. 5 is an expanded view of the shield cap of FIG. 4.

FIG. 6 is a perspective view of an exemplary body portion of the shield cap of FIGS. 4 and 5.

FIG. 7 is a perspective view of exemplary shield plates overmolded to the body portion of FIG. 6.

FIG. 8 is an expanded view of another exemplary shield cap with an exemplary support bar.

5 FIGS. 9A and 9B are side views of a cross wall and a conductor channel, illustrating that the cross wall engages an insulated wire conductor into the conductor channel 169 and a corresponding insulation displacement contact.

FIG. 10A is a perspective view of exemplary electrical connector assemblies adjoined to one another in a high density configuration.

10 FIG. 10B is a top view of the electrical connector assemblies of FIG. 10A.

FIG. 11 is a rear perspective, exploded view of the electrical connector of FIG. 1.

FIG. 12 is a perspective view of exemplary components of the contact subassembly of FIG. 11.

15 FIG. 13 is a side view of exemplary components of the contact subassembly of FIG. 11.

FIG. 14A is a top view of an exemplary wire termination conductor.

FIG. 14B is a side view of the wire termination conductor of FIG. 14A.

FIG. 14C is a bottom view of the wire termination conductor of FIG. 14A.

20 FIG. 15 is a side view illustrating an example of forming a shielding layer on a wire termination conductor.

Detailed Description

FIG. 1 is a rear perspective view of an exemplary electrical connector assembly 100. The connector assembly 100 includes a plug 106 and a jack assembly 108. The plug 106 is connected to the jack assembly 108 for transmitting high speed electronic signals between multi-conductor cable 102 and multi-conductor cable 104. In some example, the plug 106 is an RJ-45 type. However, the plug 106 can be of any type or variation. The multi-conductor cables 102 and 104 can be twisted-pair cables having a plurality of insulated wire conductors 190 (FIG. 2) running throughout the corresponding cable. In this disclosure, the term "conductive," or other similar phrase, is used to refer to electrical conductivity, and thus can be interchangeably used with "electrically conductive."

In some examples, the jack assembly 108 includes a jack housing 109, a contact subassembly 114, and a shield cap 116. The jack housing 109 has a front end 110 and a rear end 112. The plug 106 is received to the front end 110, and the contact subassembly 114 is coupled to the rear end 112. The shield cap 116 is connected to the jack housing 109 or the contact subassembly 114 and configured to at least partially cover the contact subassembly 114 and/or electrical components exposed therefrom. In other examples, the jack housing 109 and the contact subassembly 114 are integrally formed. It is noted that the electrical connector assembly 100 as shown in FIG. 1 is only a non-limiting example and many other variations and types of connectors or connector assemblies can be used in accordance with the principles of the present disclosure.

The jack housing 109 can be fabricated from a non-conductive material or dielectric material. In other examples, the jack housing 109 is made from a non-conductive material having conductive particles dispersed therein. The conductive particles form a conductive network that facilitates providing EMI/RFI shielding for the electrical connector assembly 100. As such, the jack housing 109 is adapted to avoid formation of a conductive path. More specifically, the jack housing 109 may be configured to avoid forming a conductive path with an electrical contact 134 (FIG. 2).

In some examples, the contact subassembly 114 is fabricated from a non-conductive material or dielectric material. In other examples, the contact subassembly 114 is made from a non-conductive material having conductive particles dispersed therein. The conductive particles form a conductive network that facilitates providing EMI/RFI shielding for the electrical connector assembly 100.

As discussed in further detail below, the shield cap 116 provides shield plates 215 and 217 (FIGS. 3 and 4) for reducing alien crosstalk between adjacent electrical connector assemblies. Examples of materials used to make the shield cap 116 are described below in further detail.

FIG. 2 is a front perspective view of the jack assembly 108 of FIG. 1 before the shield cap 116 engages the contact sub-assembly 114. As described above, the jack assembly 108 includes the jack housing 109, the contact subassembly 114, and the shield cap 116.

The jack housing 109 has a substantially rectangular shape and includes a front face 120, opposite sides 122 and 124, a top side 126, and a bottom side 128. The front face 120 is arranged at the front end 110 of the jack housing 109. The opposite sides 122 and 124, the top side 126, and the bottom side 128 extend between the front end 110

and the rear end 112 of the jack housing 109. The front face 120 forms an opening 130 that leads to a cavity 132 configured to receive the plug 106 (FIG. 1). The cavity 132 includes an array of electrical contacts 134 that extend through the jack housing 109 from the front end 110 to the rear end 112 and terminate at a corresponding wire termination conductor 180 (FIG. 3) on the contact subassembly 114. In this disclosure, the wire termination conductors 180 are depicted as insulation displacement contacts (IDC's) but could be other types of wire termination conductors such as wire wraps or pins. In certain examples, the arrangement of the electrical contacts 134 may be at least partially determined by industry standards, such as, but not limited to, International
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10 Electro technical Commission (IEC) 60603-7 or Electronics Industries Alliance/Telecommunications Industry Association (EIA/TIA)-568.

The contact subassembly 114 is configured to provide a plurality of insulation displacement contacts 180 that is electrically connected to a plurality of conductors 190 (FIG. 1) stripped at the end of the cable 102. The contact subassembly
15 114 is described in further detail with reference to FIG. 3.

The shield cap 116 operates to at least partially cover the contact subassembly 114 (and/or electrical components exposed therefrom) for crosstalk shielding and pass the cable 102 therethrough. In some examples, the shield cap 116 has a cable sleeve 118 extending axially in a rear direction. The cable sleeve 118 is configured to
20 receive and provide strain relief for the cable 102 when the cable 102 is engaged with the contact sub-assembly 114. The cable sleeve 118 also operates as a bend limiter for the cable 102. In order to connect the cable 102 to the jack assembly 108, a stripped end of the cable 102 is first inserted through the cable sleeve 118 and advanced toward the contact subassembly 114. In some examples, the cable sleeve 118 is shaped as a truncated
25 cone.

FIG. 3 is a front perspective view of the contact subassembly 114 of FIG. 2. The contact subassembly 114 includes a back covering 202 having an outer surface 204 and a covering edge 206 that defines a perimeter of the back covering 202. The back covering 202 encloses and holds a circuit board 262 (FIG. 11) within the jack housing 109.
30 The circuit board 262 is configured to define circuit paths that extend from the plurality of electrical contacts 134 to the plurality of insulation displacement contacts 180, thereby electrically connecting the electrical contacts 134 and the insulation displacement contacts 180.

In some examples, the contact subassembly 114 includes a plurality of arms 152-161 that project **axially** outward away from the outer surface 204 of the contact subassembly 114, and thus from the rear end 112 of the jack housing 109. The plurality of arms 152-161 extend at an angle that is substantially perpendicular to the outer surface 204. The arms 152-161 can be integrally formed with the contact subassembly 114.

The plurality of arms 152-161 define a plurality of **conductor** channels 162-169 that is configured to accommodate the insulation displacement contacts 180 therein. In particular, the arms 152 and 153 define the conductor channel 162 therebetween; the arms 153 and 154 define the conductor channel 163 therebetween; the arms 154 and 155 define the conductor channel 164 therebetween; the arms 155 and 156 define the conductor channel 165 therebetween; the arms 157 and 158 define the conductor channel 166 therebetween; the **arms** 158 and 159 define the conductor channel 167 therebetween; the arms 159 and 160 define the conductor channel 168 therebetween; and the arms 160 and 161 define the conductor channel 169 therebetween.

The contact **subassembly** 114 **includes** a plurality of insulation displacement contacts (IDC's) 180 accommodated within the conductor channels 162-169, respectively. In particular, each IDC 180 has a slot 181 configured to hold a conductor 190 (FIG. 2) when the electrical connector assembly 100 is in operation. The slot 181 of each IDC 180 is oriented and rests within the corresponding conductor channel 162-169 so that the slot 181 can receive the conductor 190.

For example, the arms 152 and 153 are configured to surround the IDC 180A and the arms 153 and 154 are configured to **surround** the IDC 180B. Each arm 152-154 includes a cut-out 183 for receiving a portion of the IDC 180. The adjacent cut-outs 183 form an IDC channel 261 that intersects a corresponding conductor channel 162-169. In some examples, when the IDC channel 261 and the corresponding conductor channel 162-169 form an angle less than or greater than 90 degree, the IDC's 180A and 180B can be positioned closer to each **other** to increase density of IDC's 180 used by the jack assembly 108. Although the foregoing description relates specifically to the arms 152-154 and the conductor channel 162 and 163, the description can be similarly be applied to the arms 155-161 and the channels 164-169.

In some examples, the contact subassembly 114 includes engaging grooves 221 (FIG. 2) for engaging corresponding latch projections 218 and 220 of the shield cap 116. As described below, the shield cap 116 is configured to cover at least partially the contact subassembly 114 and assist each wire conductor of the cable 190 to engage the slot

181 of each IDC 180 when assembling the shield cap 116 to the contact subassembly 114. The structure of the contact subassembly 114 is disclosed in further detail by U.S. Patent No. 7,563,125, entitled "Jack Assembly for Reducing Crosstalk," to Paul John Pepe, et al. The entirety of the patent is herein incorporated by reference.

5 FIGS. 4-8 illustrate an exemplary shield cap 116 formed in accordance with the principles of the present disclosure. FIG. 4 is a perspective view of an exemplary-shield cap 116 of FIGS. 1 and 2. FIG. 5 is an exploded view of the shield cap 116 of FIG. 4. FIG. 6 is a perspective view of an exemplary body portion 209 of the shield cap 116 of FIGS. 4 and 5. The shield cap 116 is configured to be coupled to the jack housing 109
10 and/or the contact subassembly 114 to at least partially cover the contact subassembly 114. In some examples, the shield cap 116 includes a hybrid structure having a main body of molded plastic material and opposite side shields made of solid metallic plates. For example, the shield cap 116 includes a body portion 209 having an inner surface 210 and an outer surface 211, and opposite shield plates 215 and 217. The inner surface 210 of the
15 body portion 209 faces the contact subassembly 114 when the shield cap 116 engages the contact subassembly 114 (FIG. 1).

 In addition to the cable sleeve 118 as described above, the body portion 209 further includes a cable sleeve opening 212, opposite sidewalls 214 and 216 and latch projections 218 and 220. The cable sleeve opening 212 is formed on the inner surface 210
20 and leads into and through the cable sleeve 118. The opposite sidewalls 214 and 216 extend outward at a substantially perpendicular angle with respect to the inner surface 210. In some examples, each side wall 214 or 216 can taper or narrow as the sidewall 214 or 216 extends outward.

 The latch projections 218 and 220 are formed on the sidewalls 214 and 216,
25 respectively, for attaching the shield cap 116 to the contact subassembly 114 or the jack housing 109. In some examples, the latch projections 218 and 220 are integrally formed with the body portion 209. For example, as discussed below, where the body portion 209 is made from homogenous plastic, the latch projections 218 and 220 can be made from the same plastic so that the latch projections 218 and 220 are formed to be unitary with the
30 plastic body portion 209. In some examples, the sidewalls 214 and 216 are configured to flex outward so that the shield cap 116 slides onto the contact subassembly 114 so that the latch projections 218 and 220 engage the corresponding engaging grooves 221 (FIG. 2). For example, as the shield cap 116 is inserted over the contact subassembly 114, each latch projection 218 and 220 suitably engages a corner or outer surface of the contact

subassembly 114, thereby exerting an outward force on the sidewalk 214 and 216, respectively. The latch projections 218 and 220 continue to slide along the outer surface of the contact subassembly 114 until the latch projections 218 and 220 engage the engaging grooves 221 of the contact subassembly 114. In other examples, instead of the engaging grooves 221 of the contact subassembly 114, the jack housing 109 can have latch openings on the top side 126 and the bottom side 128 for engaging the latch projections 218 and 220.

The body portion 209 of the shield cap 116 is fabricated from a non-conductive material. In some examples, the body portion 209 is entirely made from a homogeneous non-conductive material without conductive materials or conductive particles. In some examples, the non-conductive material includes a polypropylene or other thermoplastic polymer. The non-conductive material may also include polymeric or plastic materials such as polycarbonate, ABS, and/or PC/ABS blend.

In other examples, the body portion 209 may be made from a plastic blended with a material adapted for reducing crosstalk. For example, the body portion 209 can be made from a non-conductive material having conductive particles dispersed therein. The conductive particles may include, for example, a conductive powder or conductive fibers. For example, the conductive particles may be carbon powders, carbon fibers, silver coated glass beads or fibers, nickel coated carbon fibers, or stainless steel fibers. By way of example, the body portion 209 may be formed in an injection molding process that uses pellets containing the non-conductive material and the conductive particles. The pellets may be made by adding a conductive powder or conductive fibers to molten resin. After extruding and cooling the resin mixture, the material may be chopped or formed into pellets. Alternatively, the conductive powder or fiber may be added during an injection molding process. The conductive particles form a conductive network that facilitates providing crosstalk, EMI and/or RFI shielding. When the body portion 209 of the shield cap 116 is ultimately formed, the conductive particles may be evenly distributed or dispersed throughout. Alternatively, the conductive particles may be distributed in clusters. Further, during the molding process, the conductive particles may be forced to move (e.g., through magnetism or applied current) to certain areas so that the density of the conductive particles is greater in desired areas.

