(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 December 2011 (29.12.2011)

PCT

(10) International Publication Number
WO 2011/163433 A1

(51) International Patent Classification:
H01R 9/03 (2006.01)

(21) International Application Number:
PCT/US2011/041554

(22) International Filing Date:
23 June 2011 (23.06.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/358,063 24 June 2010 (24.06.2010) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: DATACOMMUNICATIONS MODULES, CABLE-CONNECTOR ASSEMBLIES AND COMPONENTS THEREFOR

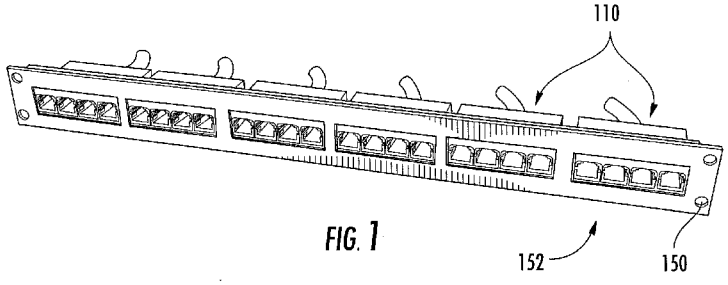

FIG. 1

(57) **Abstract**: A combination includes: (a) a communications module including: a housing; a printed wiring board mounted within the housing; a plurality of RJ-45 jacks mounted on the printed wiring board and accessible from one side of the housing; and a single module connector mounted to the printed wiring board and electrically connected to the RJ-45 jacks, connector being accessible from a second side of the housing; and (b) a cable-connector assembly including: a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket; and a single cable connector mounted to the printed circuit board and electrically connected to the conductors of the cable subunits. The module connector is attached to the cable connector.

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DATACOMMUNICATIONS MODULES, CABLE-CONNECTOR ASSEMBLIES AND COMPONENTS THEREFOR

Related Application

This application claims priority from U.S. Provisional Patent Application No. 61/358,063, filed June 24, 2010, the disclosure of which is hereby incorporated herein in its entirety.

Field of the Invention

The present invention relates generally to communications equipment, and more particularly to connectors and cables for communications.

Background

A network patching system is typically used to interconnect the various communication lines within a closet, computer room or data center. In a conventional network patching system, the communication lines are terminated within a closet or cabinet in an organized manner via one or more patch panels mounted on a rack or frame. Multiple ports are included in the patch panel, typically in some type of organized array. Each of the different ports is connected with a communications line. In small patching systems, all communications lines may terminate on the patch panels of the same rack or cabinet. In larger patching systems, multiple racks or cabinets may be used, wherein different communications lines terminate on different racks or cabinets. Interconnections between the various communications lines are made by connecting patch cords to the ports. By selectively connecting the various communications lines with patch cords, any combination of communications lines can be interconnected.

A patch panel typically includes connectors (such as RJ-45 jacks) on its front surface that receive mating connectors (such as RJ-45 plugs) for interconnection with other equipment. In most patch panels, a cable with a plurality of individual conductors is routed to the rear of the patch panel. The connection between the cable and the connectors of the patch panel is typically made through punch-down connectors or insulation displacement contacts (IDCs). Making these connections can be rather time-consuming, as can making changes to the connections subsequently. Moreover, as performance requirements become more stringent, it may be difficult for some types of connections to meet higher (*e.g.*, Category 6A) performance requirements.

In view of the foregoing, it may be desirable to provide other configurations for patch panels and the like that simplifies interconnections and/or enhances performance.

Summary

As a first aspect, embodiments of the present invention are directed to a cable-connector assembly. The cable-connector assembly comprises: a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket; a printed circuit board, the conductors of the cable subunits being attached to the printed circuit board; and a single connector mounted to the printed circuit board and electrically connected to the conductors of the cable subunits.

As a second aspect, embodiments of the present invention are directed to a cable-connector assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket, the cable subunits arranged in side-by-side relationship; and a single connector electrically connected to the conductors of the cable subunits.

As a third aspect, embodiments of the present invention are directed to a combination, comprising: (a) a communications module comprising: a housing; a printed wiring board mounted within the housing; a plurality of RJ-45 jacks mounted on the printed wiring board and accessible from one side of the housing; and a single module connector mounted to the printed wiring board and electrically connected to the RJ-45 jacks, connector being accessible from a second side of the housing; and (b) a cable-connector assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket; and a single

cable connector mounted to the printed circuit board and electrically connected to the conductors of the cable subunits. The module connector is attached to the cable connector.

As a fourth aspect, embodiments of the present invention are directed to a cable-connector assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; a connector attached to one end of the cable, the connector including a plurality of elongate contacts, each of the contacts corresponding to a respective conductors of the cable, each of the contacts having a contact end and an open loop at an opposite end; and a plurality of transition elements connecting each of the conductors with its respective contact, each of the transition elements including a first end adapted to receive and connect to with a conductor and a second end adapted to receive and connect to the open loop of a contact.

As a fifth aspect, embodiments of the present invention are directed to a datacommunications cable assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; and a cable subunit adapter. The cable subunit adapter comprises: four cable receiving channels, each of the channels including a longitudinal axis that is offset from the longitudinal axes of its neighboring receiving channels in both X and Y directions, each of the receiving channels receiving a respective cable subunit of the cable; and guides positioned below each receiving channel, the guides configured to separate each of the twisted pairs of the cable subunit from the other twisted pairs of the cable subunit.

As a sixth aspect, embodiments of the present invention are directed to a datacommunications cable assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; and a printed circuit board having at least one edge, the edge including a plurality of open-ended recesses, each of the recesses connected to a conductive trace. Each of the conductors of the cable is received in one of the open-ended recesses.

As a seventh aspect, embodiments of the present invention are directed to a combination comprising: (a) a datacommunications module, comprising: a plurality of datacommunications jacks; a vertically disposed printed circuit board; the jacks mounted on a first surface of the printed circuit board; a plurality of elongate contacts mounted to a second, opposed surface of the printed circuit board, the contacts extending being connected with the jacks and extending away from the second surface; and (b) a cable-connector assembly

comprising: a horizontally disposed printed circuit board; a connector mounted to the horizontally mounted printed circuit board and connected to the elongate contacts; and a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors, the twisting pairs of conductors being connected to the horizontal printed circuit board.

As an eighth aspect, embodiments of the present invention are directed to a cable-connector assembly, comprising: a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; a printed circuit board with electrical traces residing thereon, the printed circuit board having first and second opposed surfaces; and a connector mounted on the printed circuit board and connected with the electrical traces. Some of the subunits are connected with respective electrical traces at mounting locations on the first surface of the printed circuit board, and others of the subunits are connected with respective electrical traces at mounting locations on the second side of the printed circuit board.

Brief Description of the Figures

Figure 1 is a schematic perspective view of a cable-connector assembly according to embodiments of the present invention.

Figure 2 is an enlarged perspective view of a module of the cable-connector assembly of **Figure 1**.

Figure 3 is a rear perspective view of the module of **Figure 2** with a cable being connected thereto.

Figure 3A is a perspective section view of the cable shown in **Figure 3**.

Figure 3B is an enlarged cross-section of the cable shown in **Figure 3A**.

Figure 4 is a perspective view of a module similar to that of **Figure 2** with the housing removed.

Figure 5A is a perspective view of a cable termination sled useful for the cable of **Figure 3A**.

Figure 5B is a perspective view of the cable termination sled of **Figure 5** with the cable inserted.

Figure 6 is a perspective view of the cable and cable sled of **Figure 5B** attached to a connector.

Figure 7A is a perspective view of an element for attaching a cable conductor to a connector contact that may be employed with the cable and connector of **Figure 6**.

Figure 7B is a perspective view of an alternative embodiment of an element for attaching a cable conductor to a connector contact that may be employed with the cable and connector of **Figure 6**.

Figure 7C is a perspective view of an alternative embodiment of an element for attaching a cable conductor to a connector contact that may be employed with the cable and connector of **Figure 6**.

Figure 7D is a perspective view of an element that attaches to a cable conductor and serves as a contact for a connector such as that shown in **Figure 6**.

Figure 8 is a perspective view of a circuit board and cable management sled that connects to the conductors of a cable like that of **Figure 3A**.

Figure 9 is a perspective view of an alternative embodiment of a cable connector assembly in which connectors are arranged in two rows.

Figure 10 is a rear perspective view of the module of **Figure 9**.

Figure 11 is a rear perspective view of the module of **Figure 9** with schematically-depicted cables and connectors attached thereto.

Figure 12 is a perspective view of the schematically-depicted cable and connectors of **Figure 11**.

Figure 13A is a perspective view of an alternative embodiment of a cable-connector assembly in which the conductors of the cable are attached to a circuit board that is in turn attached to a connector suitable for insertion into a module like that of **Figure 2**.

Figure 13B is a side view of the assembly of **Figure 13A**.

Figure 13C is a perspective view of an alternative embodiment of the cable-connector assembly of **Figure 13A** in which the conductors attach to one side of the circuit board.

Figure 13D is a side view of the assembly of **Figure 13C**.

Figure 14 is an exploded perspective view of the cable-connector assembly of **13A** connected with an alternative embodiment of a module similar to that of **Figure 2**, with the housing of the module removed for clarity.

Figure 15 is a perspective view of a cable manager for use with a cable like that of **Figure 14** that facilitates the attachment of conductors to solder pads of a printed circuit board.

Figure 16 is a rear perspective view of the cable manager of **Figure 15**.

Figure 17 is a perspective view of a comb that matches the cable manager of **Figure 15**.

Figure 18 is a perspective view of the comb of **Figure 17** mated with the cable manager of **Figures 15** and **16**.

Figure 19 is an enlarged, partially schematic, perspective view of the cable manager of **Figures 15-18** with conductors inserted therein to demonstrate how attachment to a printed circuit board is facilitated.

Figure 20 is a perspective view of a cable manager for use with a cable of **Figure 14** that facilitates the attachment of conductors to IDCs on a printed circuit board.

Figure 21 is a top view of the cable manager of **Figure 20**.

Figures 22-25 are perspective views that show alternative arrangements of IDCs on a printed circuit board that can be used with a cable of **Figure 14**.

Figure 26 is a front view of an exemplary IDC such as are shown in **Figures 22-25**.

Figure 27 is a front view of an alternative embodiment of an IDC.

Figure 28 is an exploded perspective view of a connector, printed circuit board, cable manager, and piercing contacts that may be attached to a cable of **Figure 14**.

Figure 29 is an assembled perspective view of the components of **Figure 28** with the cable attached.

Figure 30 is a perspective view of an alternative embodiment of a connector assembly employing piercing contacts.

Figure 31A is a perspective view of an alternative embodiment of a cable-connector assembly that employs two circuit boards to attach the conductors to the connector.

Figure 31B is a rear perspective view of the cable-connector assembly of **Figure 31A**.

Figure 32A is a perspective view of an alternative embodiment of a cable-connector assembly that employs two circuit boards to attach the conductors to the connector.

Figure 32B is a rear perspective view of the cable-connector assembly of **Figure 32A**.

Figures 33A and **33B** are exploded perspective views of the cable-connector module of **Figure 31A** with the housing shown.

Figures 34A and **34B** are perspective views of an assembled and disassembled cable-connector assembly, extension cable and adaptive coupler.

Figures 35A and **35B** are perspective views of an assembled and disassembled cable-connector assembly with an extension cable.

Figures 36A and **36B** are perspective views of an assembled and disassembled cable-connector assembly, extension cable and adaptive coupler.

Figure 37 is a perspective view of a communication module according to alternative embodiments of the present invention.

Figure 38 is an exploded perspective view of the communication module of **Figure 37**.

Figures 39-41 are perspective views of assembly steps for a cable-connector assembly according to alternative embodiments of the present invention, the cable-connector assembly being matable to the module of **Figure 37**.

Figure 42 is a perspective view of the assembled cable-connector assembly of **Figures 39-41**.

Figure 43 is an exploded perspective view of the cable-connector assembly of **Figure 42**.

Figure 44 is a front perspective view of the module of **Figure 37** and the cable-connector assembly of **Figure 42**.

Figure 45 is a rear perspective view of the module of **Figure 37** and the cable-connector assembly of **Figure 42**.

Description of Embodiments of the Invention

The present invention will be described more particularly hereinafter with reference to the accompanying drawings. The invention is not intended to be limited to the illustrated embodiments; rather, these embodiments are intended to fully and completely disclose the invention to those skilled in this art. In the drawings, like numbers refer to like elements throughout. Thicknesses and dimensions of some components may be exaggerated for clarity.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent

with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

In addition, spatially relative terms, such as "under", "below", "lower", "over", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "under" or "beneath" other elements or features would then be oriented "over" or "above" the other elements or features. Thus, the exemplary term "under" can encompass both an orientation of over and under. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly. As used herein, "vertical" has the conventional meaning, *i.e.*, upright; or at a right angle to the horizon.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein the expression "and/or" includes any and all combinations of one or more of the associated listed items.

Where used, the terms “attached”, “connected”, "interconnected", “contacting”, "mounted" and the like can mean either direct or indirect attachment or contact between elements, unless stated otherwise.

Also, as used herein the term "connector" is intended to encompass telecommunications connectors and devices employed to facilitate the interconnection of telecommunications cords and cables for the transmission of signals therebetween. A connector may include a termination device at the end of a cord or cable, an adapter that facilitates the interconnection of two termination devices, a jack, plug, or the like typically

employed with copper cables and cords, or other devices that provide a location or site for the interconnection of cables and cords.

Referring now to the figures, a patch panel **152** that includes six modules **110** mounted to a bezel **150** is shown in **Figure 1**. An exemplary module **110** with its four RJ-45 jacks **146** is shown in **Figure 2**. **Figure 3** is a reverse angle view of **Figure 2** illustrating that a cable **122** connected to a termination module **123** interconnects with a connector **138** mounted in the housing **148** of the module **110**. More specifically, the termination module **123** includes a connector **134** that mates with the connector **138**. The connectors **134, 138** shown in **Figure 3** are 2-pair x 9 connectors (available, for example, from Foxconn Technology Group, Tucheng City, Taipei, Taiwan), although connectors of other configurations may also be employed. **Figure 3A** is an enlarged view of the cable **122** illustrating that the cable **122** includes four subunits **124**, each of which has four twisted pairs of conductors **126** (**Fig. 3B**). The subunits **124** may be covered with a jacket **128** as shown in **Figure 3A**, and may take a configuration with a "square" profile as shown in **Figure 3B**; in other embodiments, the cable **122** may take a flatter "ribbon" profile, such as is shown in **Figure 29**, wherein the subunits **124** are bonded together or connected with bands of material that extend between subunits **124**.

The modules **110, 123** may be employed in particularly high performance environments, such as Category 6A environments. Exemplary uses and environments for the module **110**, termination module **123**, and cable **122** are discussed in U. S. Provisional Patent Application No. 61/171,899, filed April 23, 2009, and U.S. Patent Application No. 12/763,410, filed April 20, 2010, the disclosure of each of which is hereby incorporated herein in its entirety. The connectors **134, 138** and associated components are selected to meet the desired level of performance. Different configurations of the module **110** and its components are discussed below.

Figure 4 illustrates an embodiment of a module **110'** (shown with the housing removed) in which six, rather than four, RJ-45 jacks **146'** are included, although the discussion below is equally applicable to the module **110** and its four RJ-45 jacks **146**. As can be seen in **Figure 4**, the RJ-45 jacks **146'** are mounted on a printed wiring board **149**, which interconnects them via traces thereon to the connector **138**, which in this embodiment is a backplane connector. Backplane connectors are discussed in some detail in U.S. Patent Application No. 12/763,410, *supra*, and need not be discussed in detail herein.

In the module **110'** or a similar module **110**, one or more of the backplane connector **138**, printed wiring board **149** and RJ-45 jacks **146'** includes crosstalk compensation features (such as wire trace crossovers, capacitors, inductors and the like) that provide an acceptable level of crosstalk for Category 6A performance. As such, similar crosstalk compensation components may not be required for the termination module **123** and cable **122**. In such an instance, components are needed within the termination module **123** to interconnect the conductors **126** of the cable **122** with the connector **134**.

In one exemplary configuration, the connector **134** has contacts **201** that have a post or pin on one end and an "eye-of-the-needle" configuration on the opposite end, with the contacts **201** being mounted in a substrate **202** (see **Figure 6**). Interconnection of the conductors **126** of the cable **122** with the eye-of-the-needle contacts can be achieved in a number of ways. As seen in **Figures 5B** and **6**, small panels **240** may be provided for the mounting of transition elements **242** that connect the ends of the conductors **126** to the eye-of-the-needle portions of the contacts **201**. A cable subunit routing sled, manager or adapter **244** (**Figure 5A**) may be included to assist with the division and routing of the individual subunits **124** of the cable **122**. The routing sled **244** includes routing channels **246** that have longitudinal axes that are offset from the longitudinal axes of their neighboring channels **246** in both the X- and Y-directions, and that guide the subunits **124** into individual quadrants. Guides **248** are present in each routing channel **246** that help to separate the individual conductors **126** into desired positions. From these locations, the conductors **126** can be connected with the transition elements **242** that are, in turn, connected to the eye-of-the-needle ends of the contacts **201**. A housing **247** covers the end of the cable **122**, the sled **244**, the panels **240**, the transition elements **242** and the periphery of the connector **134**. In some embodiments, the sled **244** (and other sleds described below) may also provide electromagnetic shielding that can help to reduce crosstalk between cable subunits and between conductor pairs of the same subunit, and/or may include strain relief elements.

Referring now to **Figures 7A-7C**, different configurations for the transition elements **242** are shown therein. In **Figure 7A**, the transition element **242a** is an elongate cylinder with a bore **260** in one end that accepts a conductor **126** (typically via soldering) and a bore **262** at the opposite end that receives the eye-of-the-needle portion of the contact **201** in an interference fit. **Figure 7B** illustrates a transition element **242b** that similarly has a bore **260** at one end, but at the opposite end has two opposed jaws **264** that form a clip for connecting

to the eye-of-the-needle portion of the contact **201**. **Figure 7C** illustrates a transition element **242c** that has jaws **264** as described above, but has a crimpable slot **268** at its opposite end that can be crimped onto a conductor **126**.

Figure 7D illustrates an element **242d** that combines the transition element **242a** with the contact **201** in a single component. A bore **270** receives a conductor **126** (typically attached via soldering), and a pin **272** extends into the connector **134** to provide a contact for interconnection with the connector **138**.

Figure 8 illustrates another configuration for the termination module **123**. In this embodiment, the conductors **126** are soldered into open-ended "half-round" recesses **281** in a printed circuit board **280**. The PCB **280** also has holes **282** in its surface that are connected with the recesses **281** (typically via electrical traces) and that are configured to receive "eye-of-the-needle" portions of the contacts **201** of the connector **134**. A routing sled **284** with a series of channels and guides may be included to divide and route first the subunits **124**, then the conductors **126**, into desired positions. In some embodiments the recesses **281** are located on all sides of the PCB **280**. The conductors **126** may pass through an adapter or manager prior to interconnection of the PCB **280**.

Figure 9 illustrates an embodiment in which a module **300** includes a vertically disposed PCB **304**. In the embodiment shown in **Figure 9**, two rows of RJ-45 jacks **302**, each row having four connectors **302**, are mounted on the PCB **304**, although in other embodiments there may be only a single row of RJ-45 jacks **302**. As can be seen in **Figure 10**, connectors **306**, each corresponding to a row of RJ-45 jacks **302**, are mounted on the surface opposite the RJ-45 connectors **302**.

As shown in **Figure 11** the connectors **306** of the module **300** mate with connectors **309** of termination modules **308** that are attached to cables **122**. As shown in **Figures 11** and **12**, the termination module **308** includes a printed wiring board **310** that is used to interconnect the conductors **126** of the cable **122** to the contacts of the connector **309**. In **Figures 11** and **12**, the actual interconnection of the conductors **126** and the PWB **310** is not illustrated for modeling simplicity. Different techniques and configurations for interconnecting the conductors **126** and the printed wiring board **310** are discussed below. It should also be noted that the termination module **308** may also be employed with a module having the configuration of module **110**.