The shield cap 116 further includes the opposite shield plates 215 and 217 for at least partially cover the contact subassembly 114 for reducing alien crosstalk between adjoining electrical connector assemblies 100. The opposite shield plates 215 and

217 are arranged to extend outward at a substantially perpendicular angle with respect to the inner surface 210 of the body portion 209 and adjacent the opposite sidewalk 214 and 216. The shield plates 215 and 217 are connected to opposite sides 232 and 234 of the body portion 209. In some examples, the shield plates 215 and 217 are symmetrically
5 arranged on the body portion 209. In some examples, the shield plates 215 and 217 are configured to cover the contact subassembly 114 and at least partially the jack housing 108 when the body portion 209 engages the contact subassembly 114 or the jack housing 108. For example, as shown in FIG. 1, when the body portion 209 is coupled to the contact subassembly 114 by the latch projections 218 and 220, the opposite sidewalk 214
10 and 216 covers the opposite sides of the contact subassembly 114 adjacent the top side 126 and the bottom side 128, and the opposite shield plates 215 and 217 covers the other opposite sides of the contact subassembly 114 and at least partially the opposite sides 122 and 124 of the jack housing 108. Accordingly, the shield cap 116 encloses the IDC's 180 and the conductors 190 exposed at the contact subassembly 114 in the rear direction and
15 shields them from other electrical components of adjacent electrical connector assemblies 100 (FIG. 10). Further, the shield cap 116 can shield other electrical components, such as the electrical contacts 134 and the circuit board, contained in the jack housing 108.

In particular, as shown in FIG. 10, the electrical connector assemblies 100 are arranged for high circuit density so that the sides 122 and 124 of the jack housings 108
20 are arranged close to one another in series. In this configuration, the opposite shield plates 215 and 217 are configured to cover the contact subassembly 104 and at least partially the sides 122 and 124 of the jack housing 108 so that the shield plates 215 and 217 reduce alien crosstalk that exists between the adjoining electrical connector assemblies 100. In other embodiments, the opposite shield plates 215 and 217 may cover the entire sides 122.
25 and 124 of the jack housing 108 as well as the contact subassembly 114.

The shield plates 215 and 217 are made of solid metallic plates. Such solid metallic plates allow the shield plates 215 and 217 to be thin enough to save space when the electrical connector assemblies 100 are arranged as shown in FIG. 10. Further, the solid metallic plates enhance the strength of the shield plates 215 and 217 and show
30 improved shielding performance. The shield plates 215 and 217 may be formed of any material suitable for minimizing crosstalk, EMI and/or RFL. The material may include, but not limited to, stainless steel, gold, nickel-plated copper, silver, silvered copper, nickel, nickel silver, copper or aluminum.

The shield plates 215 and 217 are not keyed to the body portion 209. Thus, the shield plates 215 and 217 are not fastened to the body portion 209 with fasteners. In some examples, the shield plates 215 and 217 are integrally formed with the body portion 209 in an overmolding process. In other examples, the shield plates 215 and 217 can be snap-fitted to the body portion 209. In yet other examples, the shield plates 215 and 217 are attached to the body portion 209 with adhesive.

In some examples, the shield plates 215 and 217 are self-supported to the body portion 209. In some examples, the shield plates 215 and 217 are configured to be removable from the body portion 209. For example, where one shield plate is only needed on the body portion 209, the other shield plate can be removed from the body portion 209.

FIG. 7 is a perspective view of exemplary shield plates overmolded to the body portion of FIG. 6. In some examples, the shield plates 215 and 217 are made in one piece. For example, the shield plates 215 and 217 can be part of a unitary structure including the shield plates 215 and 217 interconnected by one or more cross-members 237. In the depicted example, the shield plates 215 and 217 can be made from a sheet metal by stamping process. For example, the shield plates 215 and 217 are stamped from a sheet metal so as to be interconnected by one or more cross members 237. Such a stamped metal sheet is bent as needed to produce the shield plates 215 and 217 as shown in FIG. 7. The shield plates 215 and 217 and the cross members 237 are used as a pre-mold insert. For example, the cross members 237 are placed into a mold for producing the body portion 209 before a plastic material is injected into the mold to produce the body portion 209.

FIG. 8 is an expanded view of another exemplary shield cap with an exemplary support bar. In some examples, the shield plates 215 and 217 can be supported against the body portion 209, as well as against each other, by a support structure. For example, as shown in FIG. 8, a support bar 238 is configured to extend between the opposite shield plates 215 and 217 to secure the shield plates 215 and 217. In some examples, the support bar 238 is overmolded with other components, such as the body portion 209 and the shield plates 215 and 217. In some examples, the support bar can be integrally formed with the shield plates 215 and 217 and made from the same conductive material as the shield plates 215 and 217. In other examples, the shield plates 215 and 217 include bar holes 282 configured to receive and secure the ends of the support bar 238.

Referring again to FIG. 6, the body portion 209 includes cross walls 170-177. Each cross wall 170-177 includes a first wall portion 222, a second wall portion 224, and a gap G that separates the wall portions 222 and 224 from each other.

FIGS. 9A and 9B are side views of the cross wall 177 and the conductor channel 169 as the cross wall 177 engages the insulated wire conductor 190 and advances the conductor 190 into the conductor channel 169 and corresponding IDC 180. As shown, when the axial force F is applied to the shield cap 116 (FIG. 2), the wall portions 222 and 224 contact the wire conductor 190 and advance the wire conductor 190 through the slot 181. When the shield cap 116 and the contact subassembly 114 are engaged (FIG.!), the wall portions 222 and 224 cooperate in providing strain relief for the wire conductor 190 and maintaining the wire conductor 190 in electrical contact with the IDC 180. The structure of the inner surface 210 of the body portion 209 and the engagement mechanism between the body portion 209 and the contact subassembly 114 are further described in U.S. Patent No. 7,563,125, entitled "Jack Assembly for Reducing Crosstalk," to Paul John Pepe, et al. The entirety of the patent is herein incorporated by reference.

FIG. 10A is a perspective view of exemplary electrical connector assemblies arranged close to one another in a high density configuration. In particular, the electrical connector assemblies 100 are arranged for high circuit density so that the sides 122 and 124 of the jack housings 108 are arranged close to one another in series. In some examples, the shield plates 215 and 217 are not electrically connected between the adjacent assemblies 100. For example, the shield plate 215 of an assembly 100 is not electrically connected to the shield plate 217 of an adjacent assembly 100. In this configuration, the assemblies 100 may be shielded without ground connection, which is also referred to as electronic floating shield. In some examples, for the electronic floating shield, the assemblies 100 are spaced apart at a predetermined distance so that a gap 278 is formed between the shield plates 215 and 217 of the adjacent assemblies 100, as shown in FIG. 10B. The gap 278 operates as an electrical insulator between the adjacent assemblies 100. In other examples, the shield plates 215 and 217 may include a dielectric material 280 that operates to prevent the adjacent shield plates 215 and 217 from being electrically connected between adjoining assemblies 100. As shown in FIG. 10A, the shield plates 215 and 217 may be coated with the dielectric material, or covered with a dielectric film. In other examples, the shield plates may include one or more dielectric stubs, tabs or other projections, which are configured to maintain electric insulation between adjacent assemblies 100.

In some examples, the assembly 100 has only one shielding plate on either side 232 or 234 of the body portion 209. In this configuration, the assemblies 100 may be abutted to one another in series without the gap 278 or the dielectric material 280, as described above. When the assemblies 100 are abutted to one another, the assemblies 100 are not electrically connected to one another because the body portion 209 of one assembly 100, which is made from a non-conductive material, is arranged to touch the shield plate of the other assembly 100.

In other examples, where the assembly 100 is shielded with a ground connection, adjacent assemblies 100 may be abutted in series so that the adjacent shield plates 215 and 217 are electrically connected to each other between the adjacent assemblies 100. In this configuration, the body portion 209 may incorporate a material for reducing crosstalk. For example, the body portion 209 can be made from a non-conductive material having conductive particles dispersed therein. The conductive particles may include, for example, a conductive powder or conductive fibers. For example, the conductive particles may be carbon powders, carbon fibers, silver coated glass beads or fibers, nickel coated carbon fibers, or stainless steel fibers. FIG. 11 is a rear perspective, exploded view of the electrical connector 100 of FIG. 1. In the depicted example, the rear end 112 of the jack housing 109 is open to the cavity 132 for receiving the contact subassembly 114.

The contact subassembly 114 includes the array of electrical contacts 134, a base 260, a circuit board 262, and a wire terminating structure 274. The base 260 extends from a mating end 119 of the contact subassembly 114 to the circuit board 262. The array of electrical contacts 134 is supported on the base 260. The wire terminating structure 274 extends rearward from the circuit board 262 to terminating portions 144, and is configured to hold a plurality of wire termination conductors 180 therein. The wire terminating structure 274 is sized to substantially fill the rear portion of the cavity 132. In some examples, the wire terminating structure 274 can include key features 276 for orienting the contact subassembly 114 with respect to the jack housing 109 during assembly. The terminating portions 114 are described below in further detail with reference to FIG. 3.

The contact subassembly 114 is loaded into the jack housing 109 through the rear end 112 thereof. When loaded, the base 260 is positioned proximate the front end 110 of the jack housing 109 such that the array of electrical contacts 134 are exposed to the cavity 132. The wire terminating structure 274 is partially received within the cavity 132 and substantially fills the rear portion of the cavity 132. Tabs 138 extending from the

wire terminating structure 274 engage the jack housing 109 and secure the contact subassembly 114 to the jack housing 109. When assembled, the terminating portions 144 are exposed and configured to receive wire conductors of the cable 190 (FIG. 1).

Alternatively, the wire conductors of the cable 190 may be terminated to the terminating portions 144 prior to loading the contact subassembly 114 into the jack housing 109.

FIGS. 12 and 13 illustrate the contact subassembly 114 with the wire terminating structure 274 (FIG. 11) removed to better describe the structure of the wire termination conductors 180. FIG. 12 is a perspective view of exemplary components of the contact subassembly 114 of FIG. 11. FIG. 13 is a side view of exemplary components of the contact subassembly 114 of FIG. 11.

In the depicted example, the contact subassembly 114 further includes intermediate contacts 140 supported by the base 260 and engaged with the circuit board 262. As illustrated, each electrical contact 134 is connected to a corresponding intermediate contact 140. Each intermediate contact 140 is then connected to a corresponding wire termination conductor 180 through the circuit board 262. As described above, a wire conductor of the cable 190 is inserted into the slot 181 so as to engage a corresponding wire termination conductor 180. When the insulated wire 190 is inserted into the slot 181, opposing blades 274 (FIG. 14) defining the slot 181 cut through the insulation of the wire and exposes a conductor of the wire 190. As a result, the slot 181 embeds the conductor of the wire 190 therein, thereby making an electrical connection between the wire termination conductor 180 and the wire 190.

The array of electrical contacts 134 is configured to engage plug contacts 135 of the plug 106, respectively, at a mating interface 136 between the electrical connector 100 and the plug 106.

FIG. 14 illustrates an exemplary wire termination conductor 180. FIG. 14A is a top view of an exemplary wire termination conductor 180, FIG. 14B is a side view of the wire termination conductor 180 of FIG. 14A, and FIG. 14C is a bottom view of the wire termination conductor 180 of FIG. 14A.

In the depicted example, the wire termination conductor 180 has a fixed end 182 and a free end 184. The wire termination conductor 180 includes a support head 186 at the fixed end 182 and a wire engaging body 188 that extends from the support head 186 to the free end 184. As shown in FIG. 13, the support head 186 is inserted into a corresponding engaging hole 264 formed in the circuit board 262 so as to be supported by the circuit board 262. As described above, the support head 186 is electrically connected

to a corresponding electrical contact 134 through the circuit board 262 and/or a corresponding intermediate contact 140.

As the support head 186 is held on the circuit board 262, the wire engaging body 188 extends from the circuit board 262 in a cantilever manner. In some examples, the wire engaging body 188 extends substantially at a perpendicular angle with respect to the circuit board 262. As describe above, the wire engaging body 188 includes the slot 181 for engaging the cable 190 and electrically connecting the wire termination conductor 180 with the wire conductor of the cable 190.

In some examples, the wire engaging body 188 has opposite major surfaces 192 and 194, a peripheral surface 196, and an internal surface 197. The peripheral surface 196 and the internal surface 197 extend between the opposite major surface 192 and 194. In particular, the peripheral surface 196 and the internal surface 197 are defined by side surfaces formed between the opposite major surfaces 192 and 194 along the contours of the opposite major surfaces 192 and 194.