Turning first to **Figures 13A-D** and **14**, the termination module **308** shown therein includes contact pads **312** on the PWB **310** to which the conductors **126** of the cable **122** are soldered. As shown in **Figures 13A** and **13B**, the conductors **126** may be soldered on both the top and bottom surfaces of the PWB **310**, or as shown in **Figures 13C** and **13D** they may be soldered to only one side of the PWB **310**. The PWB **310** is received between two blocks **314**, each of which houses contacts that include eye-of-the-needle extensions that fit into apertures in the PWB **310**. The opposite ends of the contacts in the blocks **314** are presented in a backplane connector **316** that mates with the connector **306** of the module **110** or the module **300**.

Figure 14 is a partially exploded view of the termination module **308** and the module **110** in which the housing **148** of the module **110** is exploded for clarity. In **Figure 14**, the connector **309** of the termination module **308** is mated with the connector **138** of the module **110**. An exemplary patch cord **318** is shown connected to one of the RJ-45 connectors **146** of the module **110**.

In some instances, it may be advantageous to provide components that facilitate the soldering of the conductors **126** to the contacts **309** of the PWB **310**. **Figures 15** and **16** illustrate a wire manager **400** that can be inserted near the ends of the conductors **126**. The wire manager **400** includes four sets of four channels **402**, each channel **402** receiving a twisted pair of conductors **126**. Within each channel **402** is a splitter post **404** that divides the channel **402** into two lanes **406**, each of which is configured to receive a single conductor **126** and hold it in position. **Figure 17** illustrates a matching comb **410** that mates with the wire manager **400** via tabs **422** that are received in slots **408** in the wire manager **400**. The comb **410** includes slots **412** that align with the lanes **406** of the channels **402** of the wire manager **400**. A handle **414** facilitates handling of the comb **410**. The mated wire manager **400** and comb **410** are shown in **Figure 18**.

In use, the conductors **126** are routed into their individual channels **402** and lanes **406**, with the ends of the conductors **126** extending forwardly from the lanes **406**. The comb **410** is then attached to the wire manager **400** so that the conductors **126** reside in the slots **412**. Once the conductors **126** are positioned within the slots **412**, the comb **410** is removed, leaving the conductors **126** aligned with the contact pads **312** of the PWB **310** of the termination module **308** (see **Figure 19**). The conductors **126** can then be easily soldered to the contact pads **312**.

In other embodiments, the conductors **126** may be attached to the PWB **310** via insulation displacement contacts (IDCs). IDCs typically require more room on a PWB from side to side than do soldering contacts, so in some embodiments the IDC locations are offset, staggered or otherwise non-aligned in order to reduce the amount of room required. **Figures 22-25** illustrate several different arrangements for IDCs **450** on the PWB **310**. **Figure 22** illustrates an arrangement in which the IDCs **450** for a particular subunit **124** of conductors **126** are arranged in two rows, with the "back" row being staggered relative to the "front" row. In this arrangement the conductors **126** of two subunits **124** are connected on each side of the PWB **310**, and the rows of IDCs on one side of the PWB **310** are offset forwardly from the rows of IDCs on the other side of the PWB **310**. **Figure 23** illustrates a similar arrangement, but with the IDCs **450'** in one row being non-uniformly staggered from the IDCs in the adjacent row. **Figure 24** illustrates an arrangement in which the IDCs **450"** for a pair of conductors are positioned on a diagonal, with adjacent pairs defining diagonals that are perpendicular to each other. **Figure 25** illustrates a similar IDC pattern to that of **Figure 24**, with the exception that the diagonal lines defined by the pairs of IDCs **450"'** are parallel to each other.

Figure 26 shows an exemplary IDC **450**. This IDC includes an "eye-of-the-needle" extension **452**, ears **454** to facilitate press-in insertion, a slot **456**, and upper edges **458** that are angled (in this instance approximately 70 degrees from vertical) to assist with conductor insertion. **Figure 27** shows an alternative IDC in which the slot **456'** narrows at its upper end to retain a conductor therein.

Figures 20 and **21** illustrate a wire manager **460** that can be employed with one or more of connectors **308** described above to facilitate routing of the conductors **126** from the cable **122** to the IDCs **450**. The wire manager **460** includes a number of guides **462** that receive and route individual conductors **126** to an IDC for insertion. In the illustrated embodiment, the wire manager **460** is configured to guide the conductors **126** of two cable subunits **124** to the top surface of the PWB **310** and the conductors **126** of the other two cable subunits **124** to the bottom surface of the PWB **310**. The wire manager **460** also includes four cruciform guides **464** that help to route the pairs of conductors **126** from each subunit **124** to the guides **462**. The wire manager **460** can be attached to the front edge of the PCB **310** via a slot **468**.

Turning now to **Figures 28** and **29**, an exemplary termination module **308** that employs piercing contacts **500** is shown therein. The piercing contacts **500** are inserted into both sides of the PCB **310** in two rows, with the contacts **500** in one row being staggered relative to the contacts **500** of the other row. A wire managing sled **504** that slips onto the rear edge of the PWB **310** may also be included (*see* **Figure 19**). Piercing contacts **500'** of another configuration are illustrated in **Figure 30**. In either instance, typically conductors **126** to be connected with the contacts **500, 500'** are positioned over and pressed onto a piercing element (a point, blade or the like), and a crimping tool is employed to crimp arms, fingers, tabs or the like over the conductor to hold the conductor in place.

Another embodiment of a termination module that can be attached to the cable **122**, designated broadly at **600**, is shown in **Figures 31A-B** and **32A-B**. The termination module **600** includes two separate PWBs **602, 604** that are attached to a connector block **606**, wherein the connector block **606** is matable with the connector **138** of the module **110**. As shown in **Figures 31A-B**, the individual conductors **126** of the same subunit **124** of the cable **122** may be routed to both PWBs **602, 604**, or the conductors **126** of the same subunit **124** may be routed to the same PWB **602, 604** (*see* **Figures 32A-B**). In either instance the conductors **126** may be connected with the PWBs **602, 604** via any of the techniques discussed above.

Figures 33A-B illustrates a modified connector **600'**. The connector **600'** includes PWBs **602', 604'** with edge slots **608** that can receive shielding ribs **610** that depend from the main surface **612** of the housing **614**. The shielding ribs **610** can provide shielding for the subunits **124**, which may reduce crosstalk and other performance-hampering factors.

The cables **122** described above may, in some instances, be interconnected via connectors and cables to other components. In some instances, it may be necessary or desirable to provide an extension cable that enables modules connected to a cable **122** to be interconnected with other components at the end opposite the termination module **308**. **Figures 34A-36B** are directed to termination configurations for cables **122** and extension cables **720, 720', 720''**. Such cables include termination modules that are designed to enable the cables of different modules or other components to be interconnected while having suitable "gender" (*i.e.*, male or female connection) and polarity (*i.e.*, proper connection of conductors and components for signal transmission). This can be achieved in multiple ways. **Figures 35A** and **35B** illustrate a cable **122** and an extension cable **720**, wherein the cable **122** has a "female" connector **721** (*e.g.*, of the configuration of the connector **306**) and the

cable **720'** has a "male" connector **721'** (*e.g.*, of the configuration of the connector **309)** that mates directly with the female connector **721**. In this embodiment, the female connector **721** and the male connector **721'** are of opposite polarity (*i.e.*, they are compatible for mating), as any rearrangement of conductors necessary for proper polarity is achieved within the termination module of the female connector **721**, the male connector **721'**, or elsewhere in one of the cables. **Figures 36A** and **36B** illustrate a cable **122** with a female connector **721** and an extension cable **720'** that also has a female connector **721'** of opposite polarity than female connector **721**. In this embodiment, a coupler **824** with male connectors **825** extending in opposite directions is employed to interconnect the female connectors **821**. Because the connectors **721, 721'** are of opposite polarity, interconnection with the coupler **824** can provide proper polarity. **Figures 34A** and **34B** illustrate a cable **122** and an extension cable **720"**, each of which has a female connector **721** of the same polarity. A coupler connector **924** includes a pair of opposed male connectors **926** that interconnect with the connectors **721**. Proper polarity is achieved via a PCB **928** on which the connectors **926** are mounted.

Referring now to **Figures 37-45**, a communications module **1000** and a cable-connector assembly **1100** that embody some of the concepts discussed above are shown therein. Referring first to **Figures 37** and **38**, the module **1000** includes a floor **1002** that mates with a housing **1048**. A PCB spacer **1020** is positioned above the floor **1002**. A PCB **1049** is positioned above the spacer **1020**. Four RJ-45 lead frames **1046** are mounted to the PCB **1049** adjacent one edge thereof. A backplane connector **1038** is mounted to the opposite edge of the PCB **1049**; the backplane connector **1038** is electrically connected to the contacts of the RJ-45 lead frames **1046** via traces on the PCB **1049**. In this embodiment, the backplane connector **1038** is a "2x11" connector, which indicates that pairs of contacts (each comprising a "channel") are arranged in two rows of eleven contact pairs each. Two shielding housings **1030, 1032** (typically formed of metal) are mounted above the PCB **1049**. The shielding housing **1030** includes openings **1031** that align with the lead frames **1046** and form therewith RJ-45 jacks. The housing **1048** is positioned above the shielding housings **1030, 1032**. The module **1000** also includes two latches **1034** (only one of which is shown herein) mounted beside the connector **1038** and extending from the housing **1048** to facilitate securing of the module **1000** to the cable-connector assembly **1110**.

Like the modules **110, 110'** described above, the module **1000** can be mounted within a patch panel such as the patch panel **152**. Also, those skilled in this art will recognize that some embodiments may include more or fewer RJ-45 jacks **146** (*e.g.*, six jacks, as shown in **Figure 4**), and that the jacks may be formed as separate, discrete units rather than via a common housing like shielding housing **1130**.

Referring now to **Figures 39-43**, the cable-connector assembly **1100** includes a cable **1122** that comprises four interconnected cable subunits **1124** arranged in side-by-side relationship. Each of the subunits **1124** includes four twisted pairs of conductors **1126**, although other numbers of cables (*e.g.*, six) may also be employed. The cable **1122** also includes three ground wires (not shown).

The conductors **1126** are routed through a wire manager **1400** that separates the pairs from each other, then the individual conductors **1126** from each other, for presentation of the conductors for interconnection with a PCB **1110**. The wire manager **1400** is similar in configuration to that shown in **Figures 15** and **16** above. In this embodiment, the wire manager **1400** is configured to manage sixteen twisted pairs of conductors **1126** and three grounding wires.

As is best seen in **Figure 39**, the conductors **1126** are attached to the PCB **1110** via soldering, with the conductors **1126** contacting solder pads **1112** positioned on each side of the PCB **1110**. In this embodiment, the conductors **1126** of each subunit **1124** are split, with the conductors **1126** of two pairs of each subunit **1124** being mounted to the top of the PCB **1110**, and the conductors **1126** of the other two pairs of the subunit **1124** being mounted on the bottom of the PCB **1110**. In other embodiments, other arrangements may also be employed. The PCB **1110** includes holes **1111** that are connected with the solder pads **1112** via electrical traces.

As shown in **Figure 40**, an overmolded housing **1150** (typically formed of a polymeric material) is mounted to the PCB **1110** over the solder pads **1112** and the ends of the subunits **1124**. The overmolded housing **1150** can protect the connections between the conductors **1126** and the solder pads **1112** as well as the open ends of the subunits **1124**.

Referring now to **Figure 41**, a 2x11 connector **1116** is mounted onto the PCB **1110**. The connector **1116** includes eye-of-the-needle contacts (not shown) that are inserted into the holes **1111** of the PCB **1110** and provides receptacles for the contacts of the connector **1038** of the module **1000**. The connector **1116** is divided into two mating halves that interconnect,

with the result that they both overlie and underlie the edge of the PCB **1110** opposite the cable **1122**.

Referring now to **Figures 42** and **43**, the cable-connector assembly **1100** also includes a two-piece clamshell-type housing comprising halves **1120, 1121** that sandwich the ends of the cable subunits **1124**, the wire manager **1400**, the housing **1150**, the PCB **1110**, and the connector **1116**. Latches **1130** (only one of which is shown in **Figures 42** and **43**) are attached within the housing halves **1120, 1121** for interconnection with the module **1000**.

Referring now to **Figures 44** and **45**, it can be seen that the connector **1116** of the cable-connector assembly **1110** can be attached to the backplane connector **1038** of the module **1000** for use thereof, with the contacts of the connector **1038** being inserted into the receptacles of the connector **1116**. This action interconnects the conductors **1126** of the cable **1122** with the RJ-45 jacks **1046** of the module **1000**. The latches **1130** of the cable-connector assembly **1100** interact with the latches **1034** of the module **1000** to secure the connection between the module **1000** and the cable-connector assembly **1100**.

The combination of the module **1000** and the cable-connector assembly **1100** can provide a preterminated cable carrying four separate cable subunits that can be connected quickly and easily into four RJ-45 connectors. Also, the cable-connector assembly **1110** is sized and configured such that it can fit within a standard PCIe slot or a standard CFP slot. To fit these standard siszes, the dimensions of the connectors **1038, 1116** are **[Inventors: Please provide some key dimensions that define these standard slots]**.

The foregoing embodiments are illustrative of the present invention, and are not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention.

That Which is Claimed is:

1. A cable-connector assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket;

a printed circuit board, the conductors of the cable subunits being attached to the printed circuit board; and

a single connector mounted to the printed circuit board and electrically connected to the conductors of the cable subunits.

2. The cable-connector assembly defined in Claim 1, wherein the printed circuit board has first and second opposed surfaces, and wherein some of the conductors of the cable subunits are attached to the first surface, and others of the conductors of the cable subunits are attached to the second surface.

3. The cable-connector assembly defined in Claim 2, wherein some of the conductors of each of the subunits are attached to the first surface and some of the conductors of each of the subunits are attached to the second surface.

4. The cable-connector assembly defined in Claim 1, wherein the conductors are attached to the printed circuit board via soldering.

5. The cable connector assembly defined in Claim 1, further comprising a conductor manager that facilitates routing of the conductors from the cable subunits to the printed circuit board.

6. The cable-connector assembly defined in Claim 1, wherein the cable subunits are arranged in side-by-side relationship.

7. The cable-connector assembly defined in Claim 1, wherein the plurality of subunits is at least four subunits, and wherein the plurality of twisted pairs is at least four twisted pairs in each cable subunit.

8. A cable-connector assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket, the cable subunits arranged in side-by-side relationship; and

a single connector electrically connected to the conductors of the cable subunits.

9. The cable-connector assembly defined in Claim 8, further comprising a printed circuit board, the conductors and the connector being attached to the printed circuit board.

10. The cable-connector assembly defined in Claim 9, wherein the printed circuit board has first and second opposed surfaces, and wherein some of the conductors of the cable subunits are attached to the first surface, and others of the conductors of the cable subunits are attached to the second surface.

11. The cable-connector assembly defined in Claim 9, wherein some of the conductors of each of the subunits are attached to the first surface and some of the conductors of each of the subunits are attached to the second surface.

12. The cable-connector assembly defined in Claim 9, wherein the conductors are attached to the printed circuit board via soldering.

13. The cable connector assembly defined in Claim 9, further comprising a conductor manager that facilitates routing of the conductors from the cable subunits to the printed circuit board.

14. The cable-connector assembly defined in Claim 8, wherein the plurality of subunits is at least four subunits, and wherein the plurality of twisted pairs is at least four twisted pairs in each cable subunit.

15. A combination, comprising:

(a) a communications module comprising:

a housing;

a printed wiring board mounted within the housing;

a plurality of RJ-45 jacks mounted on the printed wiring board and accessible from one side of the housing; and

a single module connector mounted to the printed wiring board and electrically connected to the RJ-45 jacks, connector being accessible from a second side of the housing; and

(b) a cable-connector assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a jacket and a plurality of twisted pairs of conductors positioned within the jacket; and

a single cable connector mounted to the printed circuit board and electrically connected to the conductors of the cable subunits;

wherein the module connector is attached to the cable connector.

16. The combination defined in Claim 15, wherein the cable-connector assembly comprises a printed circuit board to which the conductors and the cable connector are mounted.

17. The combination defined in Claim 16, wherein the cable subunits are arranged in side-by-side relationship.

18. The combination defined in Claim 16, wherein the plurality of cable subunits comprises at least four cable subunits, and wherein each cable subunit comprises at least four twisted pairs of conductors.

19. A cable-connector assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors;

a connector attached to one end of the cable, the connector including a plurality of elongate contacts, each of the contacts corresponding to a respective conductors of the cable, each of the contacts having a contact end and an open loop at an opposite end; and

a plurality of transition elements connecting each of the conductors with its respective contact, each of the transition elements including a first end adapted to receive and connect to with a conductor and a second end adapted to receive and connect to the open loop of a contact.

20. The cable-connector assembly defined in Claim 19, wherein the first end of each of the transition elements includes a bore that receives a conductor.

21. The cable-connector assembly defined in Claim 19, wherein the first end of each of the transition elements includes crimpable fingers that receive a conductor.

22. The cable-connector assembly defined in Claim 19, wherein the second end of each of the transition elements comprises a clip that receives the loop of a contact.

23. The cable-connector assembly defined in Claim 19, wherein the male connector further comprises a subunit adapter that separates the subunits from each other.

24. A datacommunications cable assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; and

a cable subunit adapter comprising:

four cable receiving channels, each of the channels including a longitudinal axis that is offset from the longitudinal axes of its neighboring receiving channels in both X and Y directions, each of the receiving channels receiving a respective cable subunit of the cable; and

guides positioned below each receiving channel, the guides configured to separate each of the twisted pairs of the cable subunit from the other twisted pairs of the cable subunit.

25. The assembly defined in Claim 24, further comprising a cable strain relief device attached to the cable subunits.

26. A datacommunications cable assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors; and

a printed circuit board having at least one edge, the edge including a plurality of open-ended recesses, each of the recesses connected to a conductive trace;

wherein each of the conductors of the cable is received in one of the open-ended recesses.

27. The cable assembly defined in Claim 26, wherein the printed circuit board includes a plurality of apertures, each of the apertures connected to one of the plurality of conductive traces.

28. The cable assembly defined in Claim 26, wherein the at least one edge comprises two opposed edges.

29. The cable assembly defined in Claim 26, wherein the at least one edge comprises two sets of opposed edges.

30. The cable assembly defined in Claim 27, wherein elongate contacts are inserted in the plurality of apertures.

31. The cable assembly defined in Claim 26, further comprising a cable subunit adapter, the adapter including guides configured to separate (a) the subunits of the cable from each other and (b) the twisted pairs of a cable subunit from each other.

32. A combination comprising:

(a) a datacommunications module, comprising:

a plurality of datacommunications jacks;

a vertically disposed printed circuit board; the jacks mounted on a first surface of the printed circuit board;

a plurality of elongate contacts mounted to a second, opposed surface of the printed circuit board, the contacts extending being connected with the jacks and extending away from the second surface; and

(b) a cable-connector assembly comprising:

a horizontally disposed printed circuit board;

a connector mounted to the horizontally mounted printed circuit board and connected to the elongate contacts; and

a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors, the twisting pairs of conductors being connected to the horizontal printed circuit board.

33. A cable-connector assembly, comprising:

a cable comprising a plurality of subunits, each of the subunits comprising a plurality of twisted pairs of conductors;

a printed circuit board with electrical traces residing thereon, the printed circuit board having first and second opposed surfaces; and

a connector mounted on the printed circuit board and connected with the electrical traces;

wherein some of the subunits are connected with respective electrical traces at mounting locations on the first surface of the printed circuit board, and others of the subunits are connected with respective electrical traces at mounting locations on the second side of the printed circuit board.