The wire engaging body 188 includes a wire contact portion 198 configured to form an electrical contact with the wire conductor of the cable 190 within the slot 181 of the wire termination conductor 180. In some examples, the wire contact portion 198 includes opposing blade arms 272 and opposing blades 274 formed on the internal surface 197 of the opposing blade arms 272. The opposing blade arms 272 are configured to flex apart when the wire 190 is inserted into the slot 181. In the depicted example, the wire contact portion 198 is arranged on the internal surface 197 (e.g., a surface on which the opposing blades 274 are formed) of the wire engaging body 188.

FIG. 15 illustrates an example shielding layer 200 formed on a wire termination conductor 180. As shown, the wire termination conductor 180 is at least partially coated with the shielding layer 200. The shielding layer 200 is configured to provide EMI/RFI shielding between electrical connectors 100 arranged in high density configurations, thereby improving alien crosstalk performance. Further, the shielding layer 200 helps reducing or minimizing crosstalk between adjacent wire termination conductors 180 arranged within the same electrical connector 100.

The shielding layer 200 includes a shielding material adapted for reducing crosstalk between adjacent electrical connectors 100 and/or between adjacent wire termination conductors 180. In the depicted example, the shielding layer 200 includes a first layer 268 and a second layer 270. The first layer 268 is formed on at least a portion

of the wire termination conductor 180. The second layer 270 is formed on at least a portion of the first layer 268.

In some examples, the first layer 268 is formed with a dielectric material, which provides an electrical insulation layer. Examples of the dielectric material include a variety of polymer. As described below, in some examples, the first layer 268 may be formed by powder coating. Candidate powder materials include, but not limited to, High Density Polyethylene (HDPE), Scotchcast 5400, AkzoNobei Corvei 78-7001, Scotchcast 265, Dupont Abcite 9016, AkzoNobei Corvei 17-7005, AkzoNobei Corvei 17-7004, AkzoNobei Corvei 17-11002, Scotchcast 5133, Scotchcast 260, Scotchcast 5230N, and AkzoNobei Corvei 17-4001.

In some example, the second layer 270 is formed with a conductive material. For example, the second layer 270 may be formed with a conductive ink. Preferably, the conductive ink includes a silver ink. In other examples, however, the second layer 126 may be formed of any conductive material suitable for minimizing crosstalk, EMI and/or RFI. Examples of the conductive material include, but not limited to, stainless steel, gold, nickel-plated copper, silver, silvered copper, nickel, nickel silver, copper or aluminum.

The shielding layer 200 may be formed only on an exposed portion of the wire termination conductor 180. In the depicted example, the shielding layer 200 is coated only on at least a portion of the wire engaging body 188, and may not be formed on the support head 186. As described above, the support head 186 is configured to be inserted into the electrical connector 100 through the circuit board 262, thereby hidden from the outside of the electrical connector 100. On the other hand, the wire engaging body 188 extends from the electrical connector 100 and exposed to the outside thereof. Thus, forming the shielding layer 200 on the wire engaging body 188 is sufficient to reduce crosstalk, EMI and/or RFI between adjacent wire termination conductors 180 within the same electrical connector 100 and/or between wire termination conductors 180 of adjacent electrical connectors 100.

In some examples, the shielding layer 200 may be formed only on a portion of the wire termination conductor 180, provided that the wire contact portion 198 of the wire termination conductor 180 is provided for an electrical contact with the wire conductor of the cable 190. In the depicted example, the shielding layer 200 is formed only on the opposite major surfaces 192 and 194. The shielding layer 200 is not formed on the peripheral surface 196 or the internal surface 197 so that the wire contact portion

198 is saved from being covered by the shielding layer 200 and, thus, properly operates as an electrical contact point with the wire conductor of the cable 190. In other examples, the peripheral surface 196 can be coated while the internal surface 197 is not coated.

A thickness of the shielding layer 200 (the first layer 268 and/or the second layer 270) may be varied based upon several factors, such as a level of crosstalk, EMI and/or RFI. The thickness of the shielding layer 200 may be varied among the wire termination conductors 180 or may be substantially the same for all the wire termination conductors 180. In some examples, the first layer 268 is thicker than the second layer 270. In some embodiments, the thickness of the first layer 268 can range between 0.12 mm and 0.26 mm, and the thickness of the second layer 270 can range between 0.08 mm and 0.2 mm. In some examples, the thickness of the first layer 268 is about 0.15 mm, and the thickness of the second layer 270 is about 0.10 mm. In other embodiments, the first and second layers 268 and 270 can have other thicknesses as well.

The first layer 268, which is a dielectric layer, may be formed by various processes, such as, but not limited to, powder coating. In some examples, the first layer 268 may be provided on the wire termination conductor 180 by applying electrically insulative particles onto the surface of the wire termination conductor 180. For example, the first layer 268 may be formed by spraying, sputtering, depositing, or adhering dielectric particles onto a predetermined portion of the wire termination conductor. In one example, the first layer 268 is formed by electrostatically charging polymer particles, either thermosets or thermoplastics. In another example, the first layer 268 is formed by a fluidized bed process. The powder particles cling to the wire termination conductor 180 due to their opposite charge polarity. The larger the charge difference and the longer the wire termination conductor 180 is exposed to the powder, the thicker the first layer 268 builds up. Once the required thickness is reached, the coated conductor 180 is transferred to a thermal curing oven where the powder gels and solidifies forming a durable polymer coating. In yet another example, the first layer 268 is formed by spraying an epoxy onto the wire engaging body 188 of the wire termination conductor 180. In still another example, the first layer 268 is formed by dipping the wire engaging body 188 into a bath or other containers that include a fluid comprising a dielectric material. The support head 186 of the wire termination conductor 180 and/or any other portions on which the first layer 268 is not desired may be masked off prior to spraying the remaining exposed portion of the wire termination conductor 180 with a dielectric material or dipping the exposed portion of the wire termination conductor 180 into a bath that includes the

dielectric material. Alternatively, the first layer 268 may be provided on the wire termination conductor 180 by adhering electrically insulative films to the predetermined portion of the wire termination conductor 180. For example, the first layer 268 may be polyimide film that is joined to the predetermined portion of the wire termination
5 conductor 180.

The second layer 270, which is a conductive ink layer, may be formed by various processes, such as printing processes. Examples of printing processes include screen, gravure, pad, ink-jet and aerosol-jet printings.

The shielding layer 200 on the wire termination conductor 180 according to
10 the present disclosure is advantageous where a plurality of the wire termination conductors 180 are closely arranged in the electrical connector 100 as described in the depicted examples, and/or whether a plurality of electrical connectors 100 are arranged closely arranged or abutted to one another, as found in high density patch panels, for example.

In some examples, the wire termination connector 180 with the shielding
15 layer 200, as shown in FIG. 15, and the shield cap 116, as shown in FIGS. 1, 2, 4, 5, 7, 8, and 10, may be independently implemented in the connector assembly 100. For example, the connector assembly 100 may include either the shielding layer 200 or the shield cap 116, but not both. In other examples, the configurations of the shielding layer 200 and the shield cap 116 are both implemented in the connector assembly 100.

20 The various examples described above are provided by way of illustration only and should not be construed to limit the scope of the present disclosure. Those skilled in the art will readily recognize various modifications and changes that may be made without following the example examples and applications illustrated and described herein, and without departing from the true spirit and scope of the present disclosure.

25

What is claimed is:

- i. An electrical connector comprising:
 - a connector housing having a front end and a rear end, the connector housing comprising:
 - a cavity opened at the front end for receiving a plug;
 - an insulation displacement contact supported by the connector housing and extending from the connector housing at the rear end, and
 - a shield cap mounted to the connector housing at the rear end, the shield cap comprising:
 - a molded, electrically non-conductive body portion including one or more unitary latch portions for attaching the shield cap to the connector housing; and
 - opposite shield plates connected to opposite sides of the body and configured to at least partially cover the insulation displacement contact, wherein the opposite shield plates are made from electrically conductive material.
2. The electrical connector of claim 1, wherein the opposite shield plates are made from metallic material adapted for reducing crosstalk between adjoining electrical connectors.
3. The electrical connector of claim 1, wherein the body portion is entirely made from homogenous plastic.
4. The electrical connector of claim 1, wherein the shield cap includes a cable sleeve through which a cable is inserted to be connected to the insulation displacement contact.
5. The electrical connector of claim 1, wherein the body portion includes opposite sidewalls configured to engage the shield cap with the connector housing.
6. The electrical connector of claim 5, wherein the opposite sidewalls are configured to at least partially cover the insulation displacement contact.
7. The electrical connector of claim 5, wherein each of the opposite sidewalls includes the latch projection configured to engage the connector housing.

8. The electrical connector of claim 1, wherein the opposite shield plates are overmolded with the body portion.
9. The electrical connector of claim 1, wherein the opposite shield plates are connected with a support bar, the support bar arranged to transverse the body portion between the shield cap and the connector housing at the rear end, wherein the support bar is overmolded with the body portion and the opposite shield plates.
10. The electrical connector of claim 1, wherein the opposite shield plates are interconnected with one or more cross members, the one or more cross members configured to be inserted into the body portion during an ovenmolding process.
11. The electrical connector of claim 1, wherein the insulation displacement contact is at least partially coated with a shielding layer.
12. The electrical connector of claim 1, wherein the shielding layer includes a first layer and a second layer formed above the first layer, the first layer formed with a dielectric material, and the second layer formed with a conductive material.
13. The electrical connector of claim 12, wherein the dielectric material is a polymer.
14. The electrical connector of claim 12, wherein the conductive material is a conductive ink.
15. The electrical connector of claim 14, wherein the conductive ink is a silver ink.
16. A shield cap mounted to an electrical connector, the shield cap comprising:
 - a molded body portion including one or more unitary latch portions for attaching the shield cap to the electrical connector, wherein the body portion is formed from an electrically non-conductive material; and
 - opposite shield plates connected to opposite sides of the body portion and configured to at least partially cover one or more insulation displacement contacts exposed from the electrical connector, wherein the opposite shield plates are made from electrically conductive material.

17. The shield cap of claim 16, wherein the opposite shield plates are made from conductive material adapted for reducing crosstalk between adjoining electrical connectors.
18. The shield cap of claim 16, wherein the shield cap includes a cable sleeve through which a cable is inserted to be connected to the one or more insulation displacement contacts.
19. The electrical connector of claim 16, wherein the opposite shield plates are overmolded with the body portion.
20. The electrical connector of claim 16, wherein the opposite shield plates are connected with a support bar, the support bar arranged to transverse the body portion between the shield cap and the connector housing at the rear end, wherein the support bar is overmolded with the body portion and the opposite shield plates.
21. The electrical connector of claim 16, wherein the opposite shield plates are interconnected with one or more cross members, the one or more cross members configured to be inserted into the body portion during an overmolding process.
22. A jack assembly for terminating a plurality of line wires of a communications cable, the jack assembly comprising:
a dielectric jack housing having a front end and a rear end, the jack housing comprising:
a cavity opened at the front end for receiving a plug;
a contact subassembly joined to the rear end, the contact subassembly comprising a plurality of arms extending from the contact subassembly against the rear end of the jack housing and spaced part to define a plurality of conductor channels; and a plurality of insulation displacement contacts, each held within each of the plurality of conductor channels; and
a plurality of electrical contacts configured and positioned in the cavity for engaging corresponding contacts of the plug, and

a shield cap mounted to the jack housing at the rear end to at least partially cover the contact subassembly, the shield cap comprising:

a molded body portion having an inner surface and an outer surface, wherein the body portion is made from a non-conductive material;

a cable sleeve extending outwardly from the outer surface of the body and configured to receive a cable having a plurality of conductors, wherein the cable is inserted through the cable sleeve and, wherein each of the plurality of conductors of the cable is connected to each of the plurality of insulation displacement contacts;

opposite sidewalls extending from the inner surface and having one or more latch projections configured to attach the shield cap to the jack housing, wherein the opposite sidewalls including the one or more latch projections are formed to be unitary with the body portion; and

opposite shield plates extending from the inner surface and configured to at least partially cover the contact subassembly, wherein the opposite shield plates are made from an electrically conductive material, and wherein the opposite shield plates and the opposite sidewalls are alternately arranged on a peripheral of the body portion.

23. The jack assembly of claim 22, wherein the non-conductive material includes a homogeneous thermoplastic polymer.
24. The jack assembly of claim 2.2, wherein each of the plurality of insulation displacement contacts includes a slot configured to hold each of the plurality of conductors of the cable.
25. The jack assembly of claim 19, wherein each of the plurality of insulation displacement contacts extends across each of the plurality of conductor channels so that, when each of the plurality of conductors of the cable is inserted into the each of the plurality of insulation displacement contacts, each of the plurality of conductors of the cable rests within each of the plurality of conductor channels.
26. The jack assembly of claim 20, wherein the body portion includes a plurality of cross walls projecting outwardly from the inner surface, each cross wall having first and

second wall portions separated by a gap, wherein each cross wall is positioned to be inserted into one of the plurality of conductor channels so that each of the plurality of insulation displacement contacts fits within the gap.

27. The electrical connector of claim 22, wherein the opposite shield plates are overmolded with the body portion.

28. The electrical connector of claim 22, wherein the opposite shield plates are connected with a support bar, the support bar arranged to transverse the body portion between the shield cap and the connector housing at the rear end, wherein the support bar is overmolded with the body portion and the opposite shield plates.

29. The electrical connector of claim 22, wherein the opposite shield plates are interconnected with one or more cross members, the one or more cross members configured to be inserted into the body portion during an overmolding process.

30. The electrical connector of claim 22, wherein the plurality of insulation displacement contacts is at least partially coated with a shielding layer.

31. The electrical connector of claim 22, wherein the shielding layer includes a first layer and a second layer formed above the first layer, the first layer **formed** with a dielectric material, and the second layer formed with a conductive material.

32. The electrical connector of claim 31, wherein the dielectric material is a polymer.

33. The electrical connector of claim 31, wherein the conductive material is a conductive ink.

34. The electrical connector of claim 33, wherein the conductive ink is a silver ink.

35. An electrical connector comprising:
a connector housing having front and rear ends and configured to receive a plug at the front end;

an electrical contact configured for engaging a corresponding electrical contact of the plug; and

a wire termination conductor connected to the electrical contact and extending from the connector housing at the rear end, the wire termination conductor configured to be connected to a wire conductor of a cable, and at least partially coated with a shielding layer.

36. The electrical connector of claim 35, wherein the shielding layer is adapted for reducing cross-talk between adjacent electrical connectors, and between adjacent wire termination conductors.

37. The electrical connector of claim 35, wherein the shielding layer includes a first layer and a second layer formed above the first layer, the first layer formed with a dielectric material, and the second layer formed with a conductive material.

38. The electrical connector of claim 37, wherein the dielectric material is a polymer.

39. The electrical connector of claim 37, wherein the conductive material is a conductive ink.

40. The electrical connector of claim 39, wherein the conductive ink is a silver ink.

41. A wire termination conductor used for an electrical connector, the wire termination conductor comprising:

a support head supported by the electrical connector; and

a wire engaging body extending from the electrical connector and connected to a wire conductor of a cable, the wire engaging body at least partially coated with a shielding layer.

42. The wire termination conductor of claim 41, wherein the wire engaging body has a wire contact portion configured to form an electrical contact with the wire conductor of the cable, the wire contact portion excluded from being coated with the shielding layer.

43. The wire termination conductor of claim 42, wherein the wire engaging body has a first surface, a second surface opposite to the first surface, and a third surface extending between the first and second surfaces;

wherein the wire contact portion is provided on the third surface; and

wherein the shielding layer is coated on the first and second surfaces.

44. The wire termination conductor of claim 43, wherein the shielding layer is adapted for reducing crosstalk between adjacent electrical connectors, and between adjacent wire termination conductors.

45. The electrical connector of claim 41, wherein the shielding layer includes a first layer and a second layer formed above the second layer, the first layer formed with a dielectric material, and the second layer formed with a conductive material.

46. The electrical connector of claim 45, wherein the dielectric material is a polymer.

47. The electrical connector of claim 45, wherein the conductive material is a conductive ink.

48. The electrical connector of claim 47, wherein the conductive ink is a silver ink.

49. A method of forming a shielding layer on a wire termination conductor used for an electrical connector, the method comprising:

forming a first layer on at least a portion of the wire termination conductor, wherein the first layer includes a dielectric material; and

forming a second layer on at least a portion of the first layer, where the second layer includes a conductive material.

50. The method of claim 49, wherein the step of forming the first layer is performed by powder coating with polymer particles.

51. The method of claim 49, wherein the step of forming the second layer is performed by a printing process with silver ink.

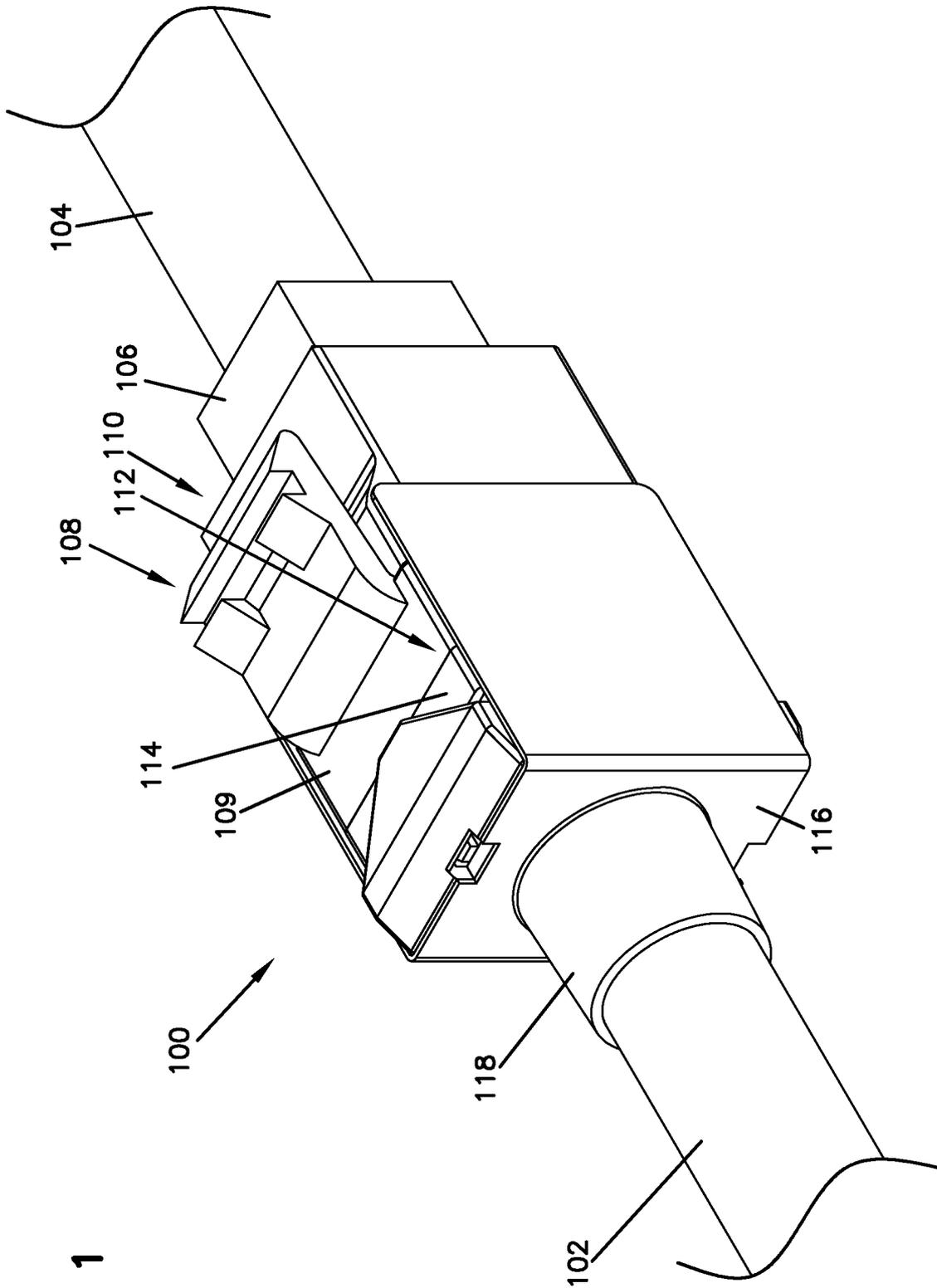


FIG. 1

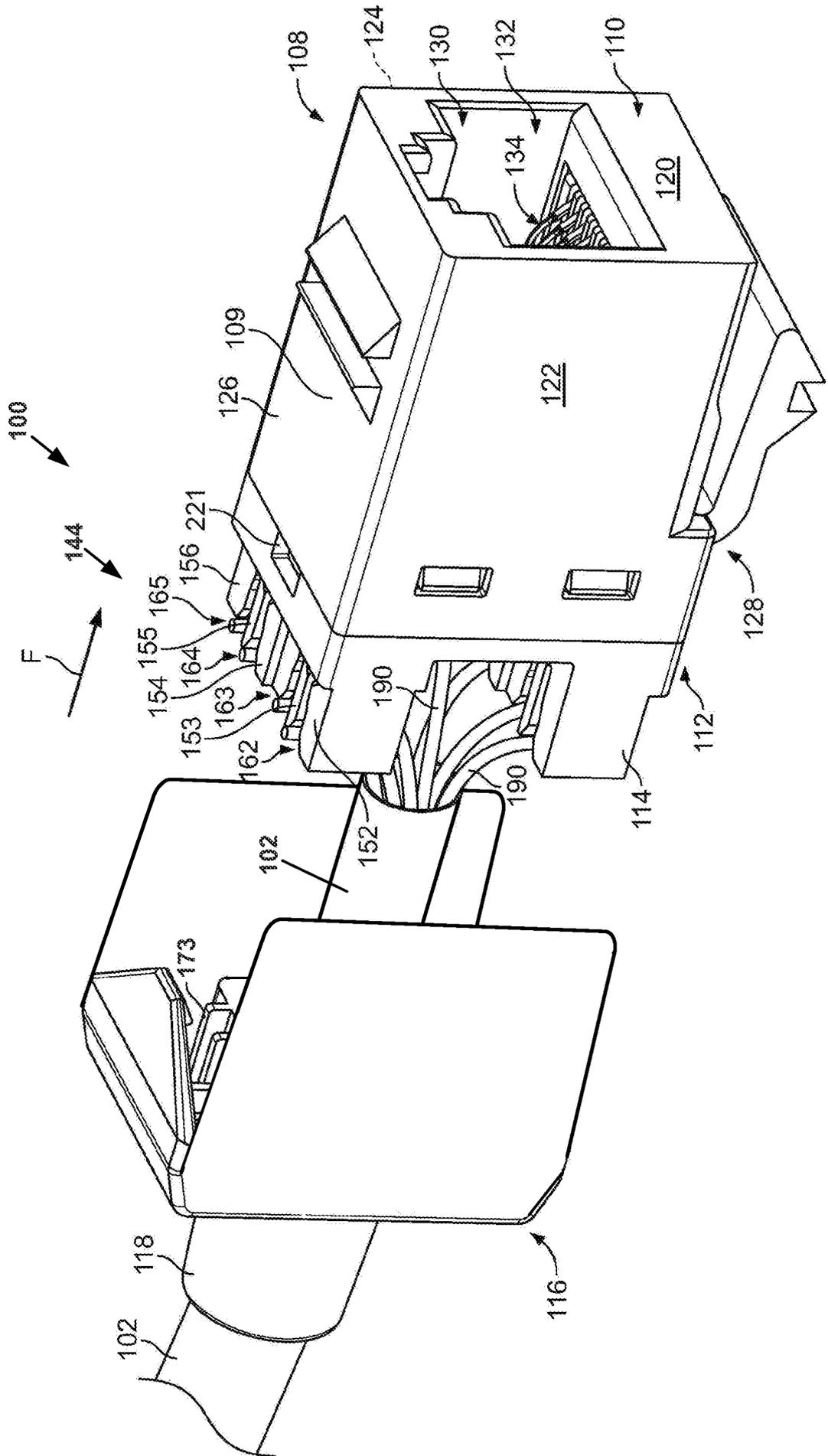
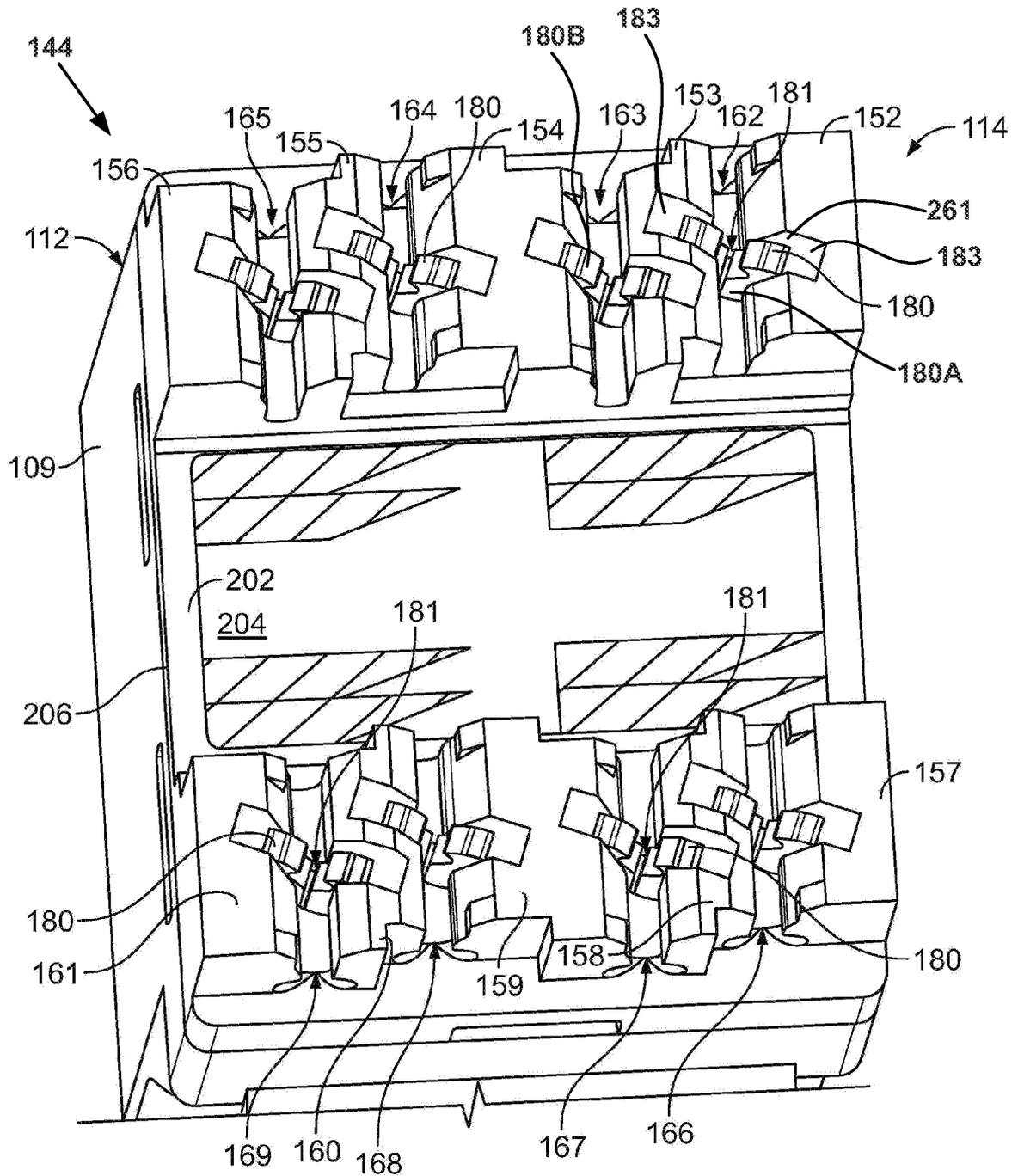