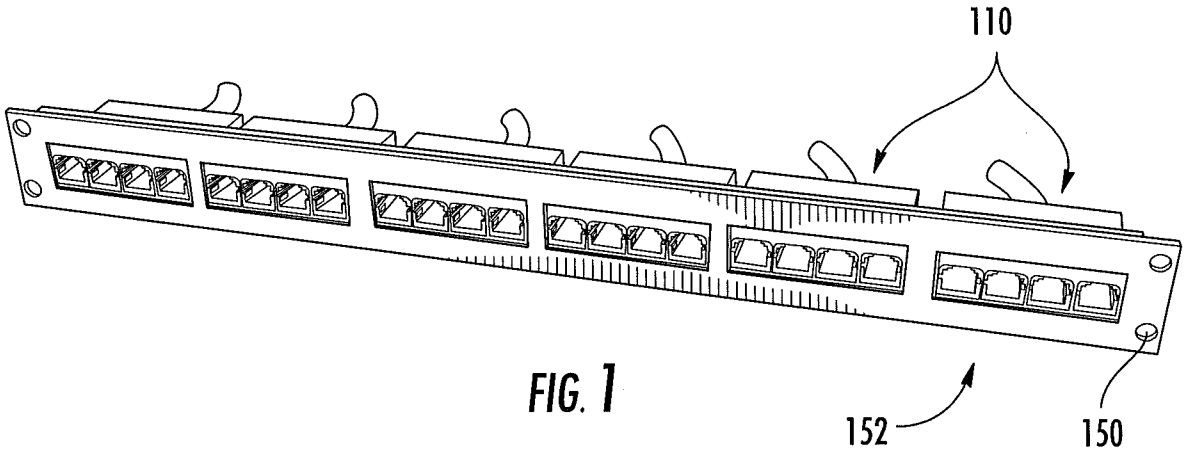

FIG. 1

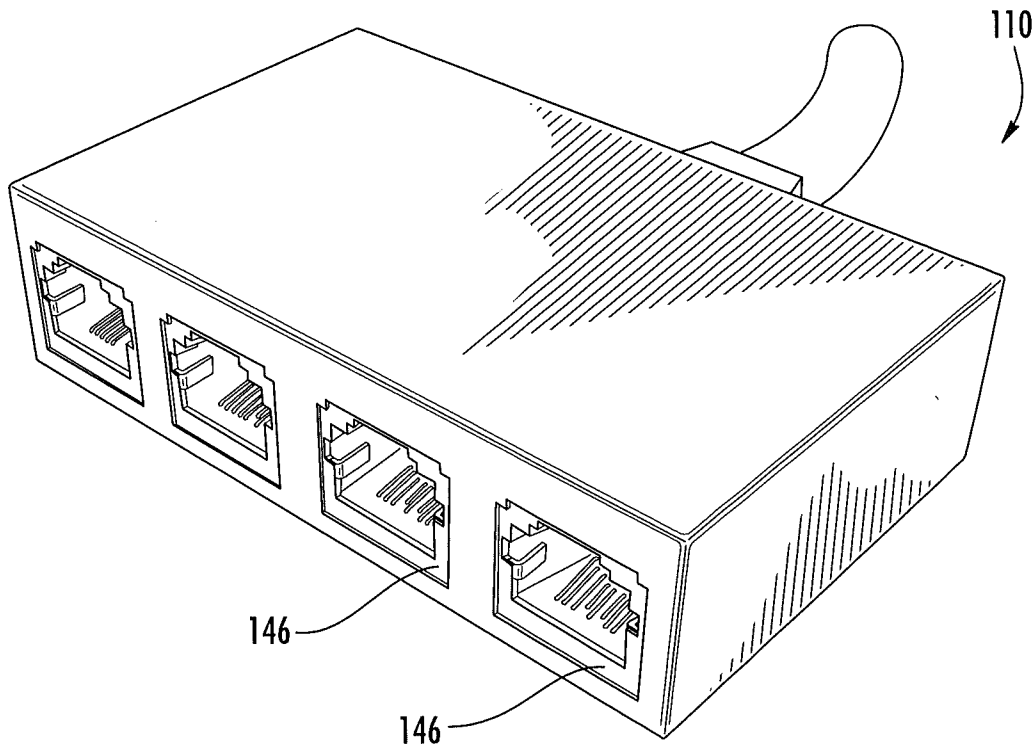

FIG. 2

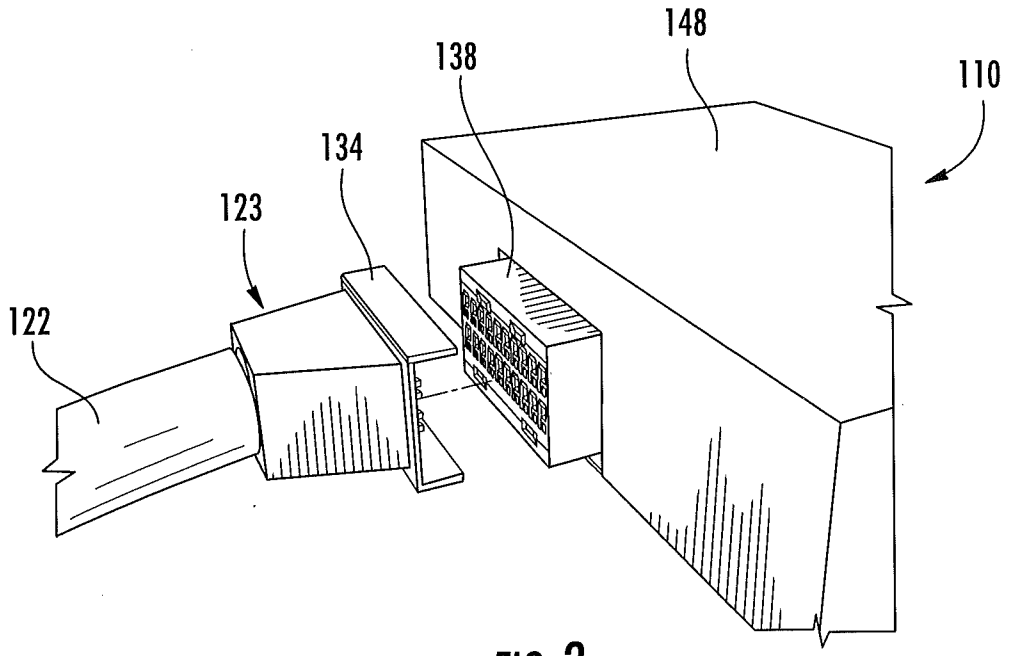

FIG. 3

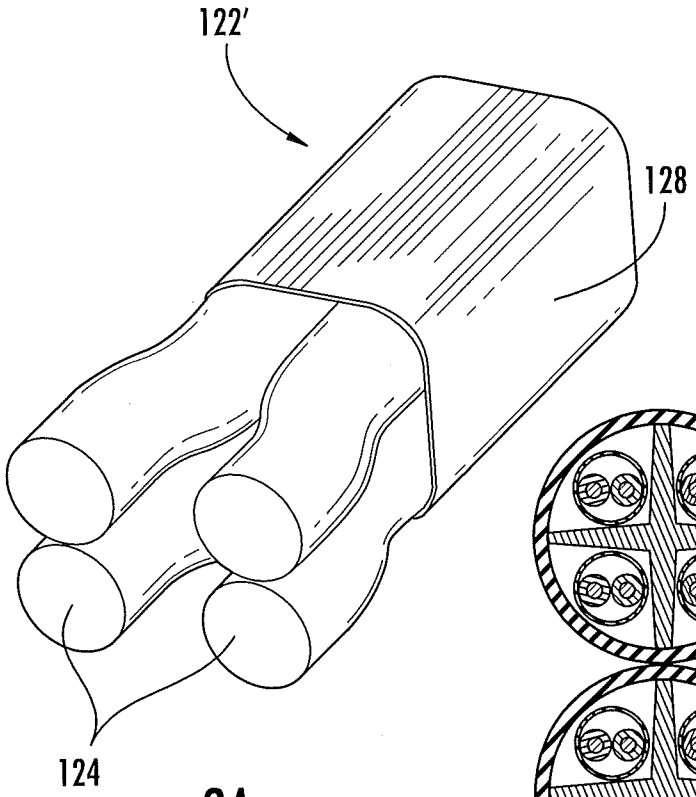

FIG. 3A

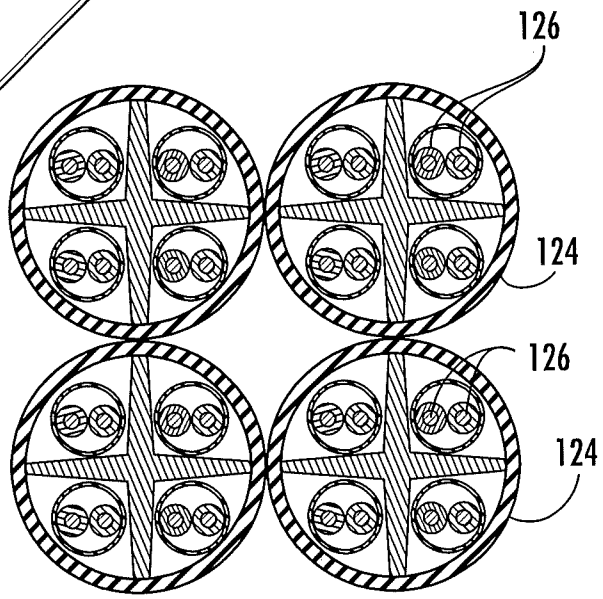

FIG. 3B

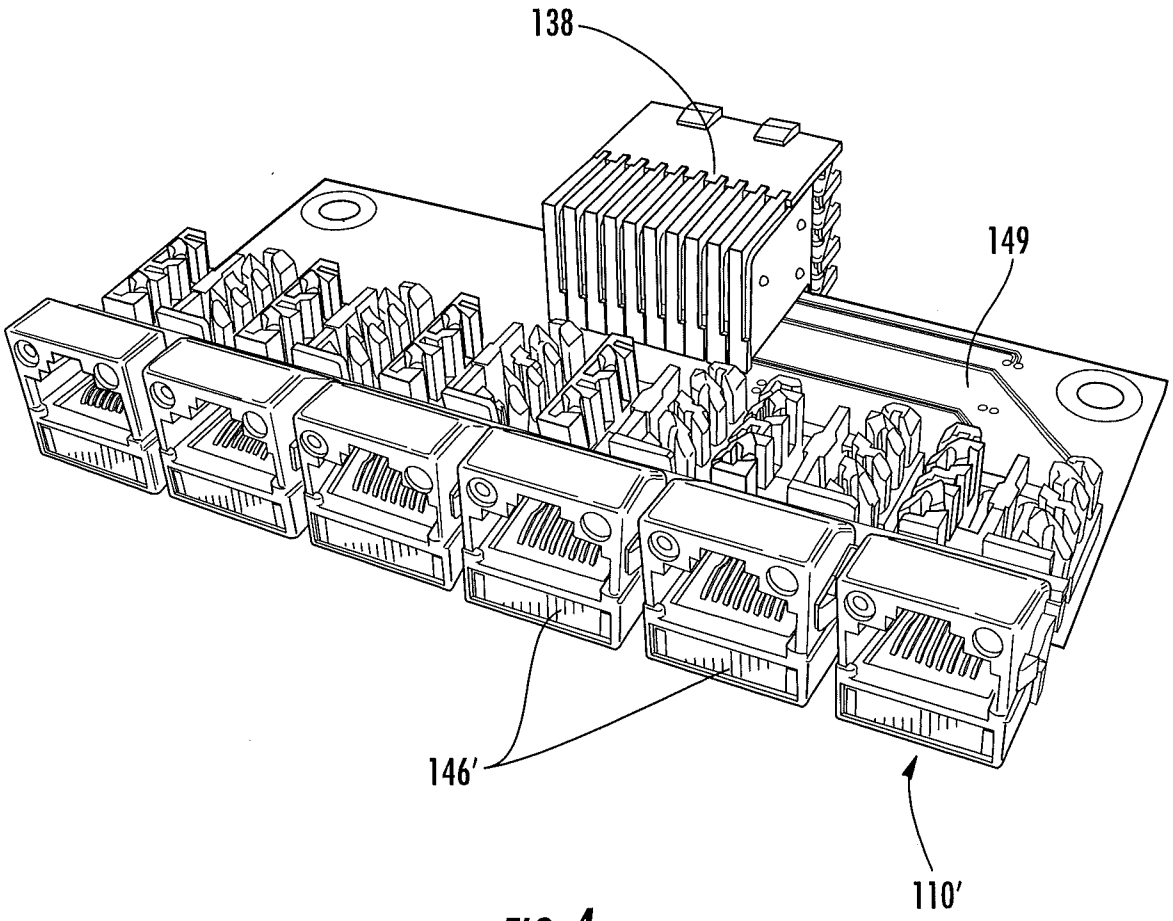

FIG. 4

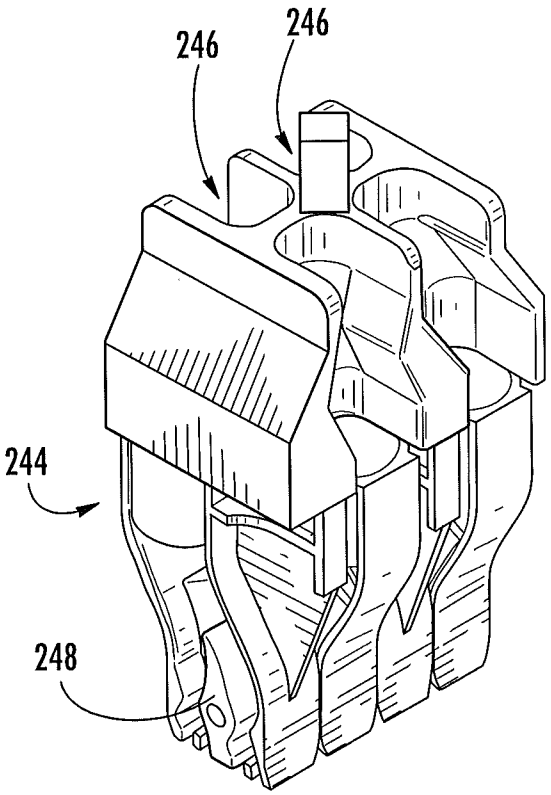

FIG. 5A

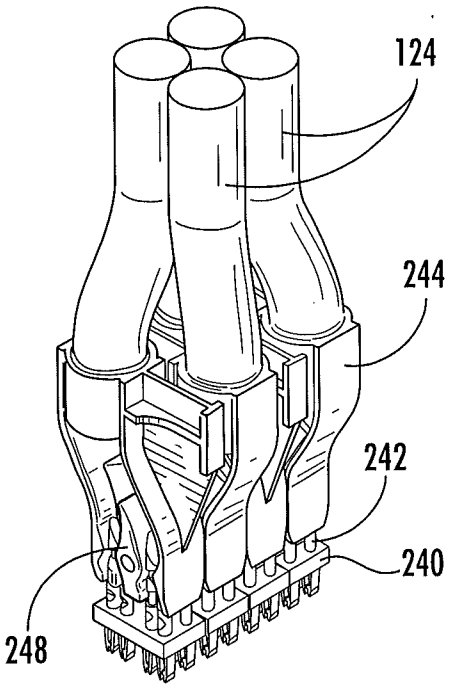

FIG. 5B

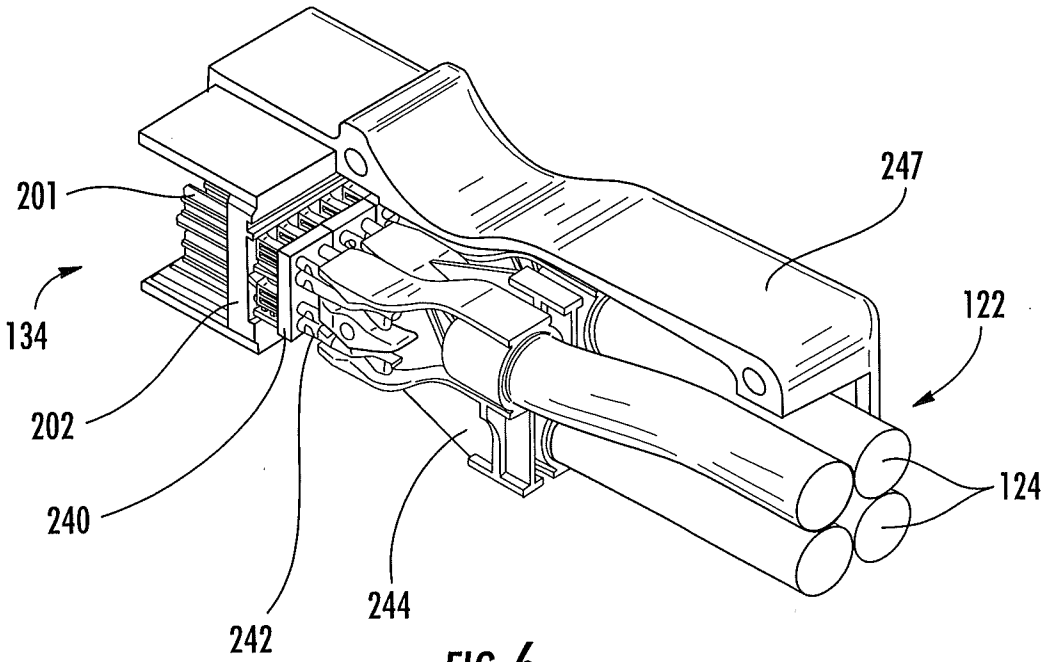

FIG. 6

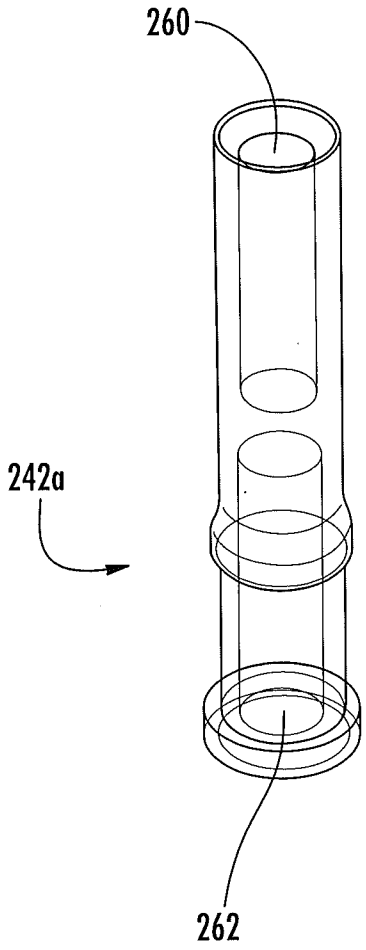

FIG. 7A

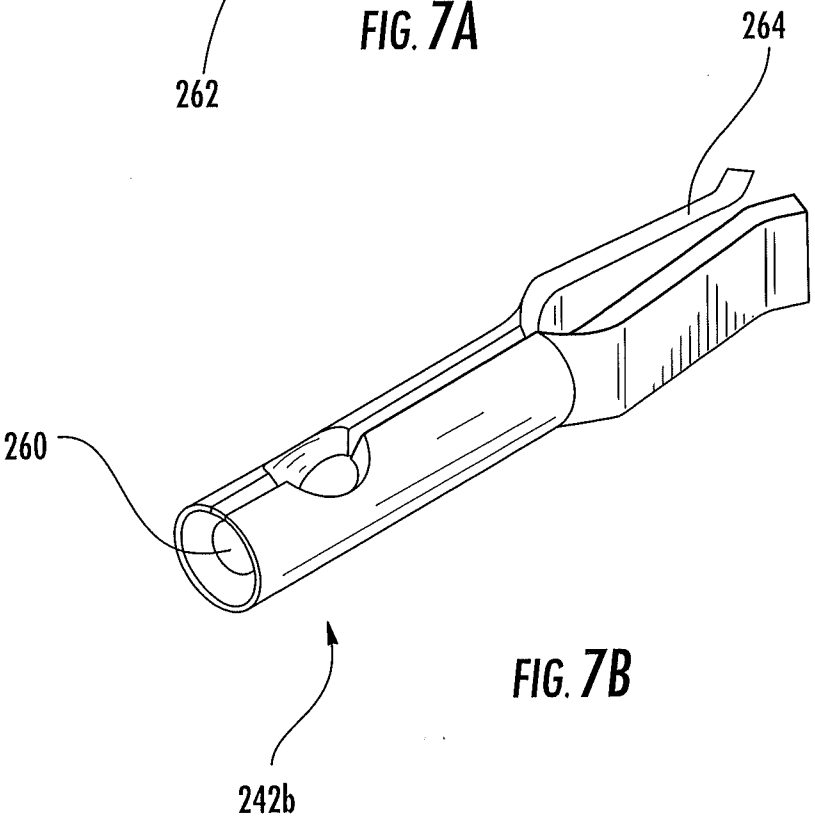

FIG. 7B

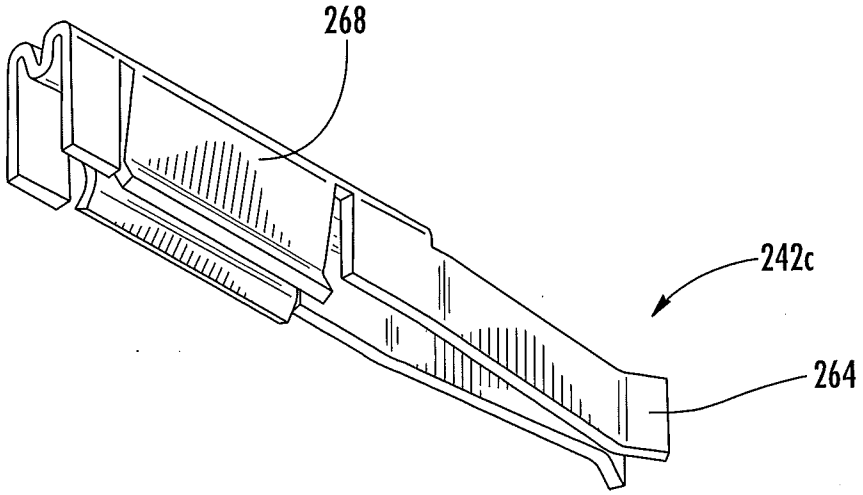

FIG. 7C

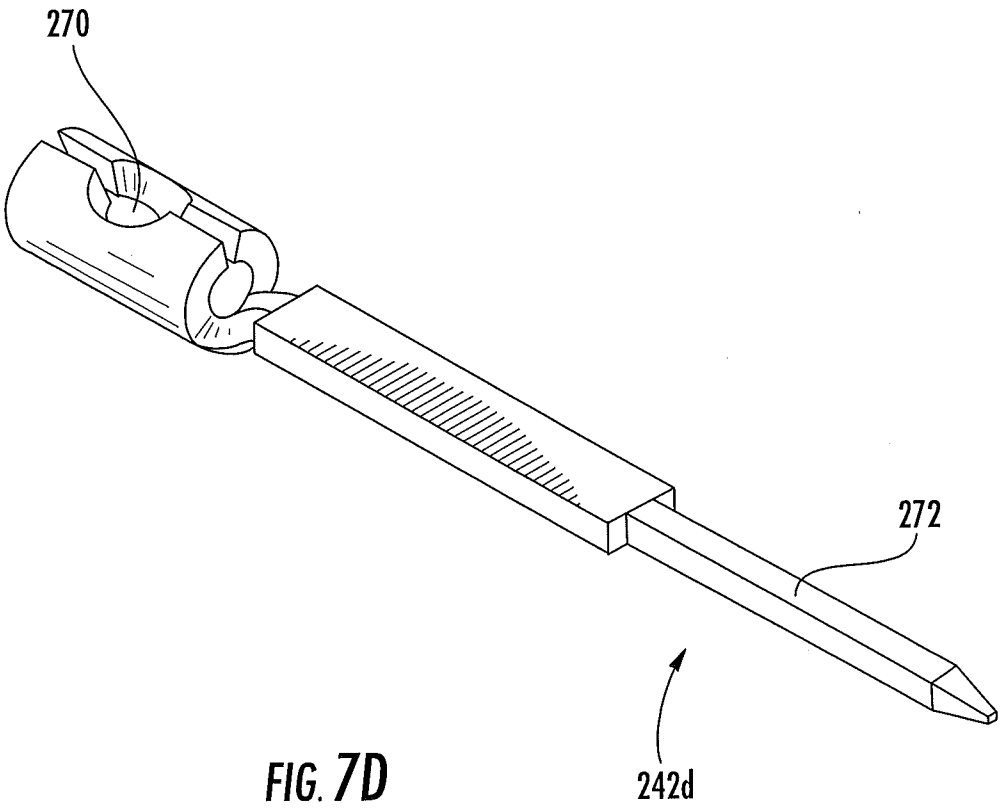

FIG. 7D

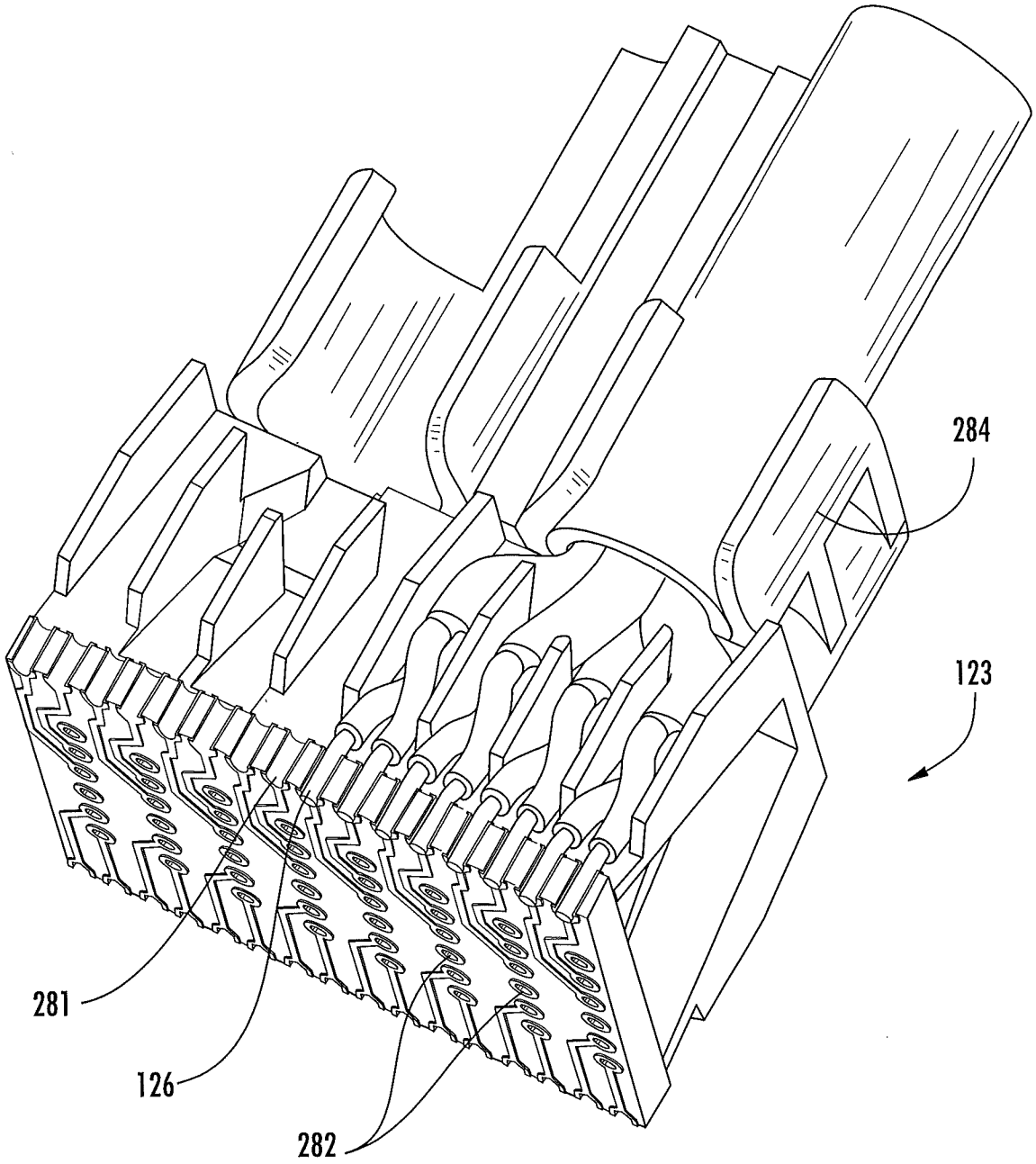

FIG. 8

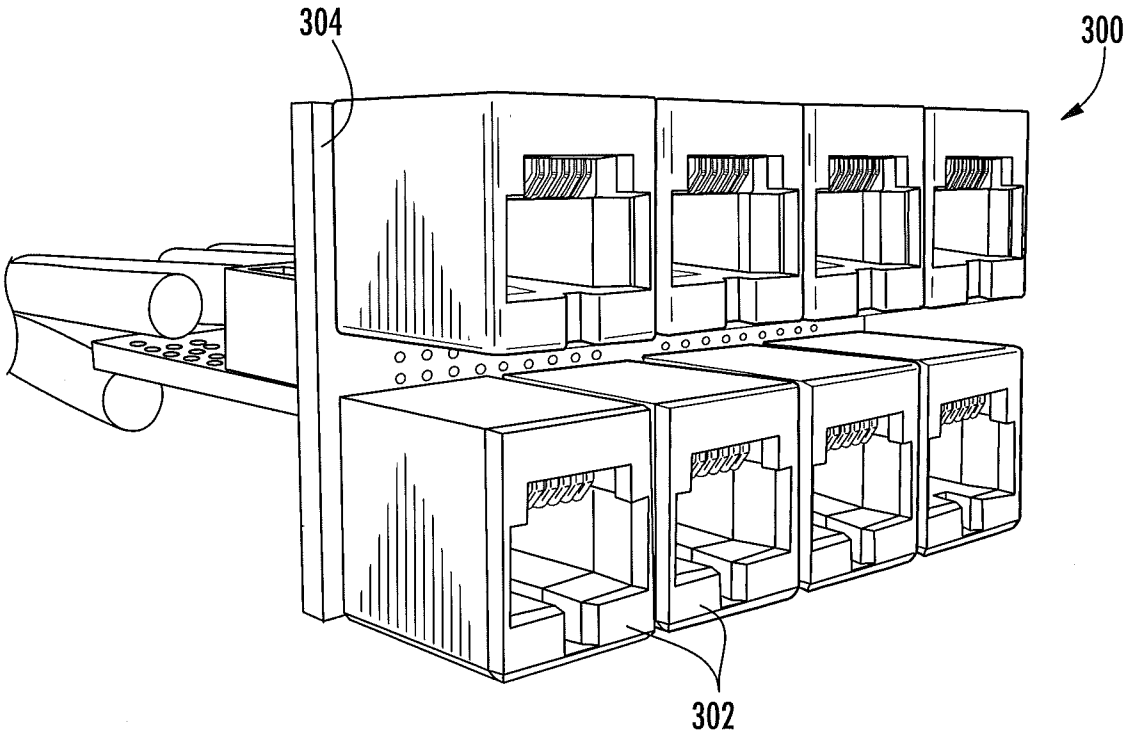

FIG. 9

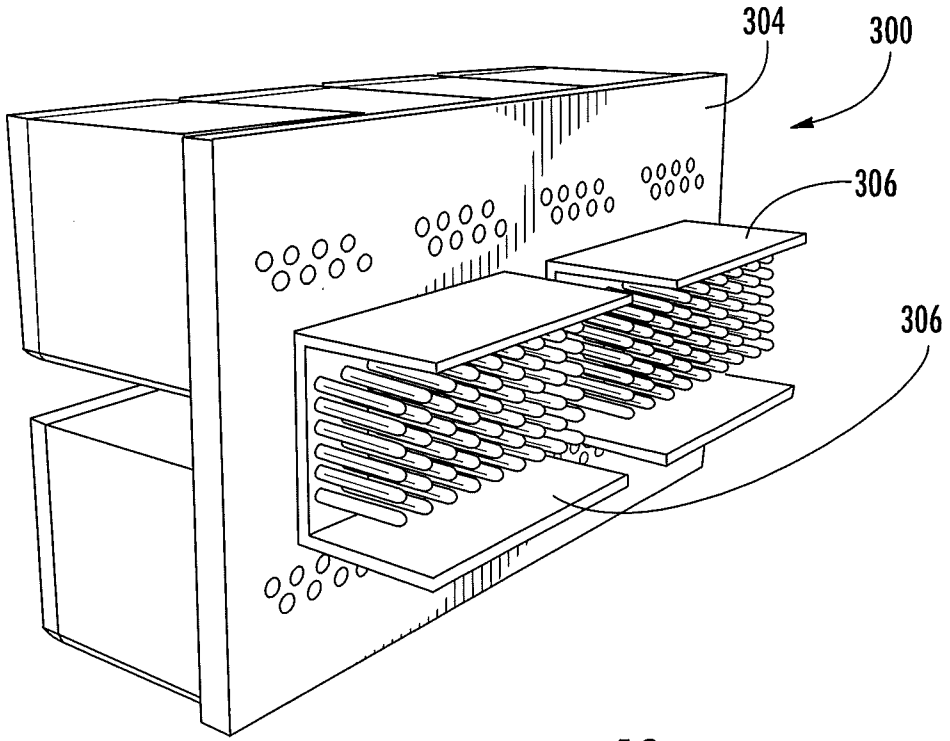

FIG. 10

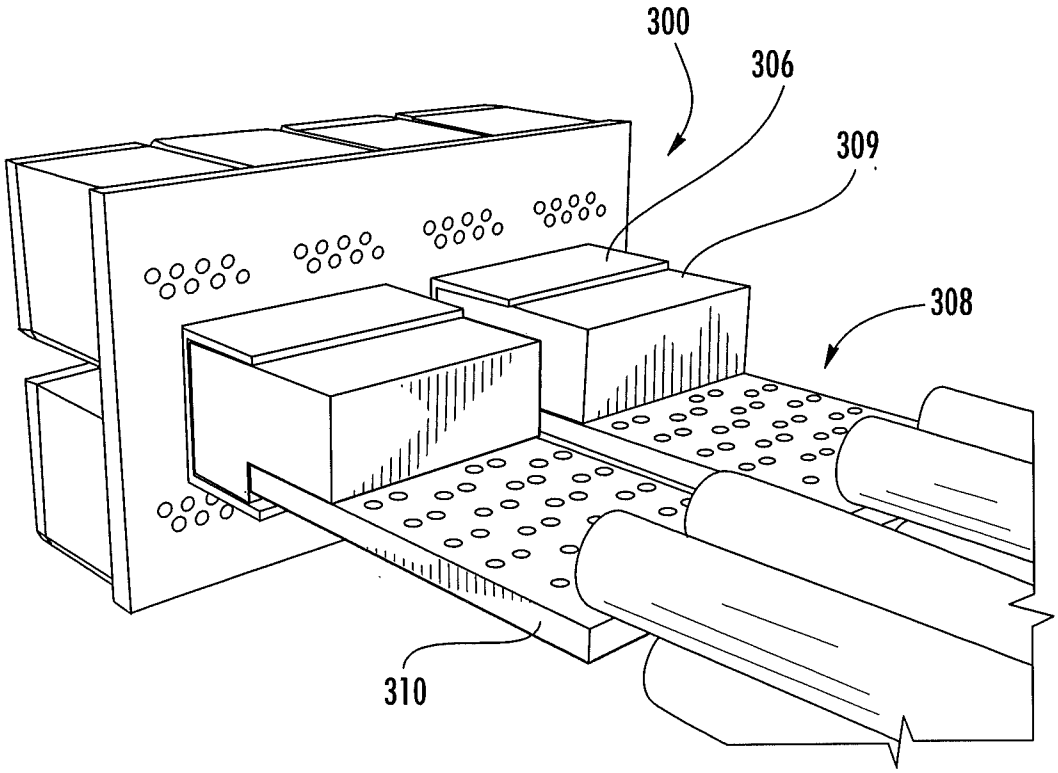

FIG. 11

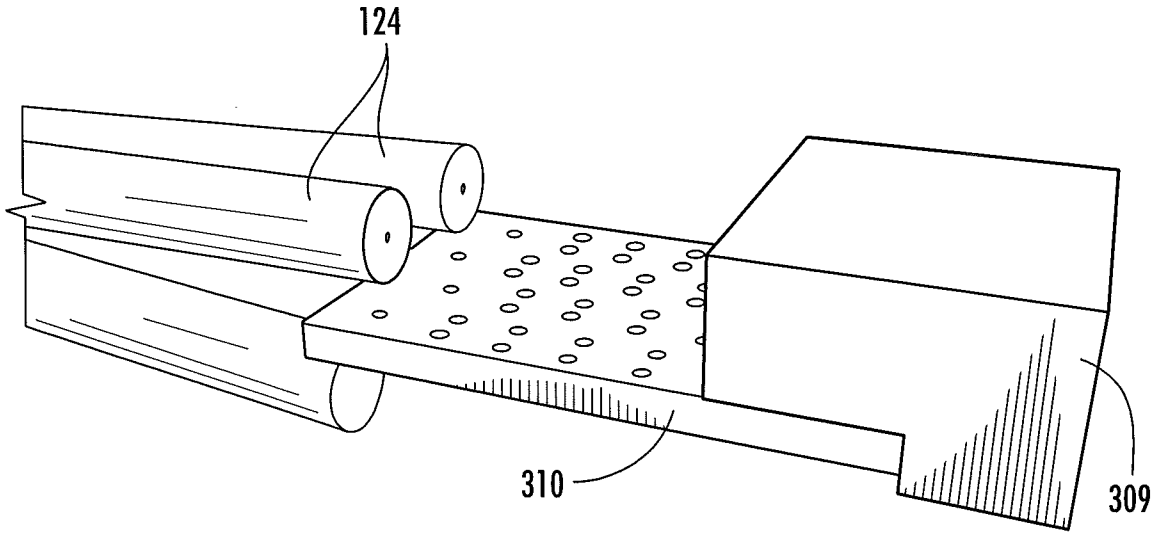

FIG. 12

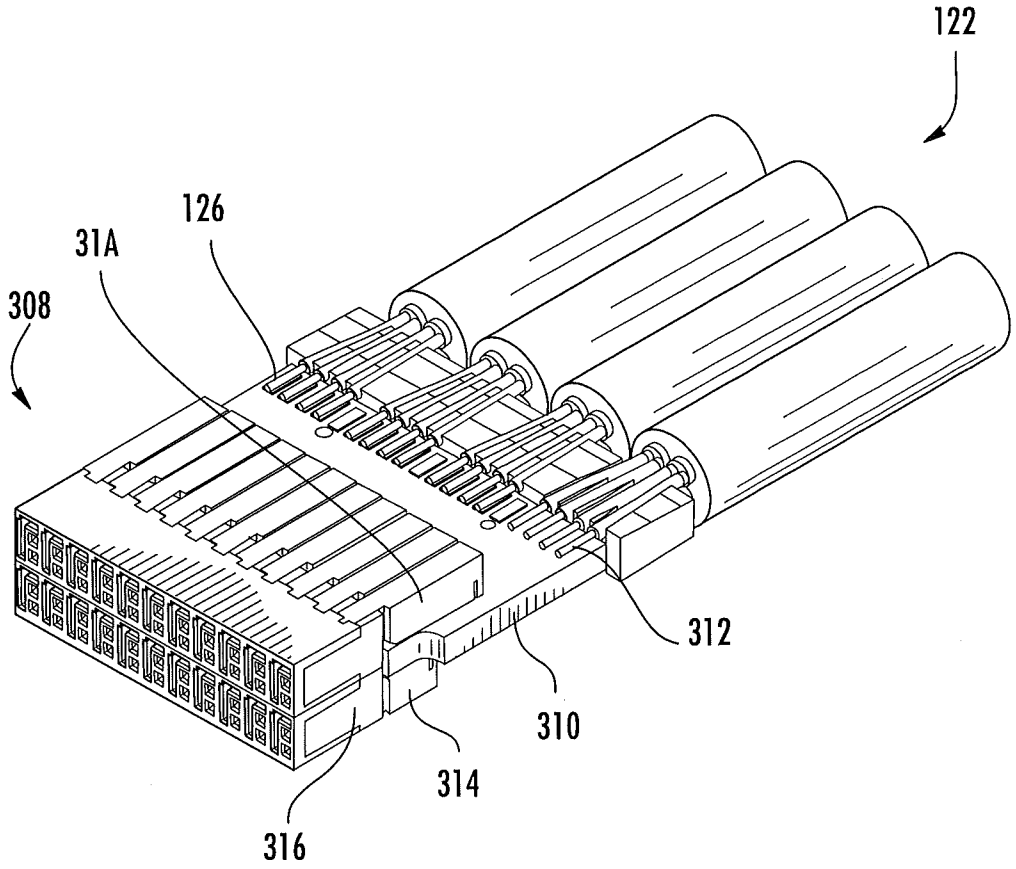

FIG. 13A

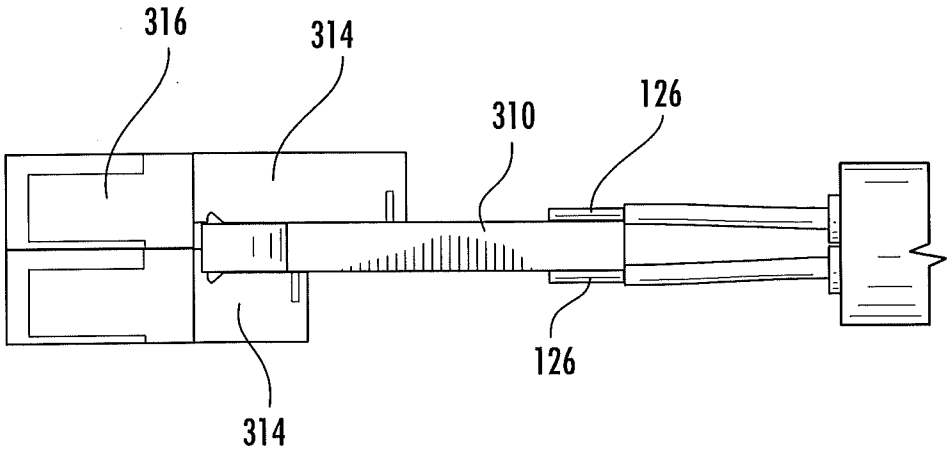

FIG. 13B

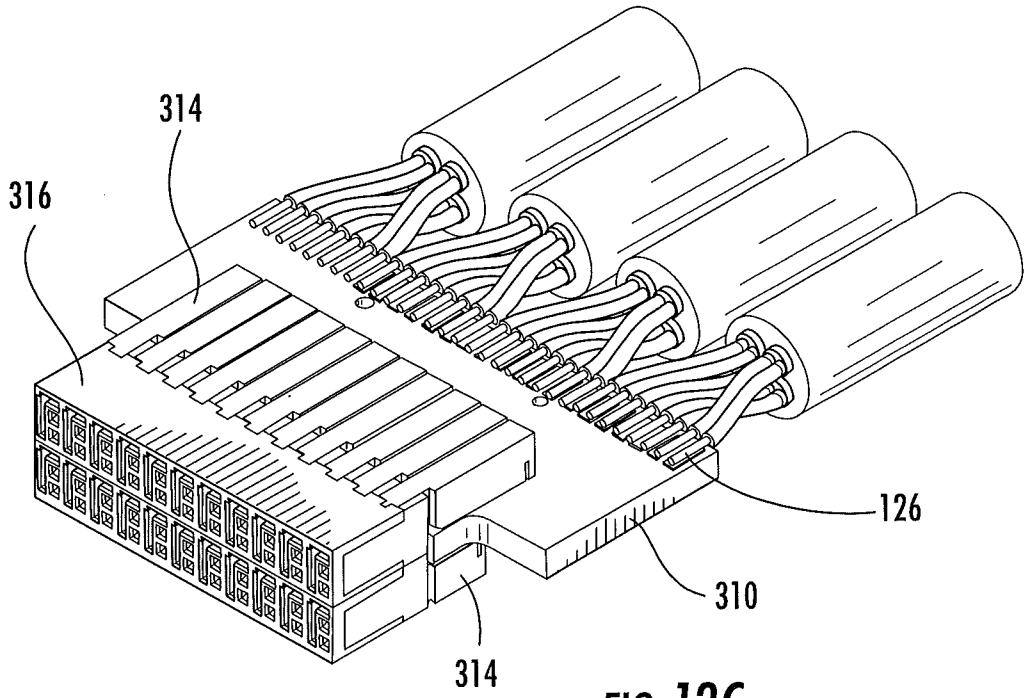

FIG. 13C

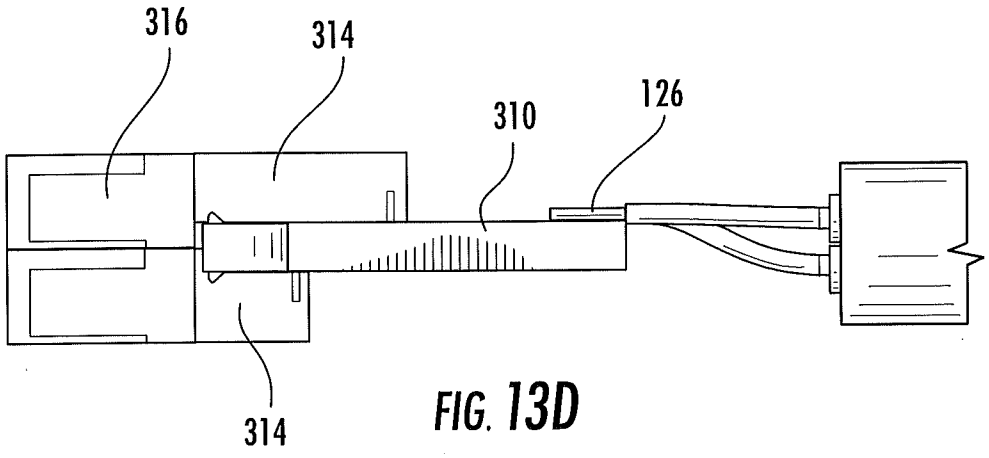

FIG. 13D

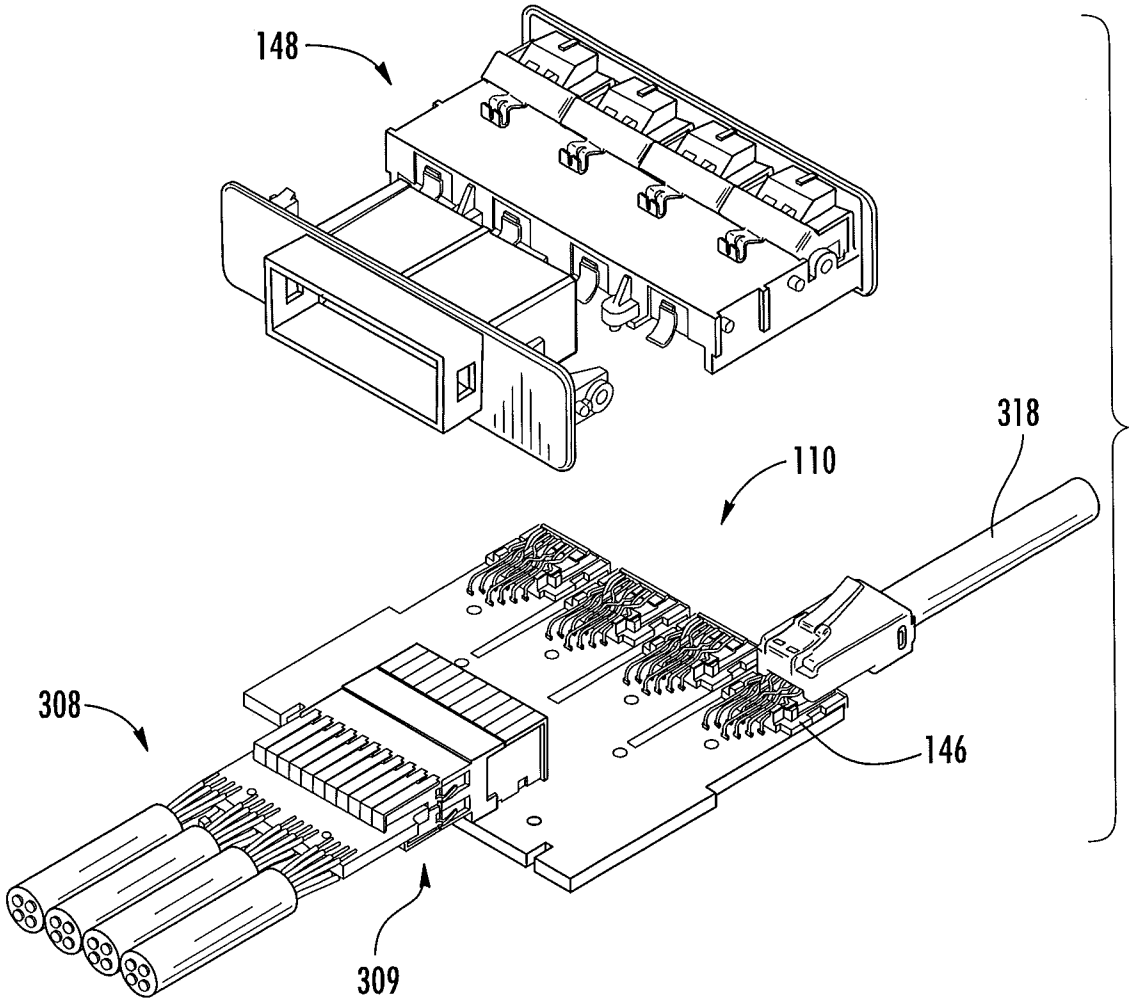

FIG. 14

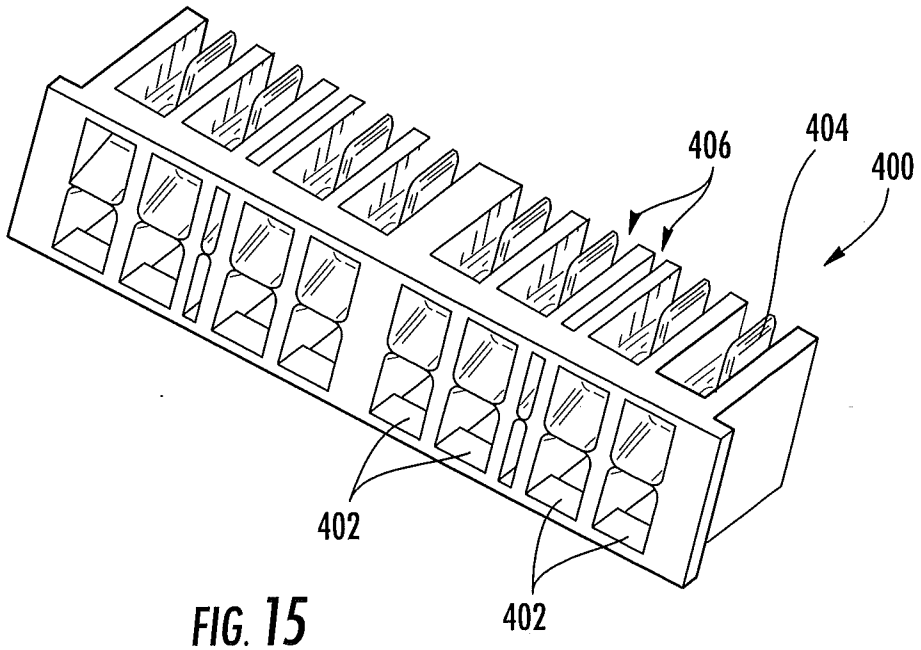

FIG. 15

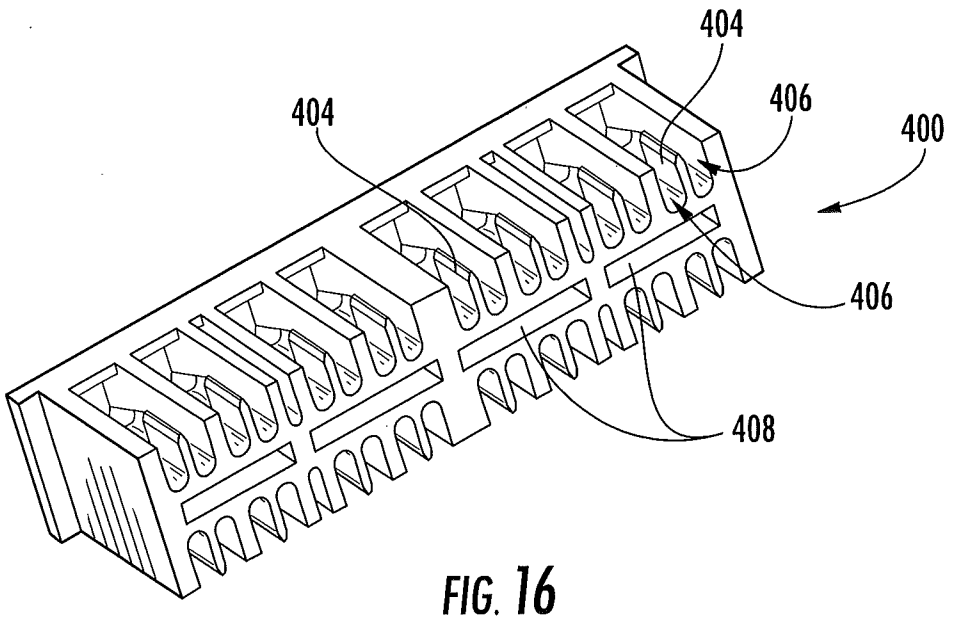

FIG. 16

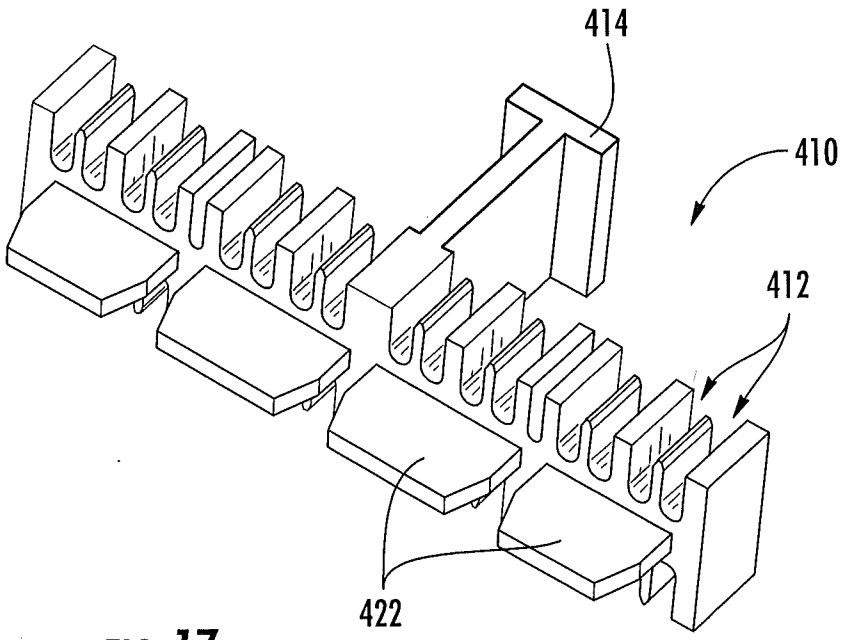

FIG. 17

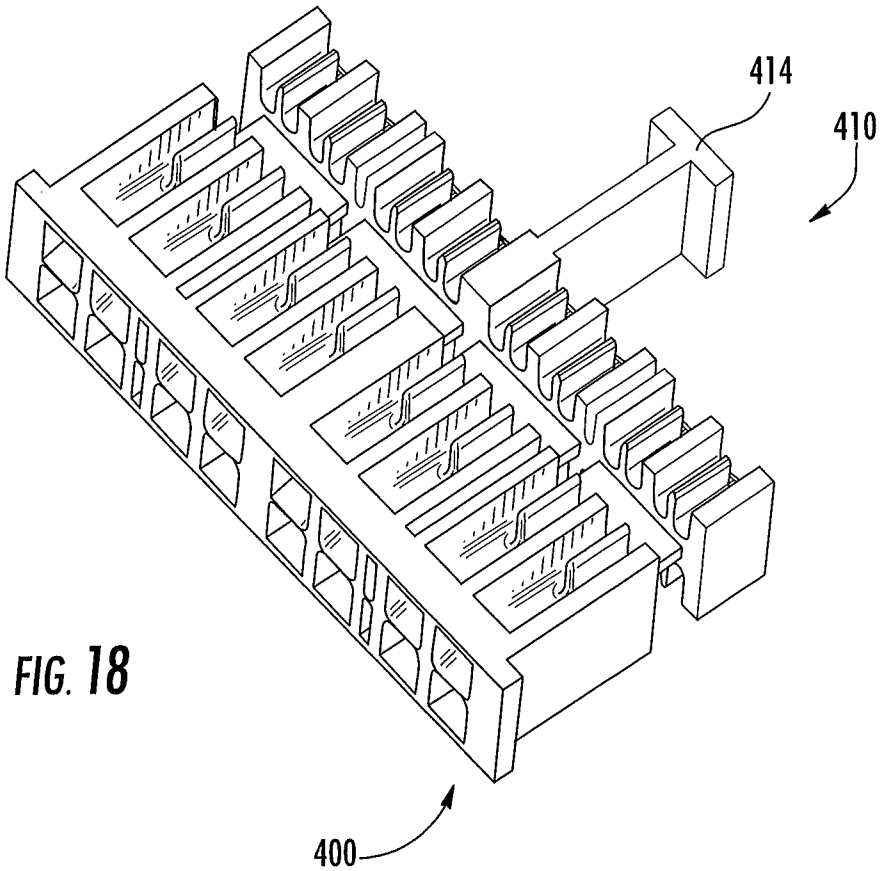

FIG. 18

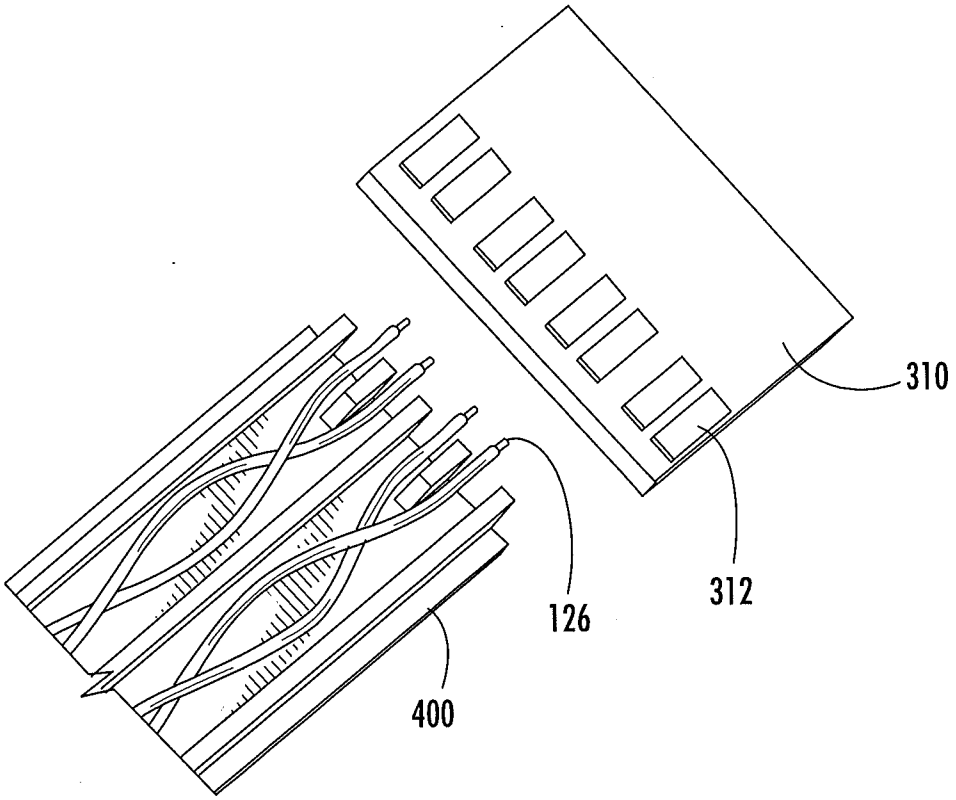

FIG. 19

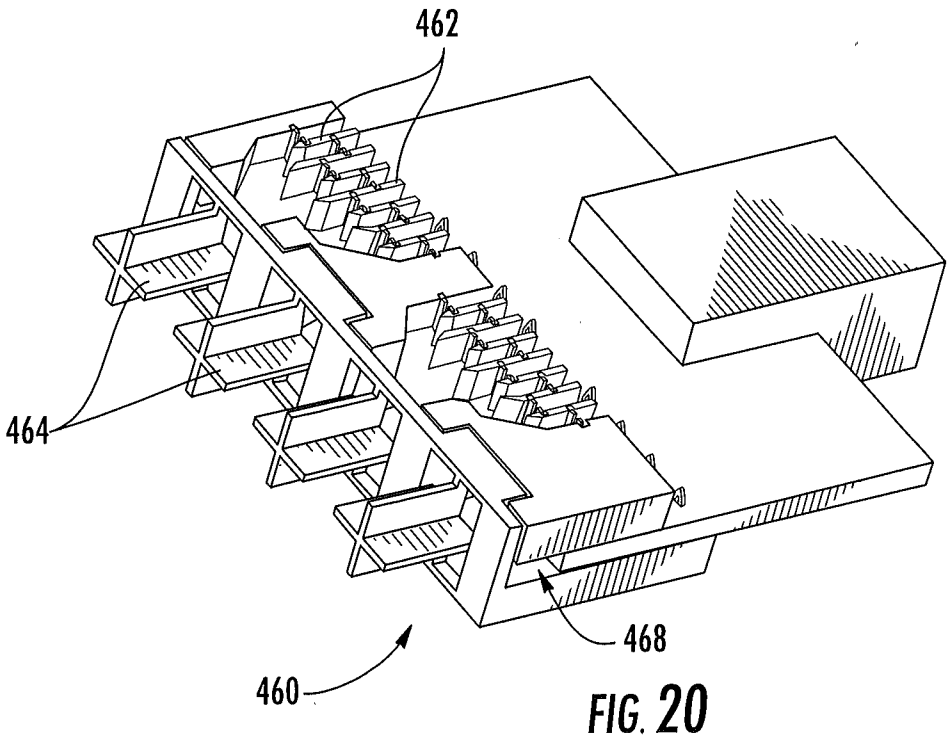

FIG. 20

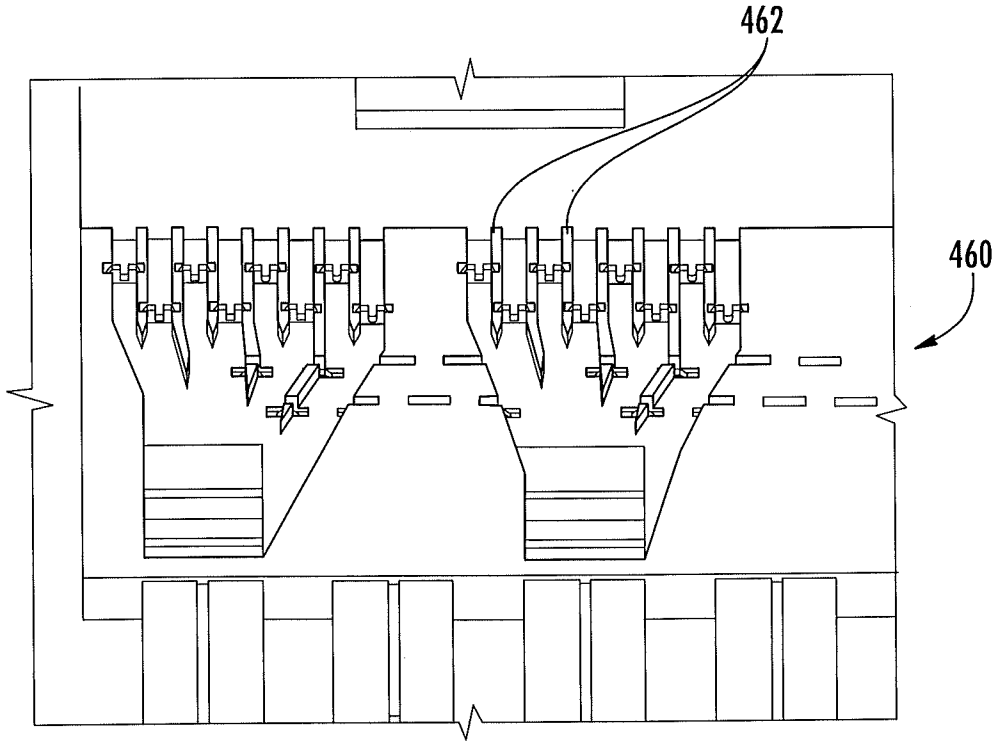

FIG. 21

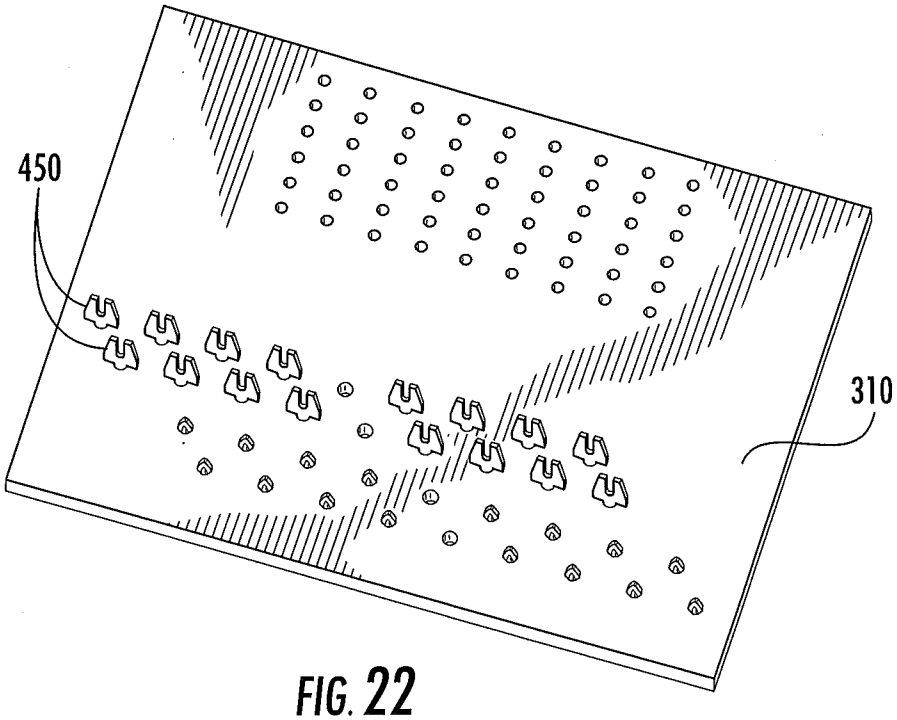

FIG. 22

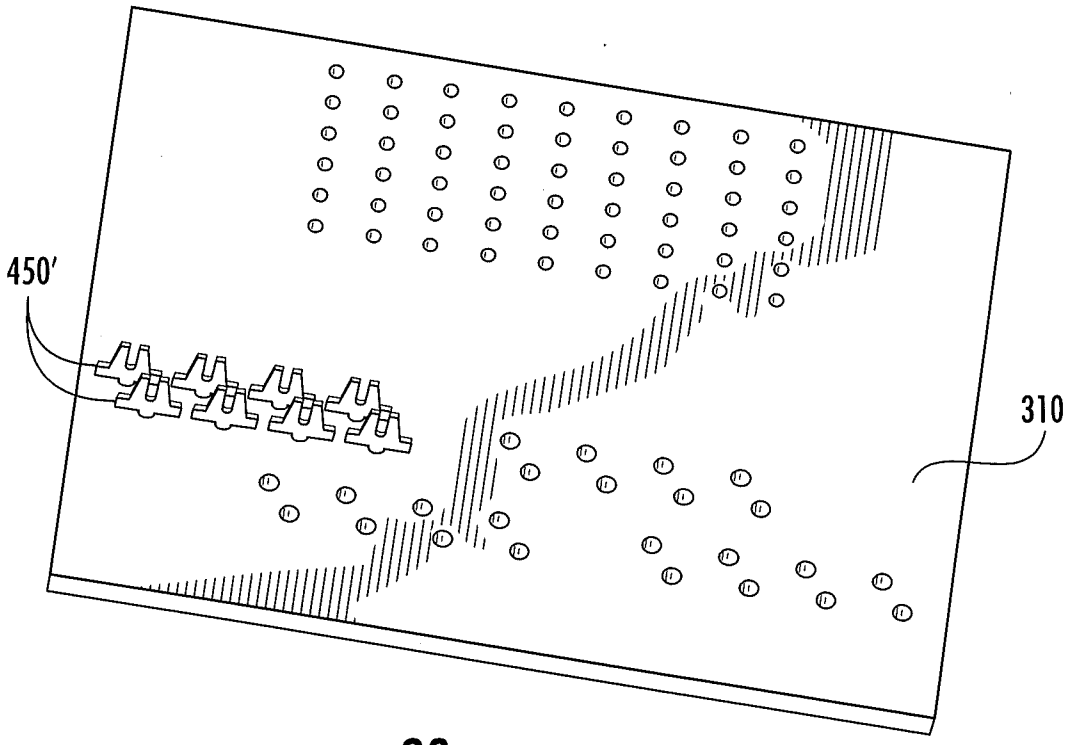

FIG. 23

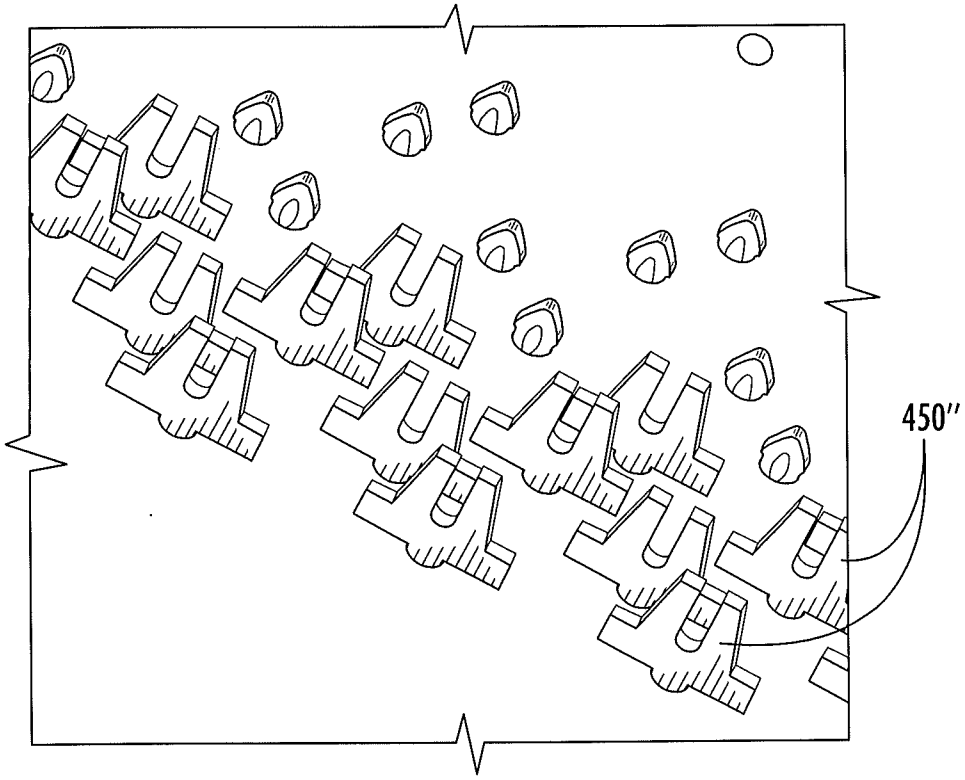

FIG. 24

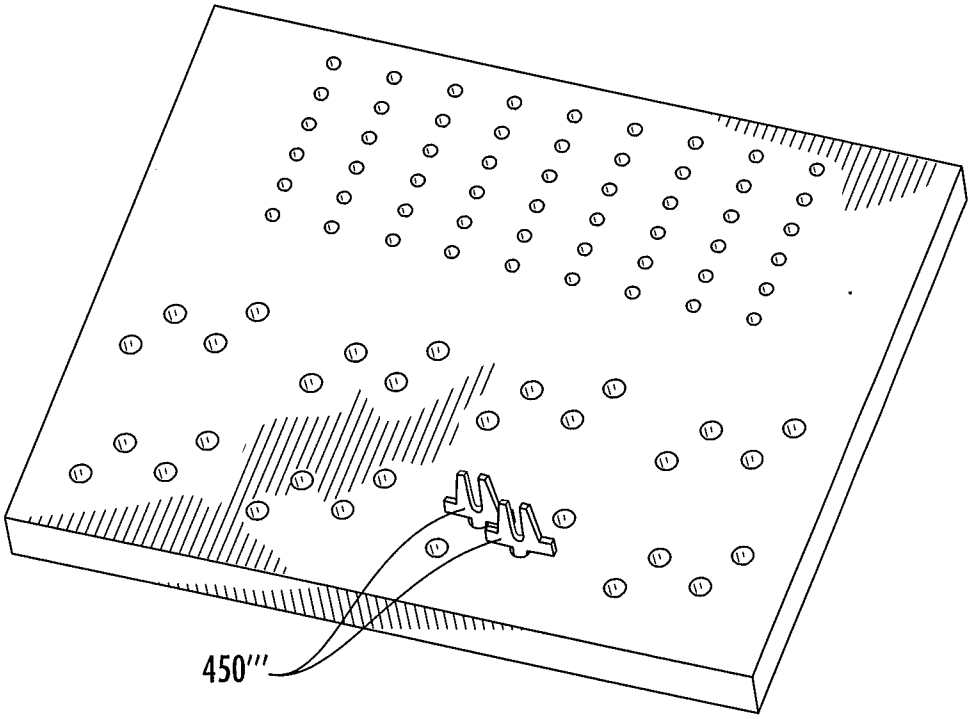

FIG. 25

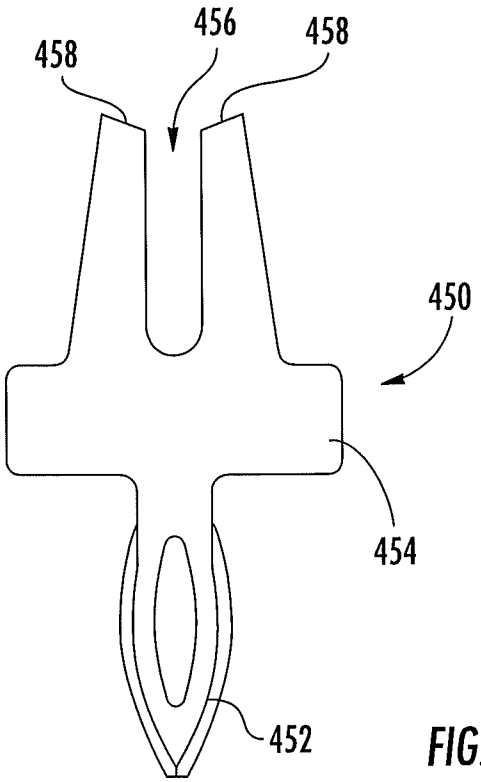

FIG. 26

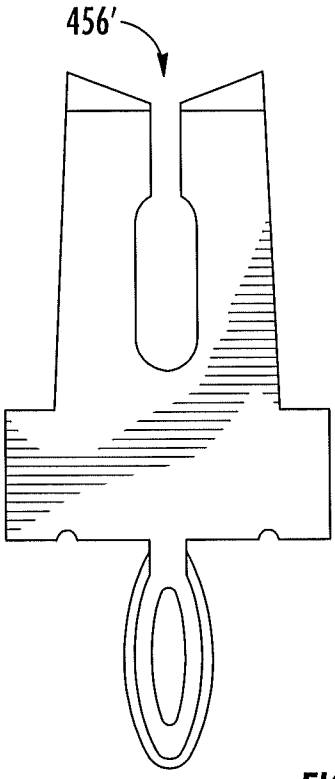

FIG. 27

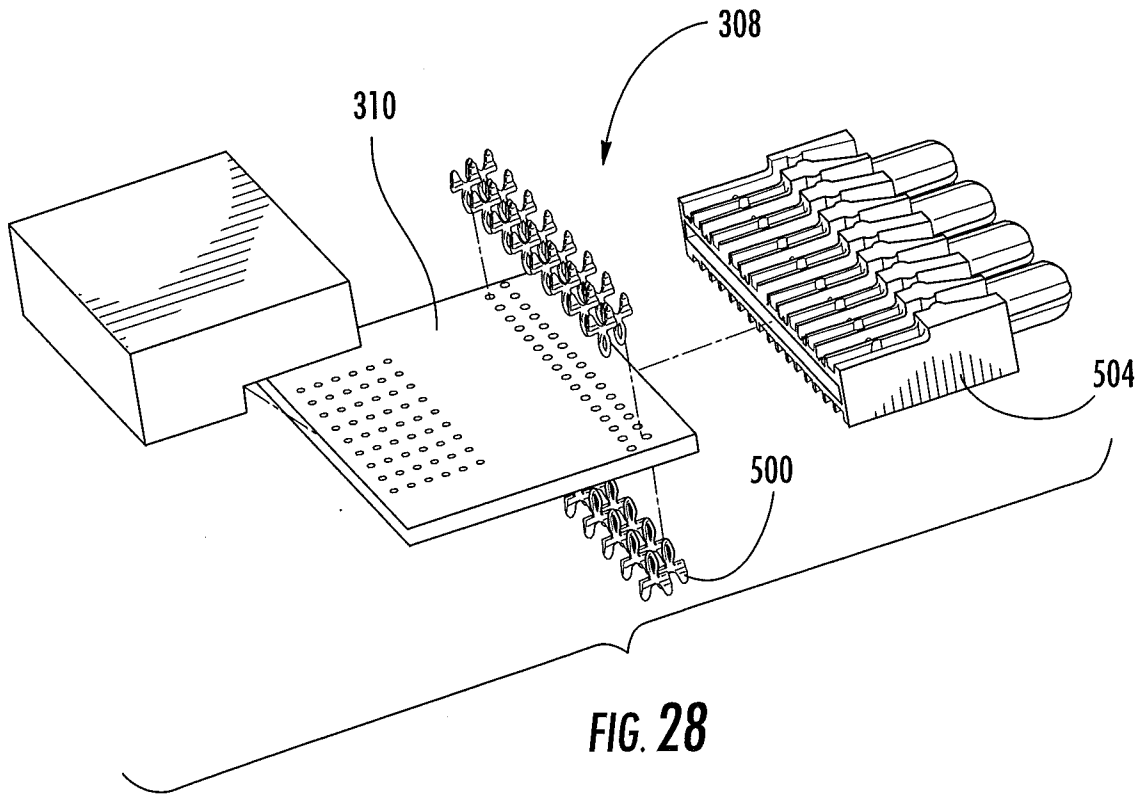

FIG. 28

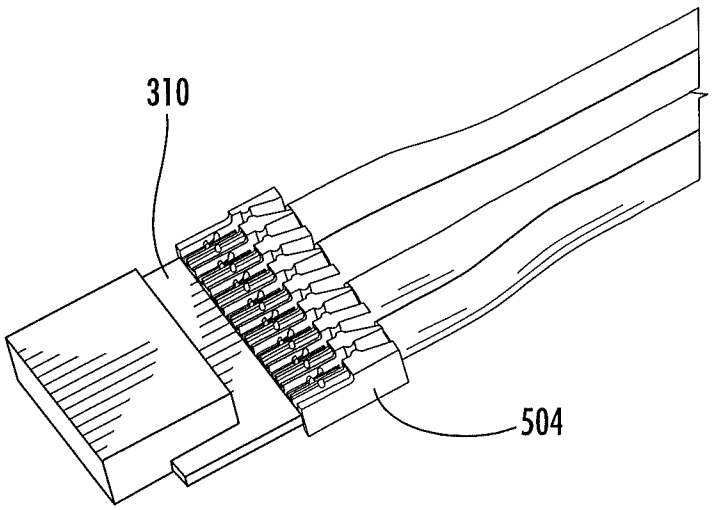

FIG. 29

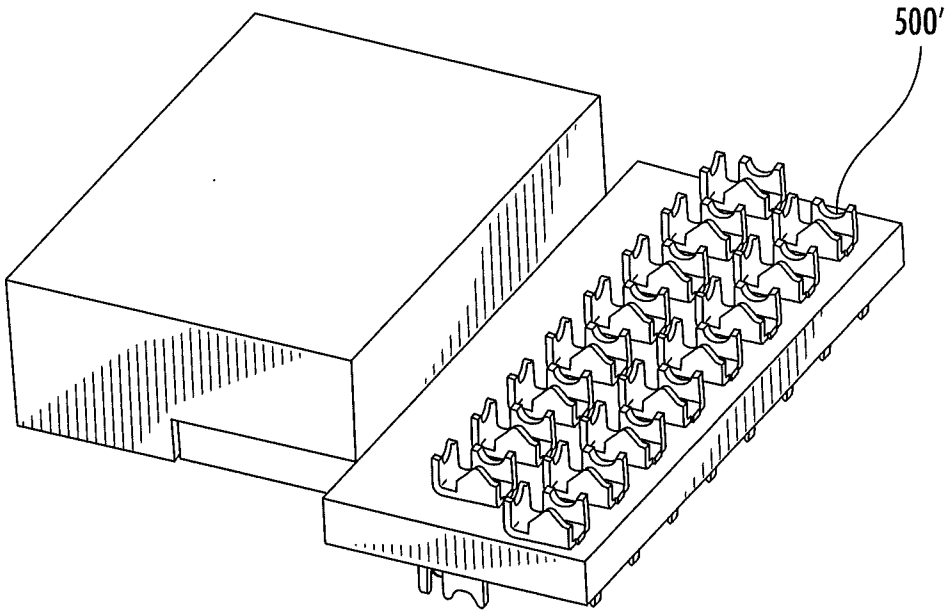

FIG. 30

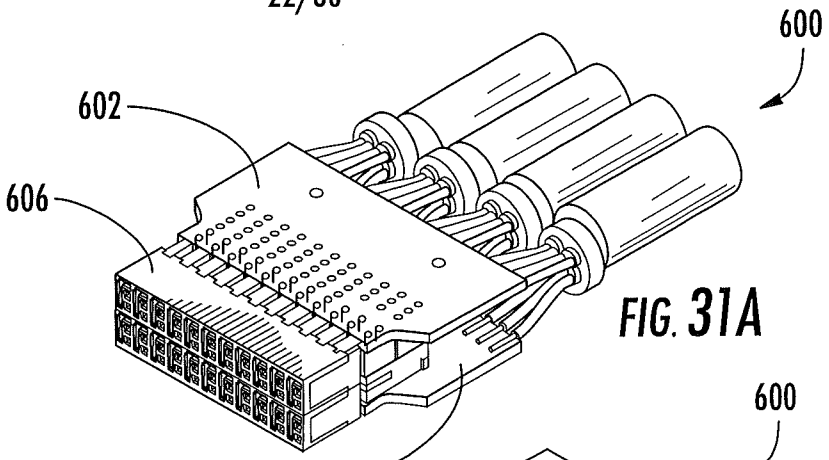

FIG. 31A

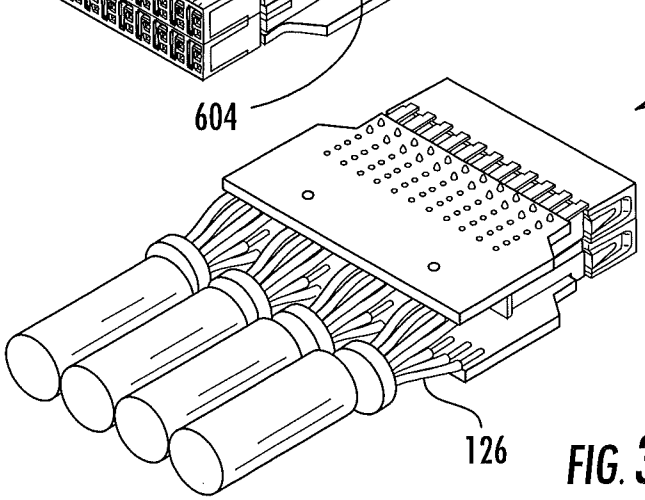

FIG. 31B

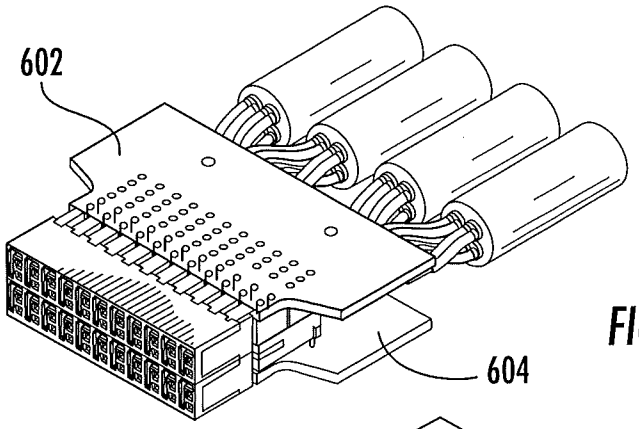

FIG. 32A

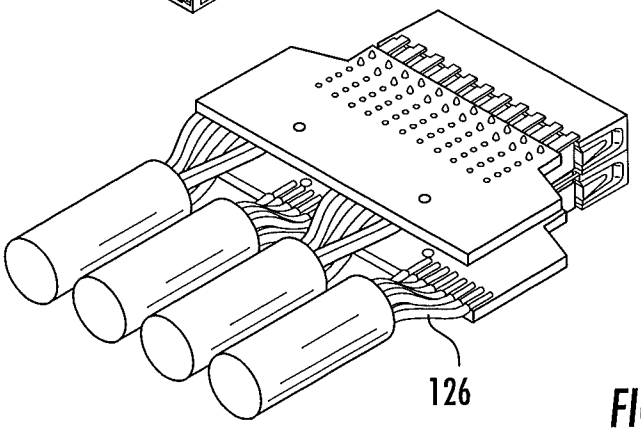

FIG. 32B

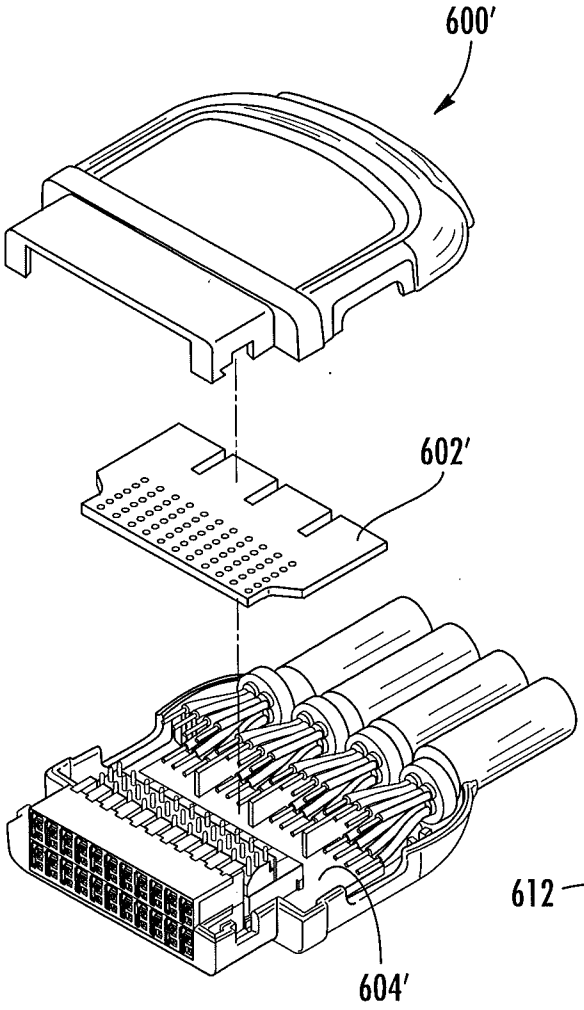

FIG. 33A

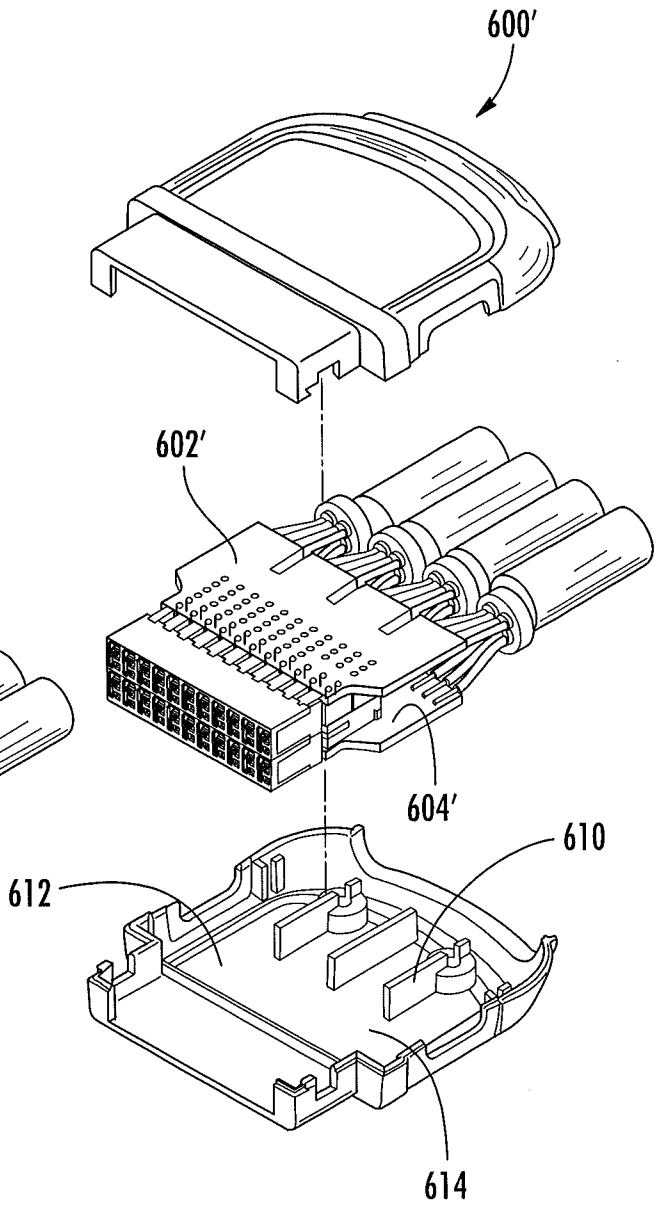

FIG. 33B

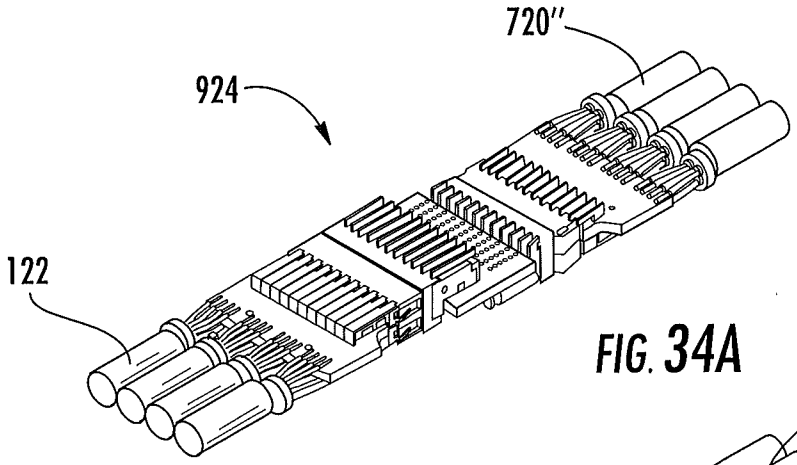

FIG. 34A

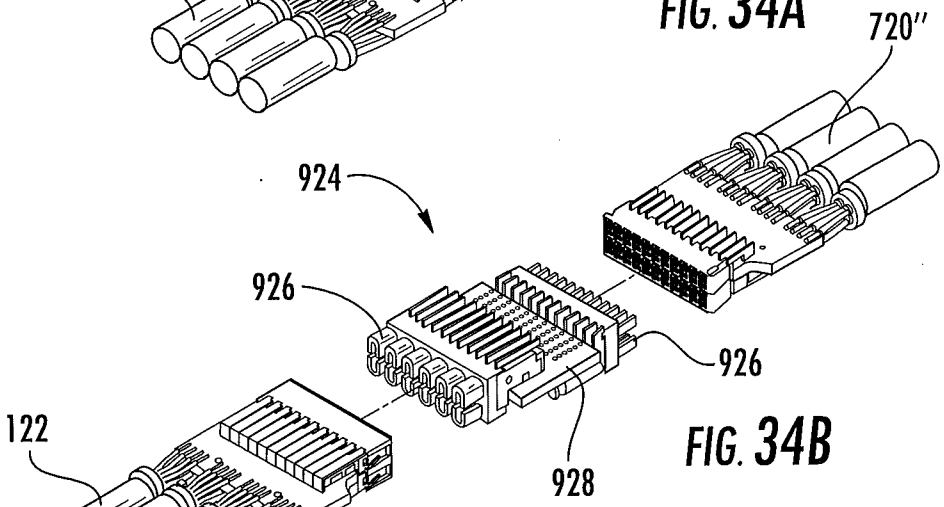

FIG. 34B