FIG. 2

FIG. 3



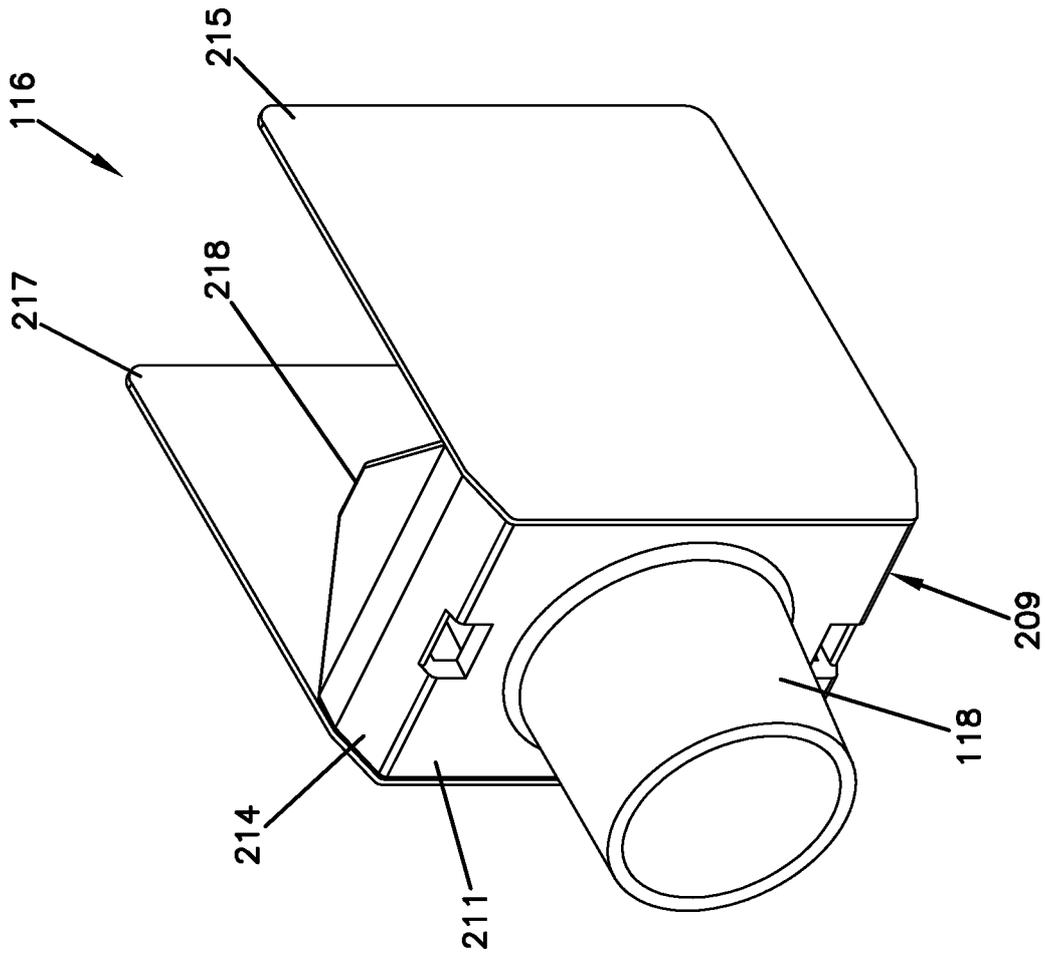


FIG. 4

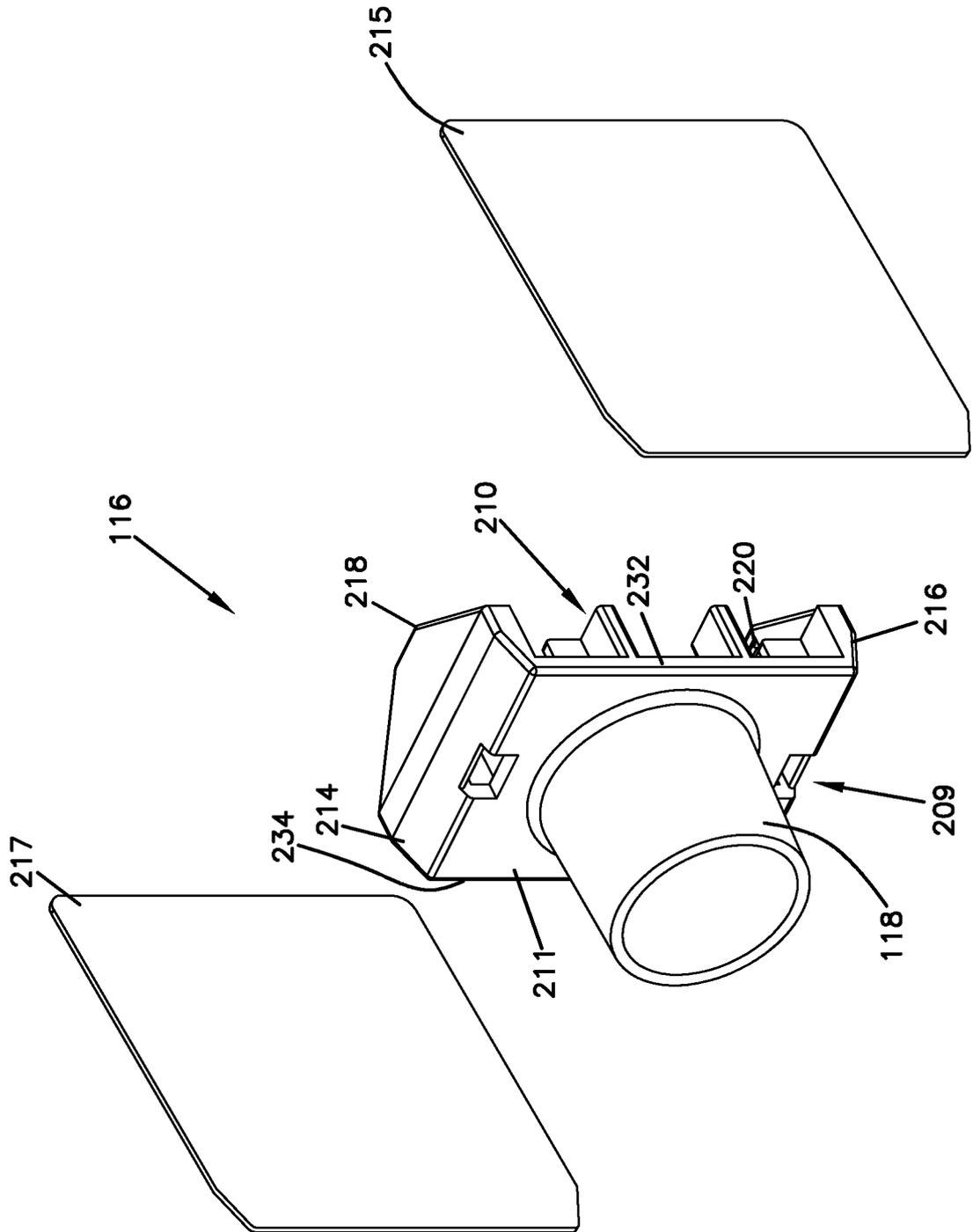


FIG. 5

FIG. 6

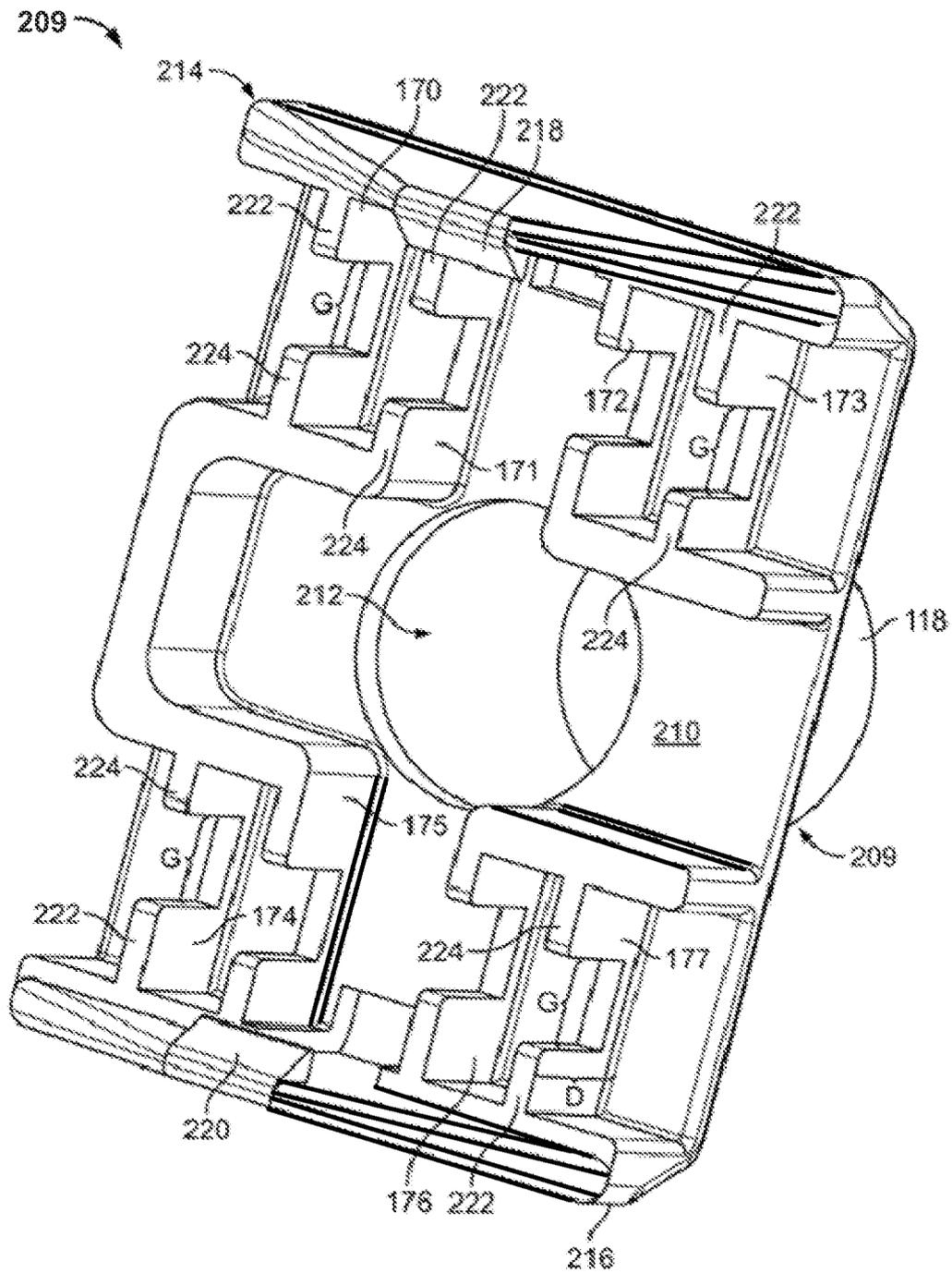
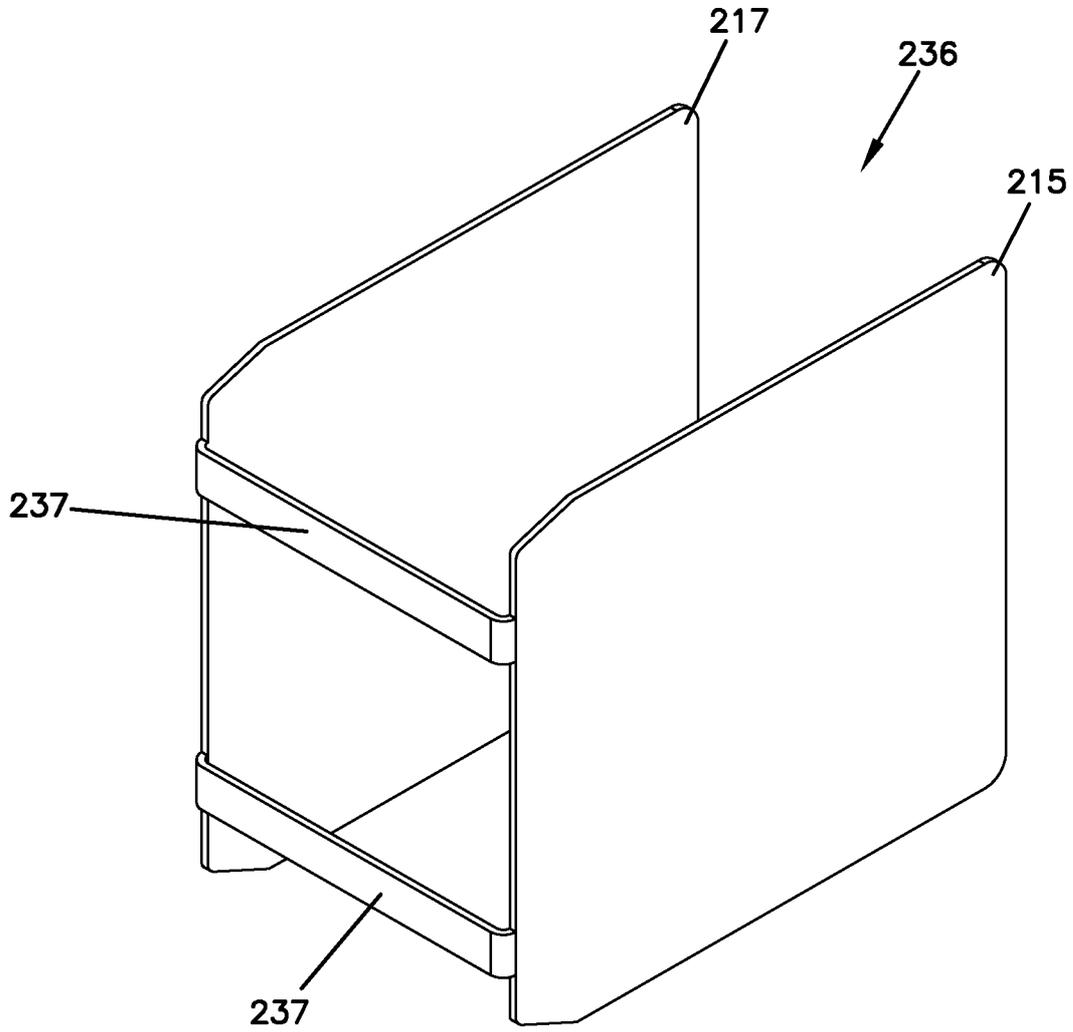


FIG. 7



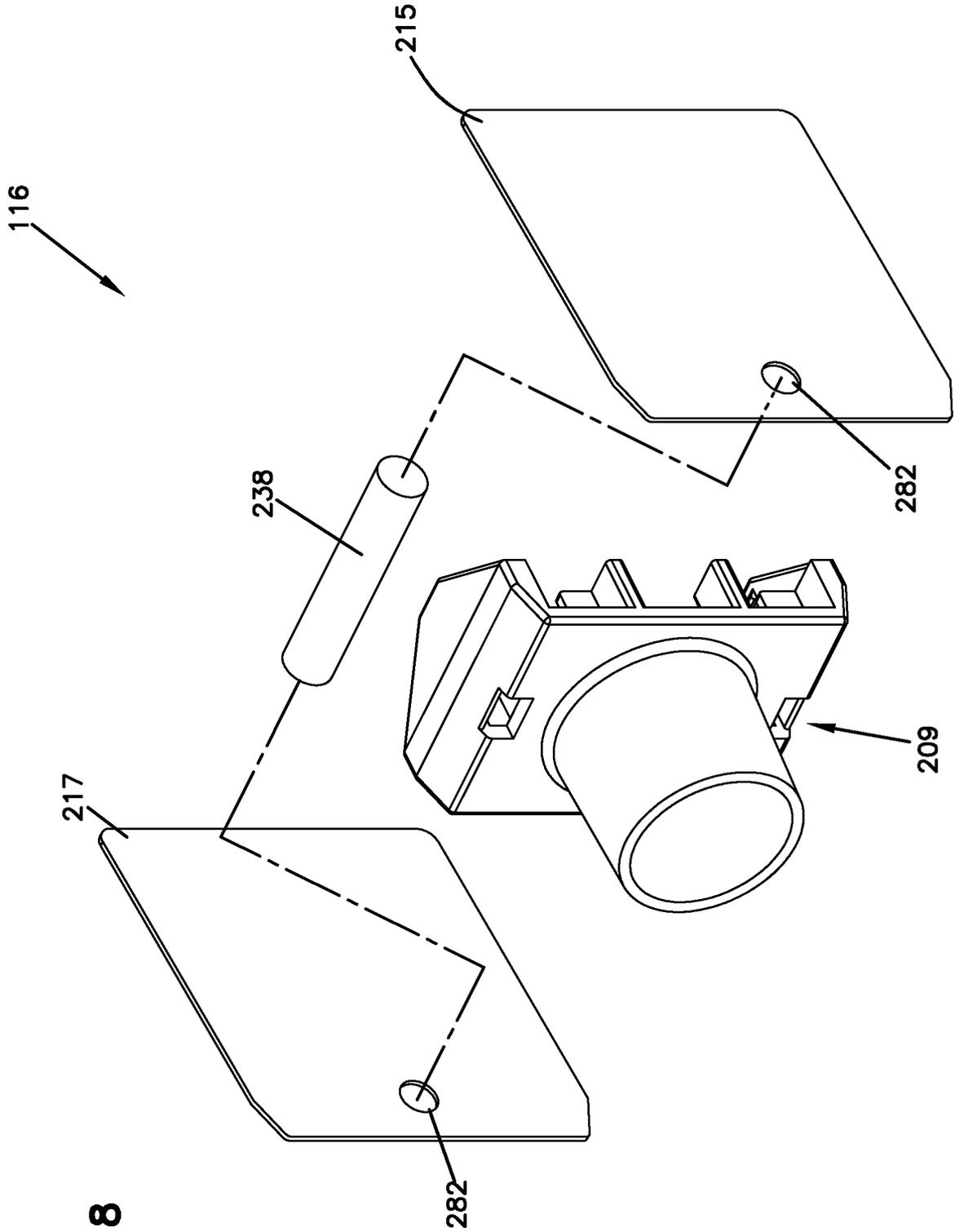


FIG. 8

FIG. 9A

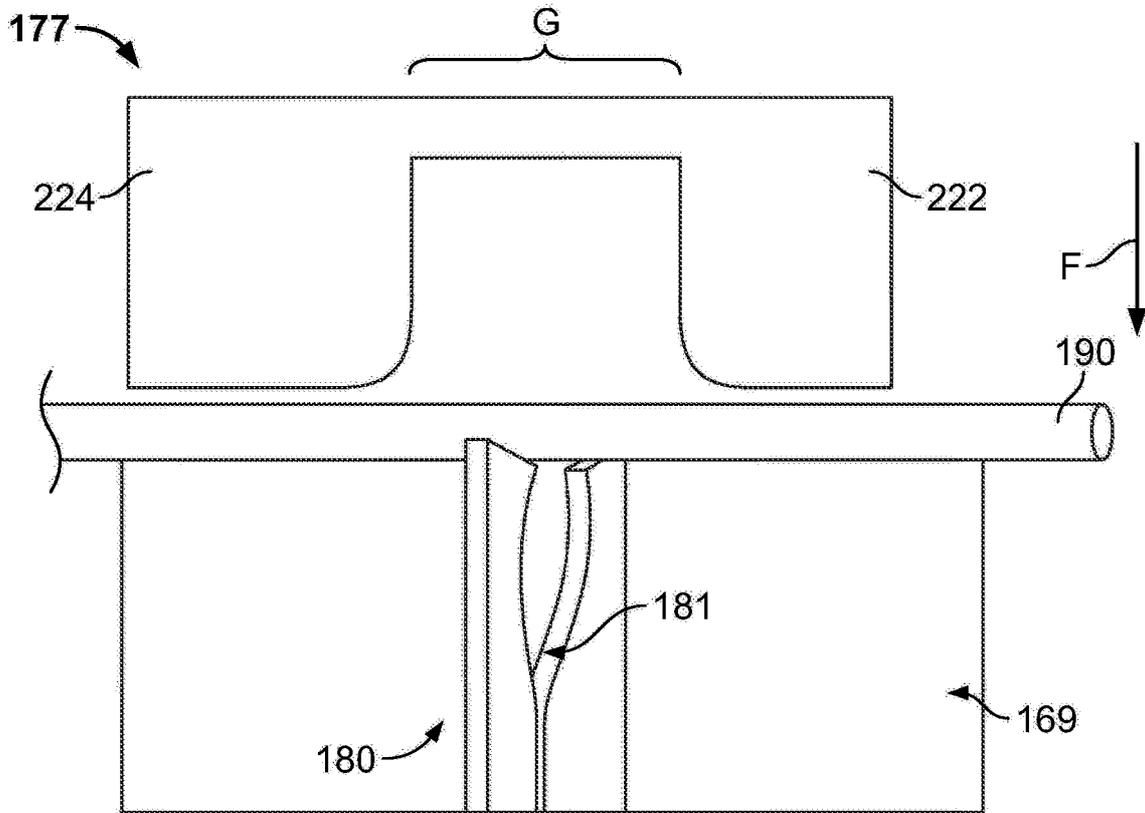
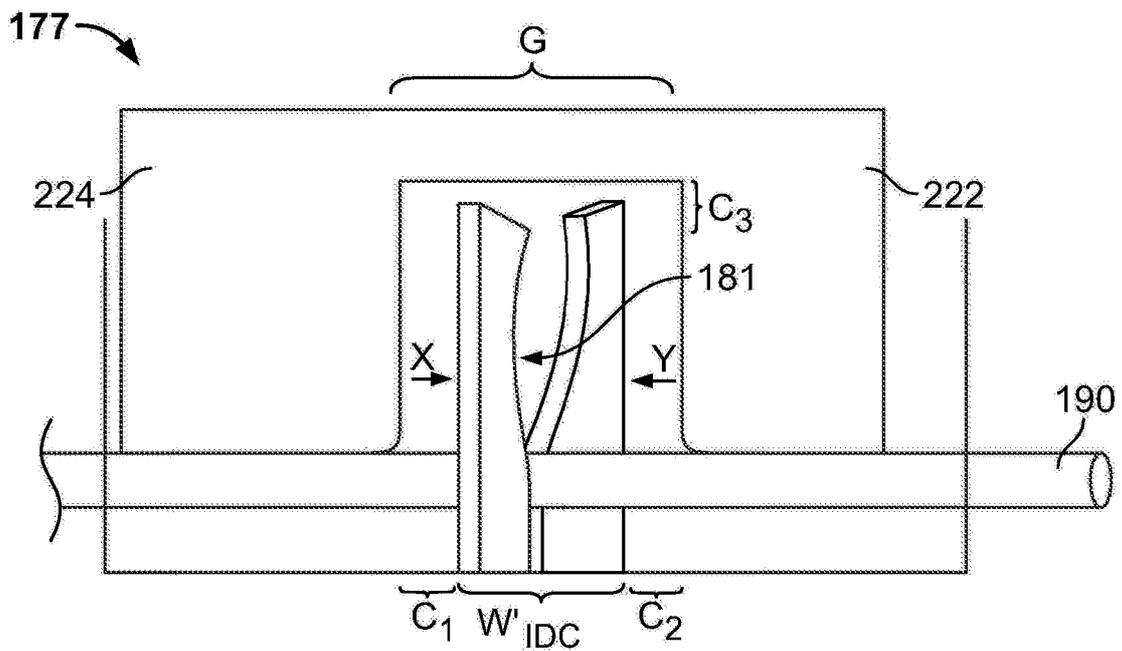