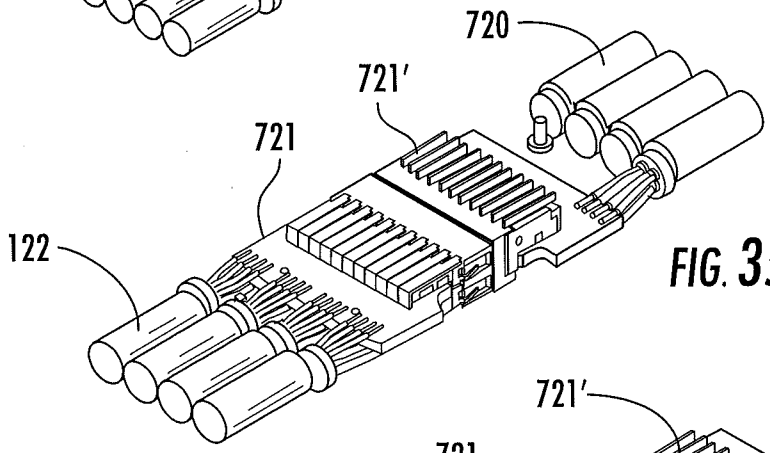

FIG. 35A

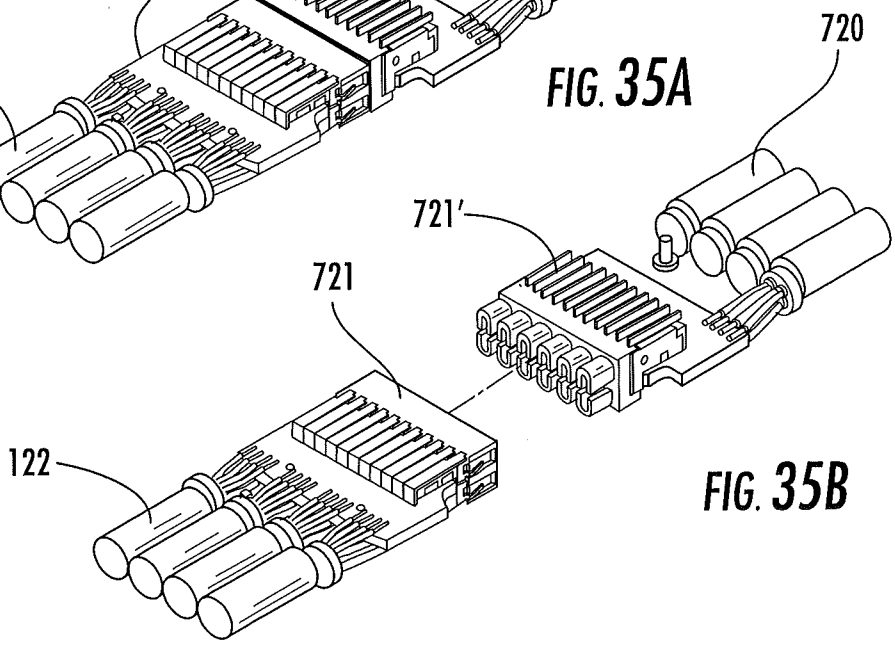

FIG. 35B

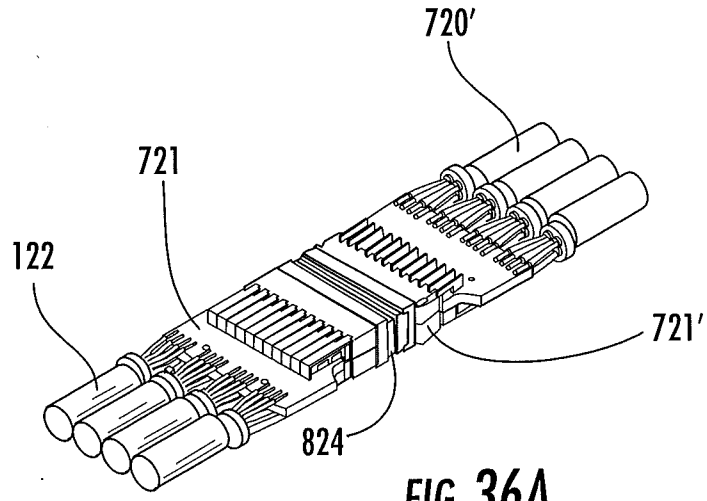

FIG. 36A

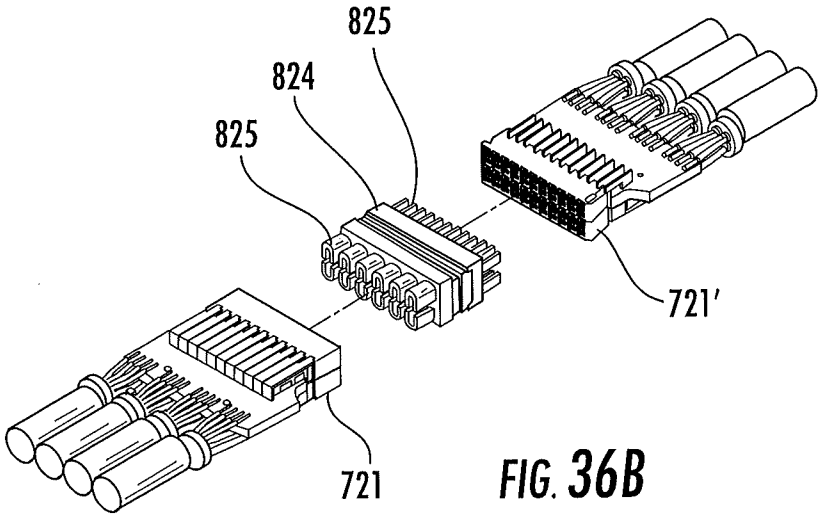

FIG. 36B

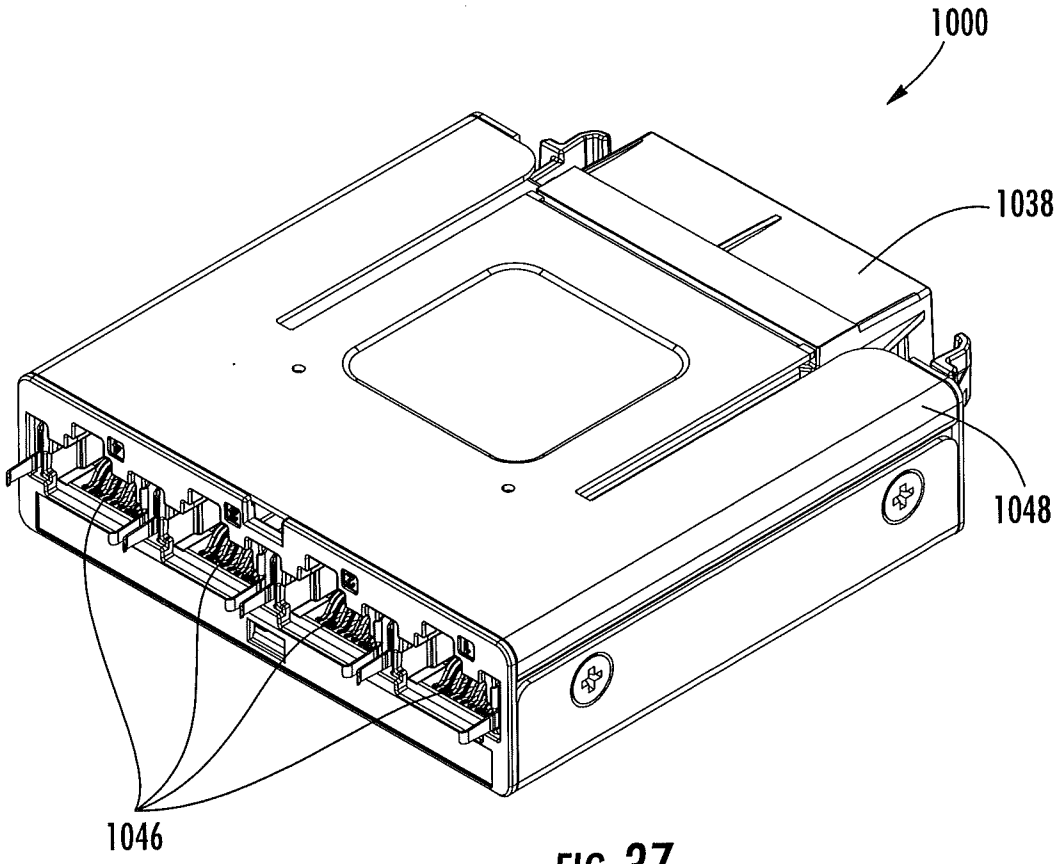

FIG. 37

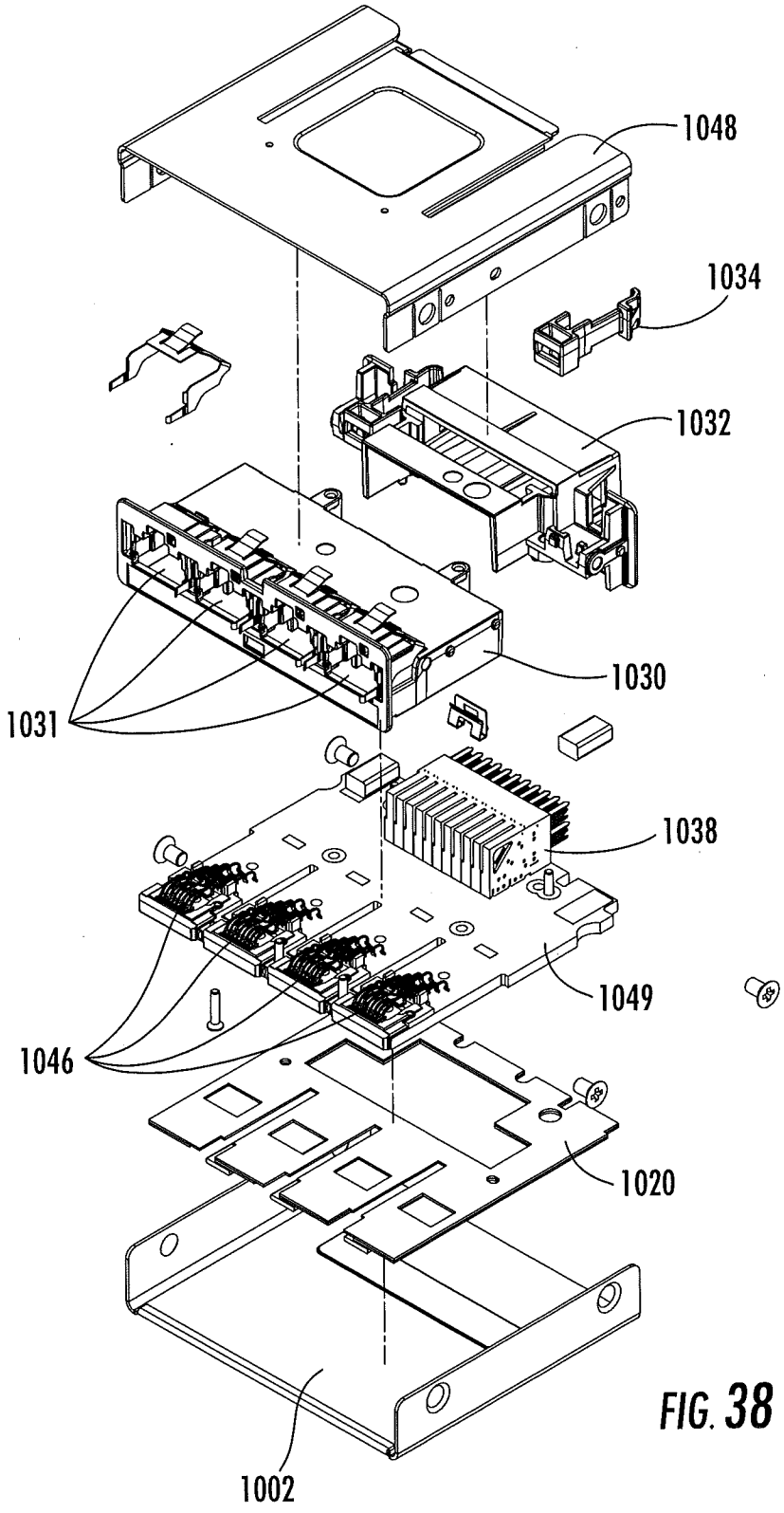

FIG. 38

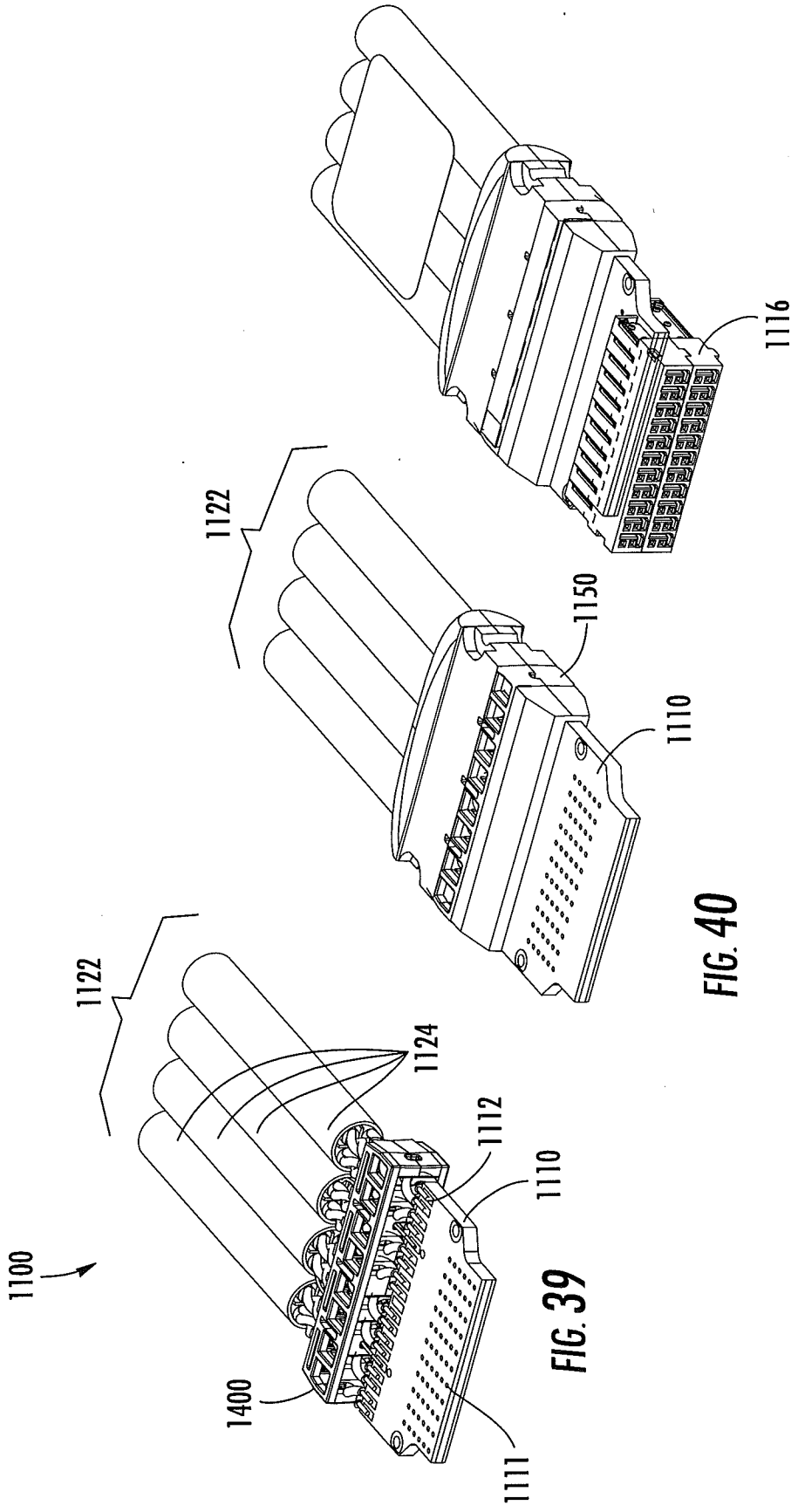

FIG. 39

FIG. 40

FIG. 41

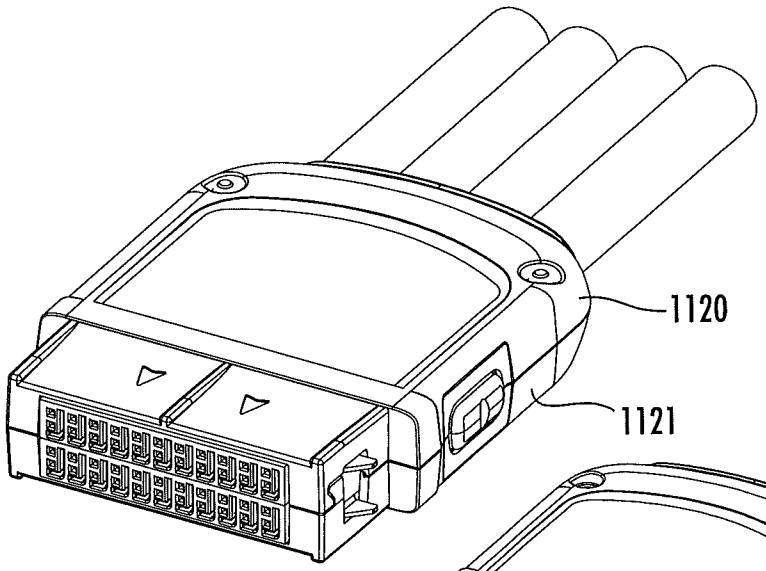

FIG. 42

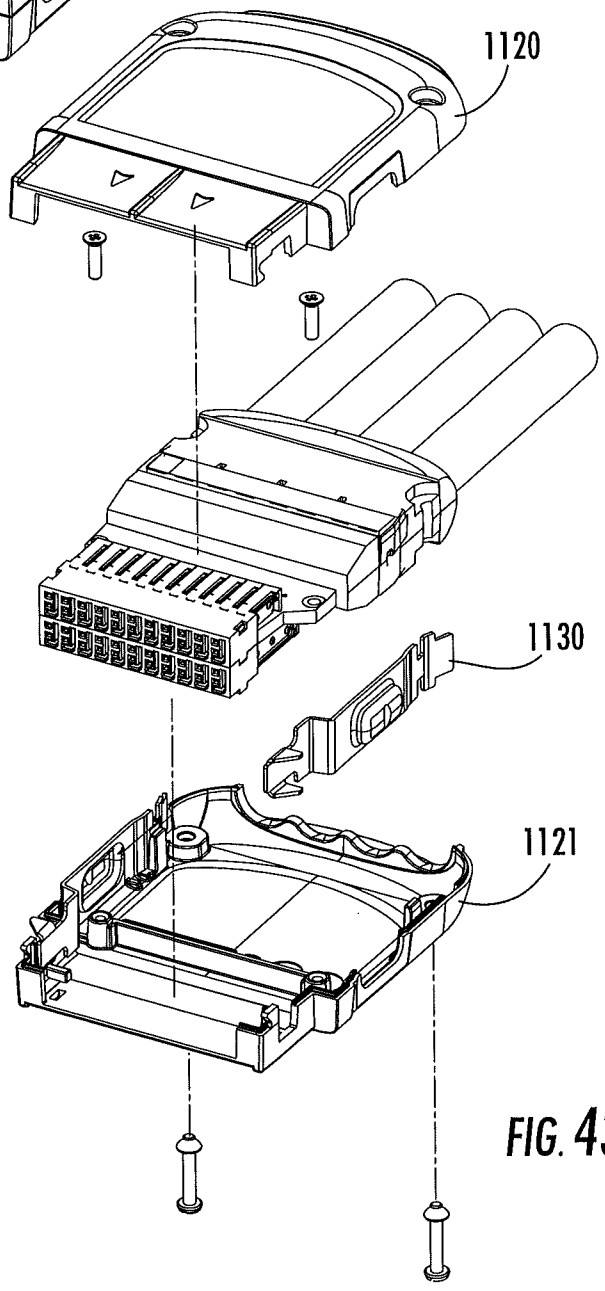

FIG. 43

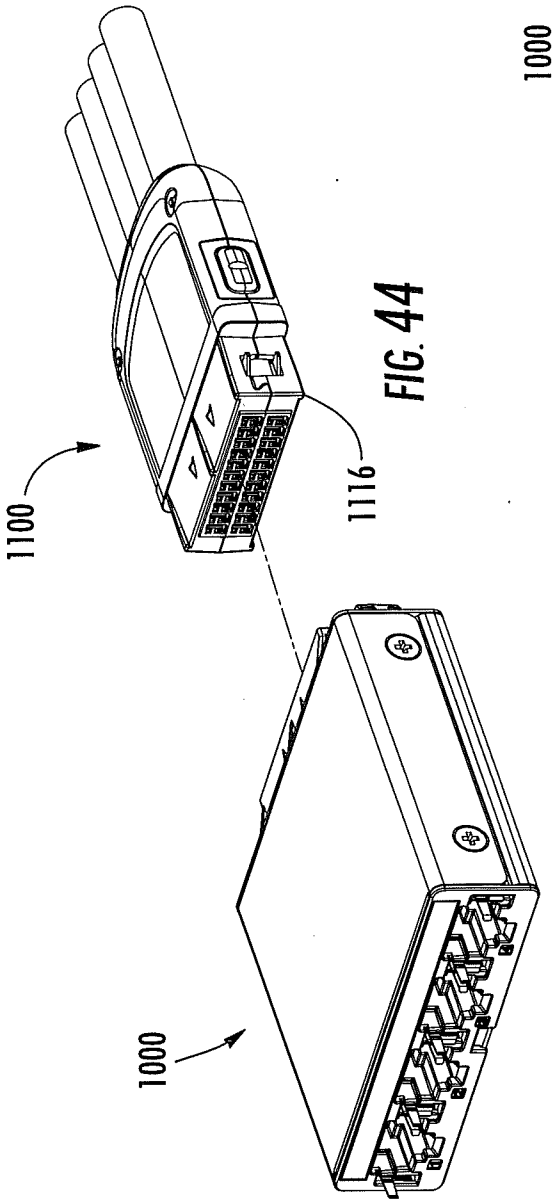

FIG. 44

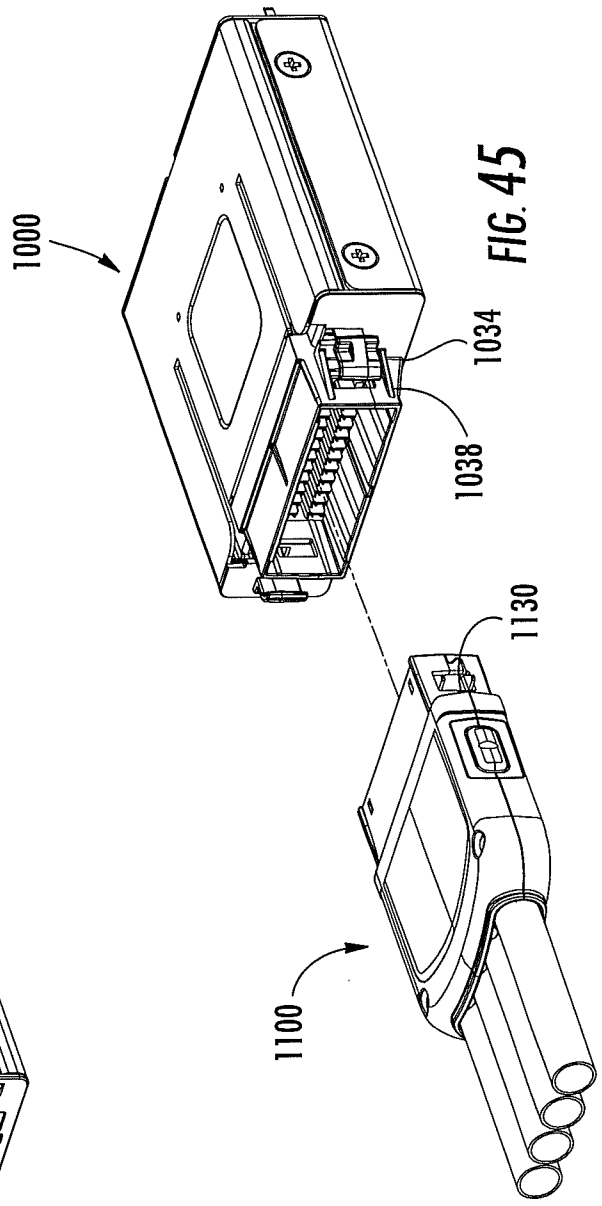

FIG. 45

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/041554

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R9/03
ADD.

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

B. FIELDS SEARCHED

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/046569 A1 (KONDOU TAKAHIRO [JP] ET AL) 2 March 2006 (2006-03-02)	1-4, 6-12,14, 33
Y	paragraph [0008] - paragraph [0011] paragraph [0040] - paragraph [0047] figures 2A-5, 8-11	5,13, 15-18,32
Y	FR 2 768 862 A1 (INFRA SA [FR]) 26 March 1999 (1999-03-26) page 8, line 15 - line 30 figures 1, 2	5,13
Y	US 6 302 742 B1 (BERST JOHN RAY [US] ET AL) 16 October 2001 (2001-10-16) the whole document	15-18,32