FIG. 9B



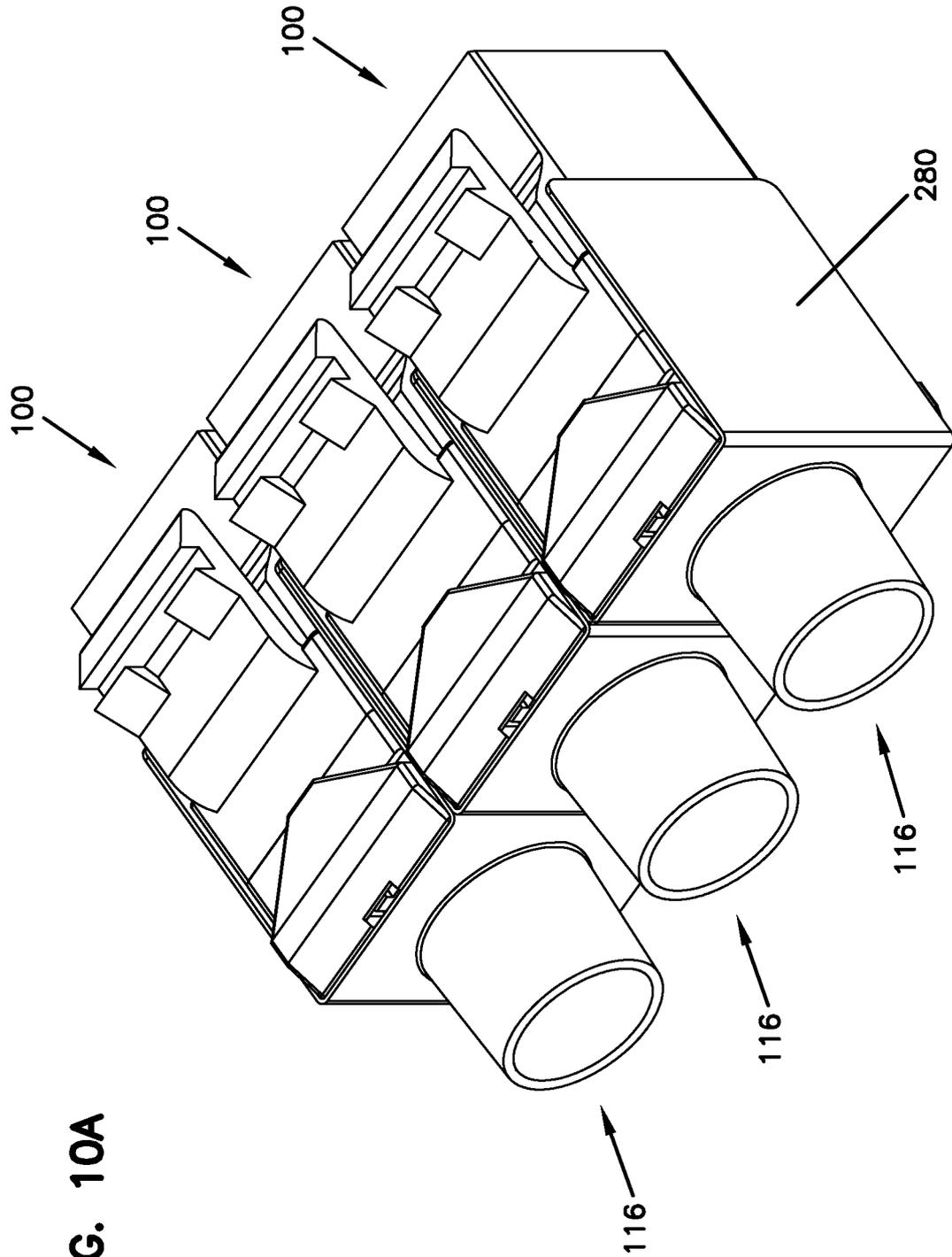
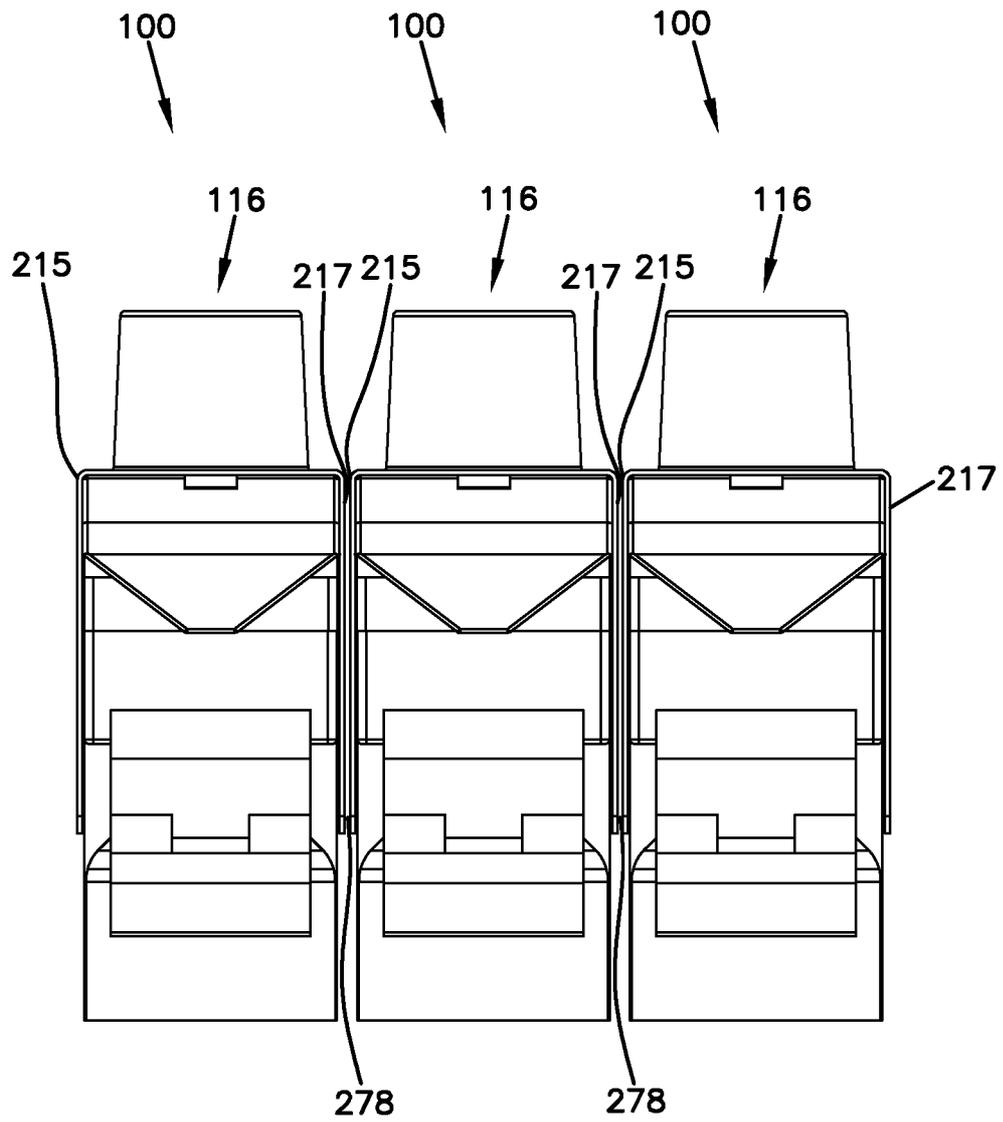


FIG. 10A

FIG. 10B



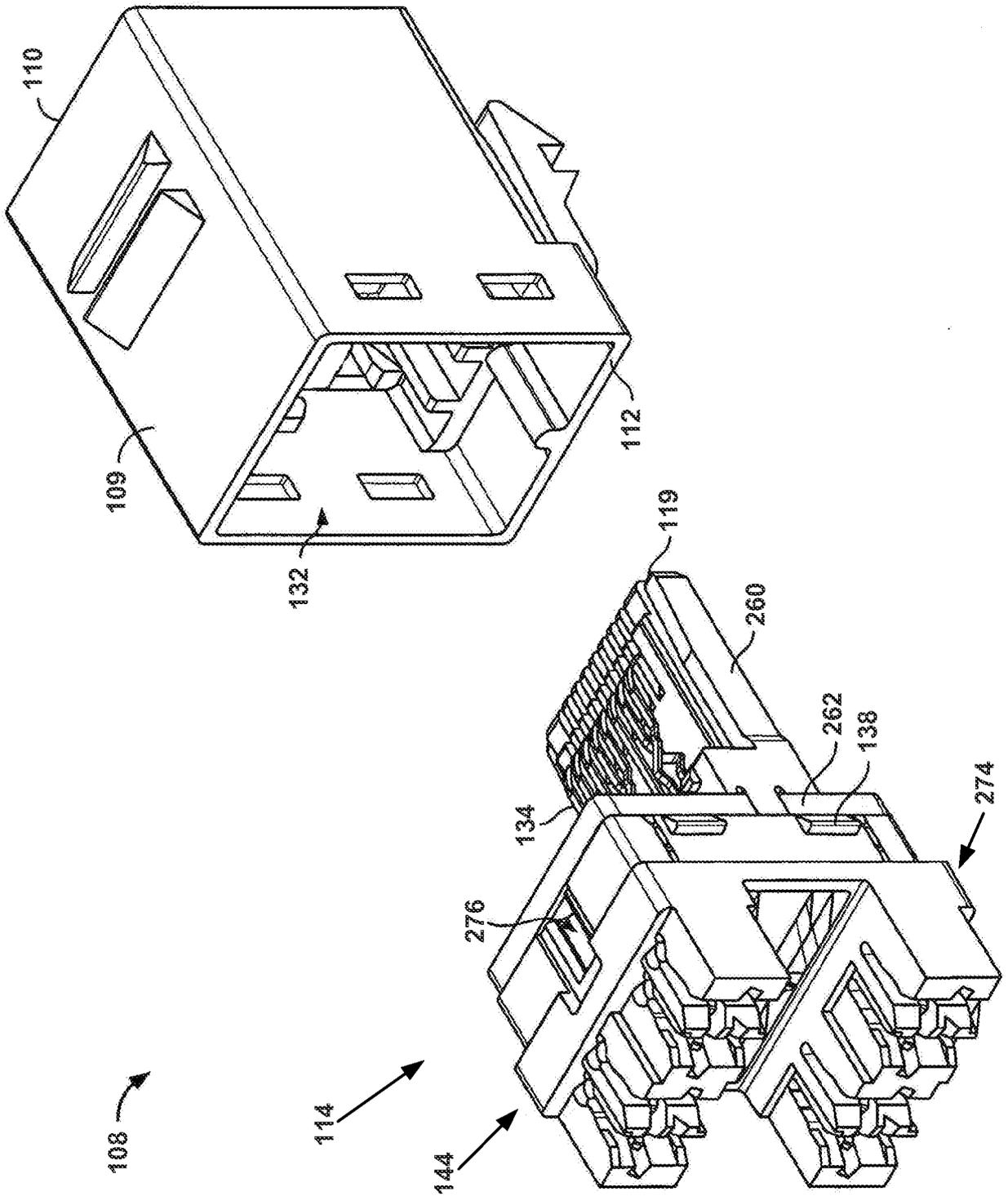


FIG. 11

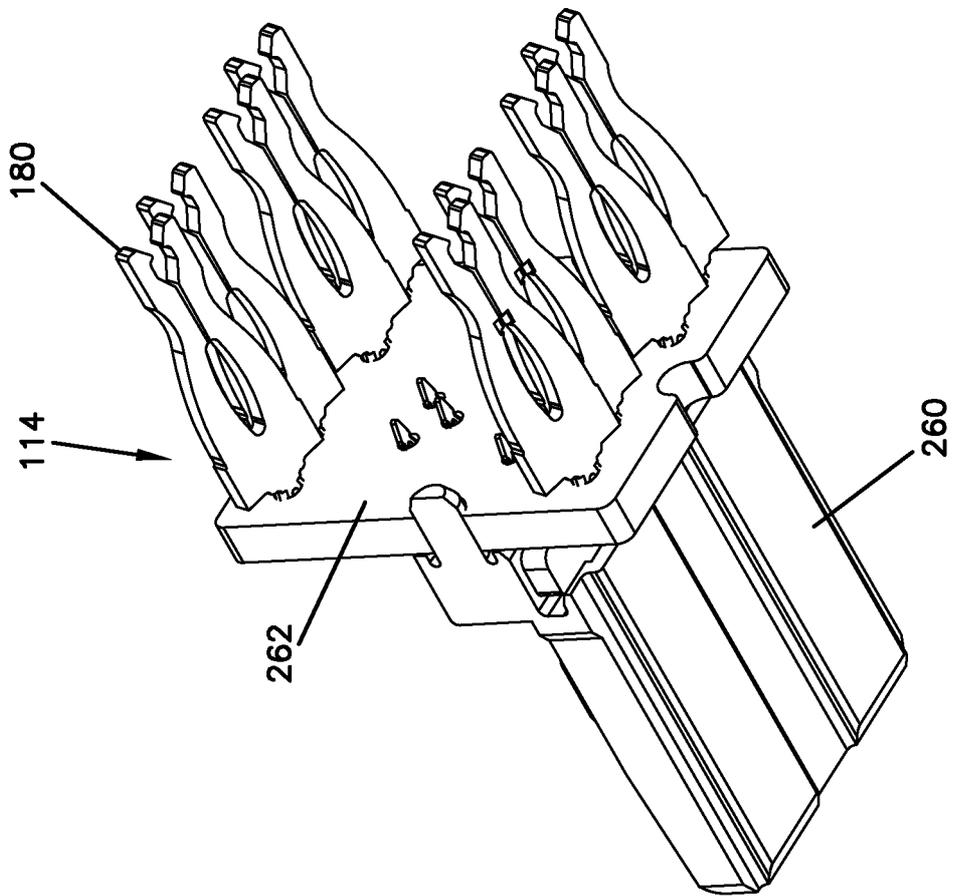


FIG. 12

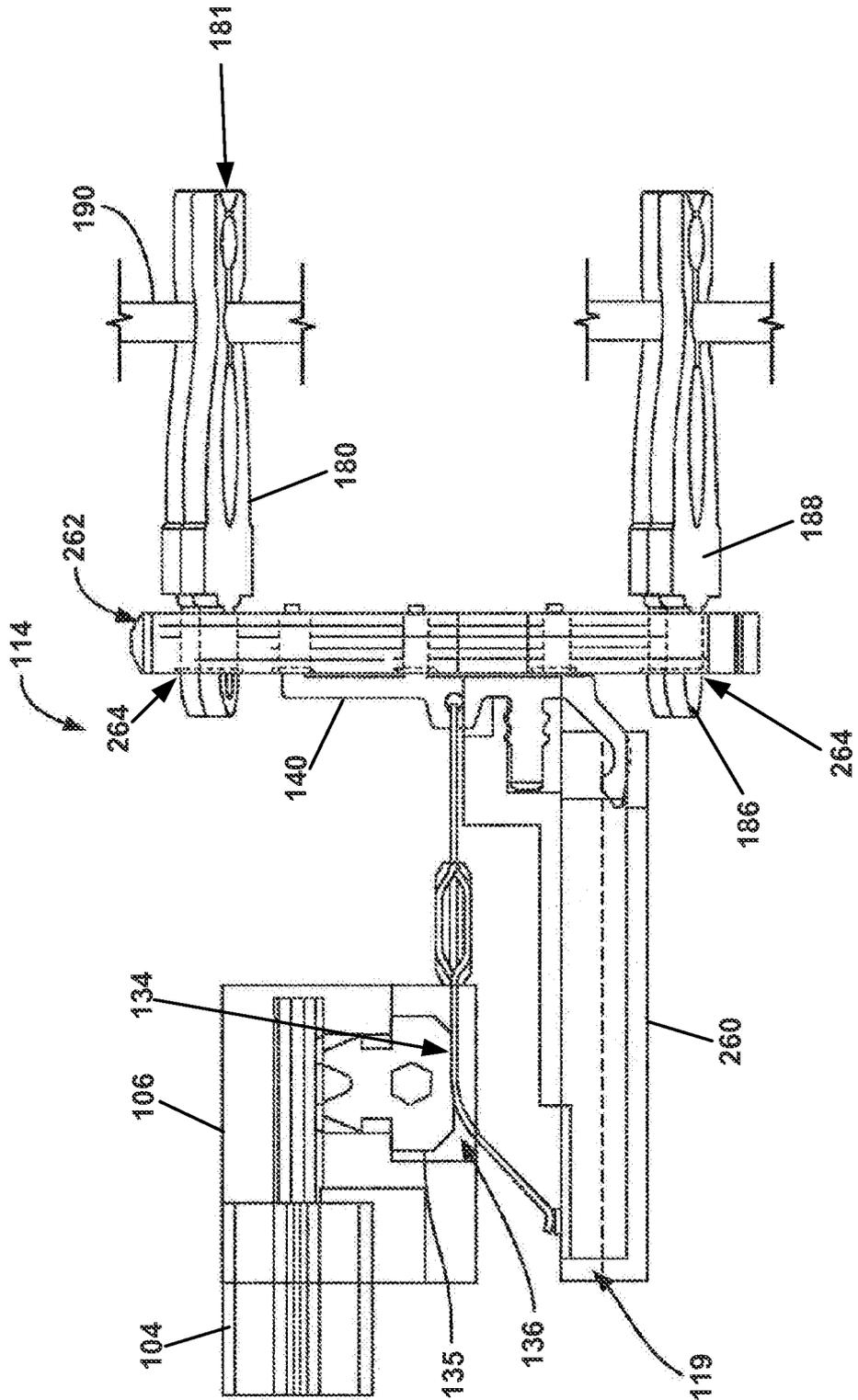


FIG. 13

FIG. 14A

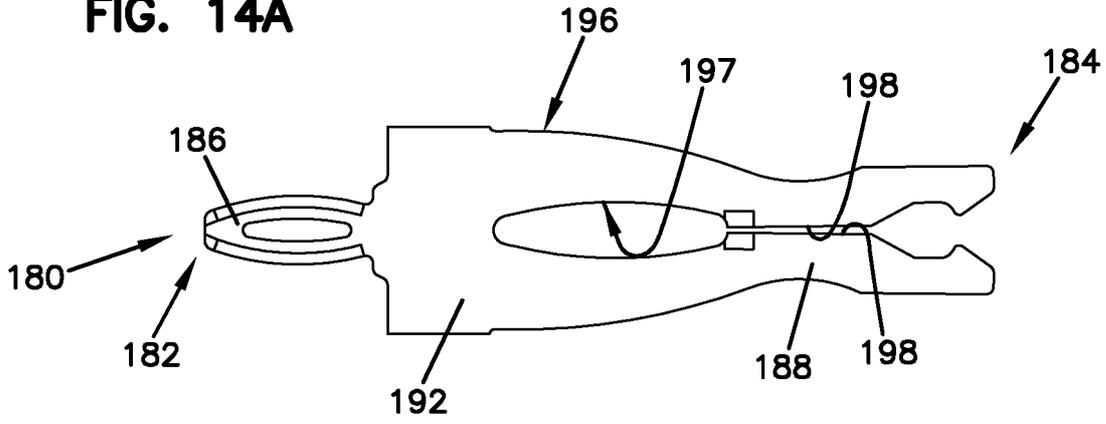


FIG. 14B

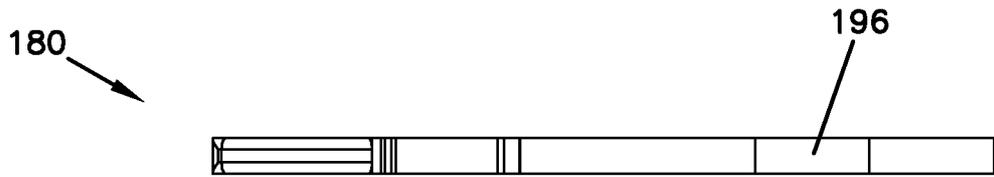


FIG. 14C

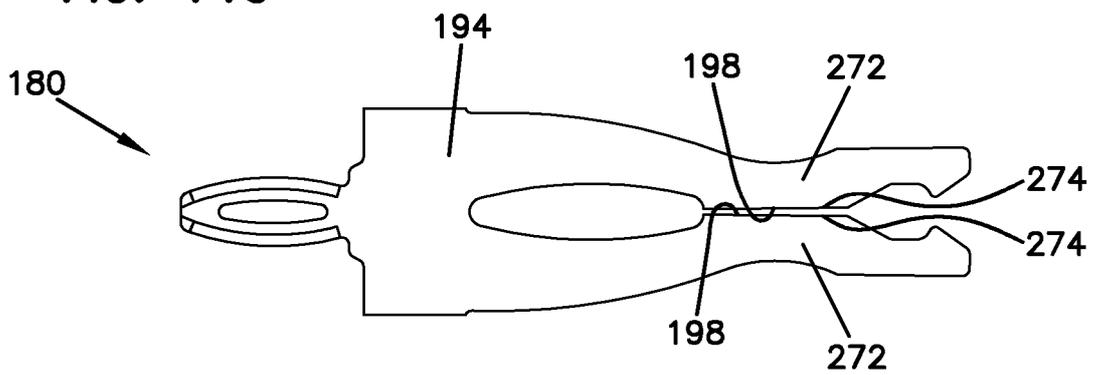
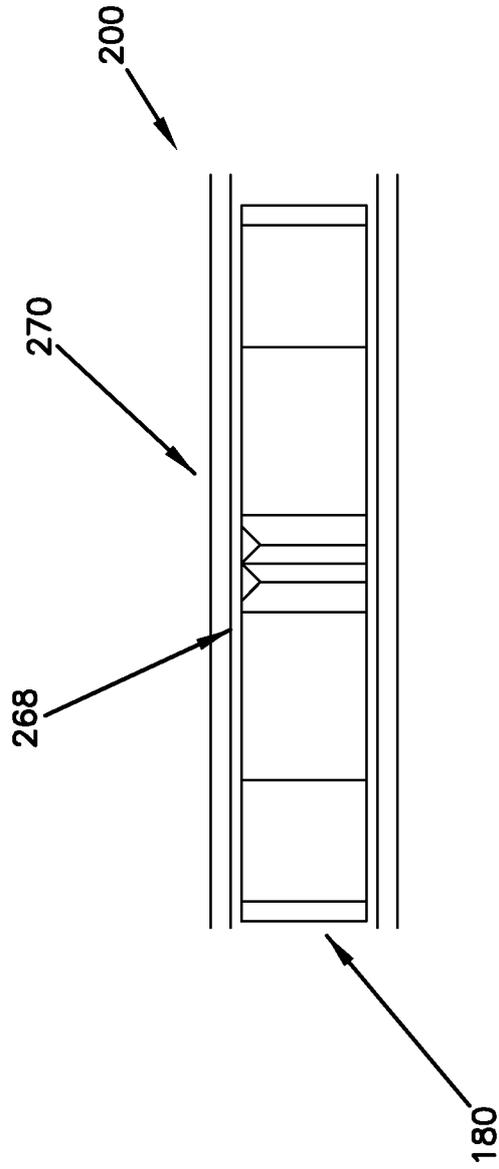


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/027159

A. CLASSIFICATION OF SUBJECT MATTER

HOIR 13/6585(2011.01)i, HOIR 13/58(2006.01)i, HOIR 24/62(20 11.01)i

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)

HOIR 13/6585; HOIR 4/24; HOIR 24/00; H01R 13/52; H01R 24/28; H01R 43/26; H01R 12/00; H01R 13/58; H01R 24/62

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: connector, cap, shield, housing, crosstalk, support head, wire engaging body

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ¹	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009-0124136 AI (PAUL JOHN PEPE et al.) 14 May 2009 See paragraphs [0008] , [0017H0030] and figures 1-5.	1-51
Y	US 2010-0267255 AI (CHIA-PING MO) 21 October 2010 See paragraphs [0019]- [0024] , claim 1 and figures 1-2 .	1-34 ,36, 44
Y	US 2013-0078871 AI (DONALD W. MILBRAND, JR.) 28 March 2013 See paragraphs [0056]- [0067] , [0120]- [0122] and figures 1, 9-10 .	11-15, 30-51
Y	US 5127845 A (GEORGE E. AYER et al.) 07 July 1992 See column 3, line 60 - column 4, line 57 and figures 2-3 .	41-48
A	KR 10-0833802 BI (KOREA ELECTRIC TERMINAL CO. , LTD.) 30 May 2008 See paragraphs [0022]- [0031] and figures 1-4.	1-51

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search

04 August 2015 (04.08.2015)

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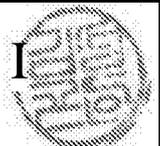
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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