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 2011	21/11/2011

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/041554

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2010/123958 A1 (COMMSCOPE INC [US]; MEI RICHARD [US]; MACAULEY DANIEL WARREN [US]; GER) 28 October 2010 (2010-10-28) the whole document	15
Y	EP 2 034 565 A2 (ADC GMBH [DE]) 11 March 2009 (2009-03-11) paragraph [0013] figure 2	15-18,32

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/041554

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

1-18, 32, 33

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7, 33

A cable-connector assembly, comprising:
- a cable comprising a plurality of subunits comprising a plurality of twisted pairs of conductors;
- a printed circuit board, the conductors being attached thereto;
- a single connector mounted on the printed circuit board and electrically connected to the conductors.

---

2. claims: 8-14

A cable-connector assembly, comprising:
- a cable comprising a plurality of subunits comprising a plurality of twisted pairs of conductors;
- the cable subunits arranged in a side-by-side relationship;
- a single connector mounted electrically connected to the conductors.

---

3. claims: 15-18, 32

A combination comprising:
(a) a datacommunications module, comprising:
- a plurality of datacommunications jacks;
- a printed circuit board;
- the jacks mounted the printed circuit board;
- a plurality of elongate contacts electrically connected with the jacks; and
(b) a cable-connector assembly comprising:
- a cable comprising a plurality of subunit comprising a plurality of twisted pairs of conductors,
- a connector mounted to the printed circuit board and elctrically connected to the conductors; and
the module connector is attached to the cable connector.

---

4. claims: 19-23

A cable-connector assembly, comprising:
- a cable comprising a plurality of subunits comprising a plurality of twisted pairs of conductors;
- a connector including a plurality of elongate contacts,
- each of the contacts having a contact end and an open loop at an opposite end; and
- a plurality of transition elements connecting each of the conductors with its respective contact,
- each of the transition elements including a first end adapted to receive and connect to with a conductor and a second end adapted to receive and connect to the open loop

of a contact.

---

5. claims: 24, 25

A datacommunications cable assembly, comprising:
- a cable comprising a plurality of subunits comprising a plurality of twisted pairs of conductors; and
- a cable subunit adapter comprising:
- four cable receiving channels including a longitudinal axis that is offset from the longitudinal axes of its neighboring receiving channels in both X and Y directions; and
- guides positioned below each receiving channel, configured to separate each of the twisted pairs of the cable subunit from the other twisted pairs of the cable subunit.

---

6. claims: 26-31

A datacommunications cable assembly, comprising:
- a cable comprising a plurality of subunits comprising a plurality of twisted pairs of conductors; and
- a printed circuit board having at least one edge, the edge including a plurality of open-ended recesses;
- each of the conductors of the cable is received in one of the open-ended recesses.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/041554

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006046569 A1	02-03-2006	JP 4421427 B2	24-02-2010
		JP 2006073269 A	16-03-2006
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