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(54) **HIGH SPEED BYPASS CABLE ASSEMBLY**

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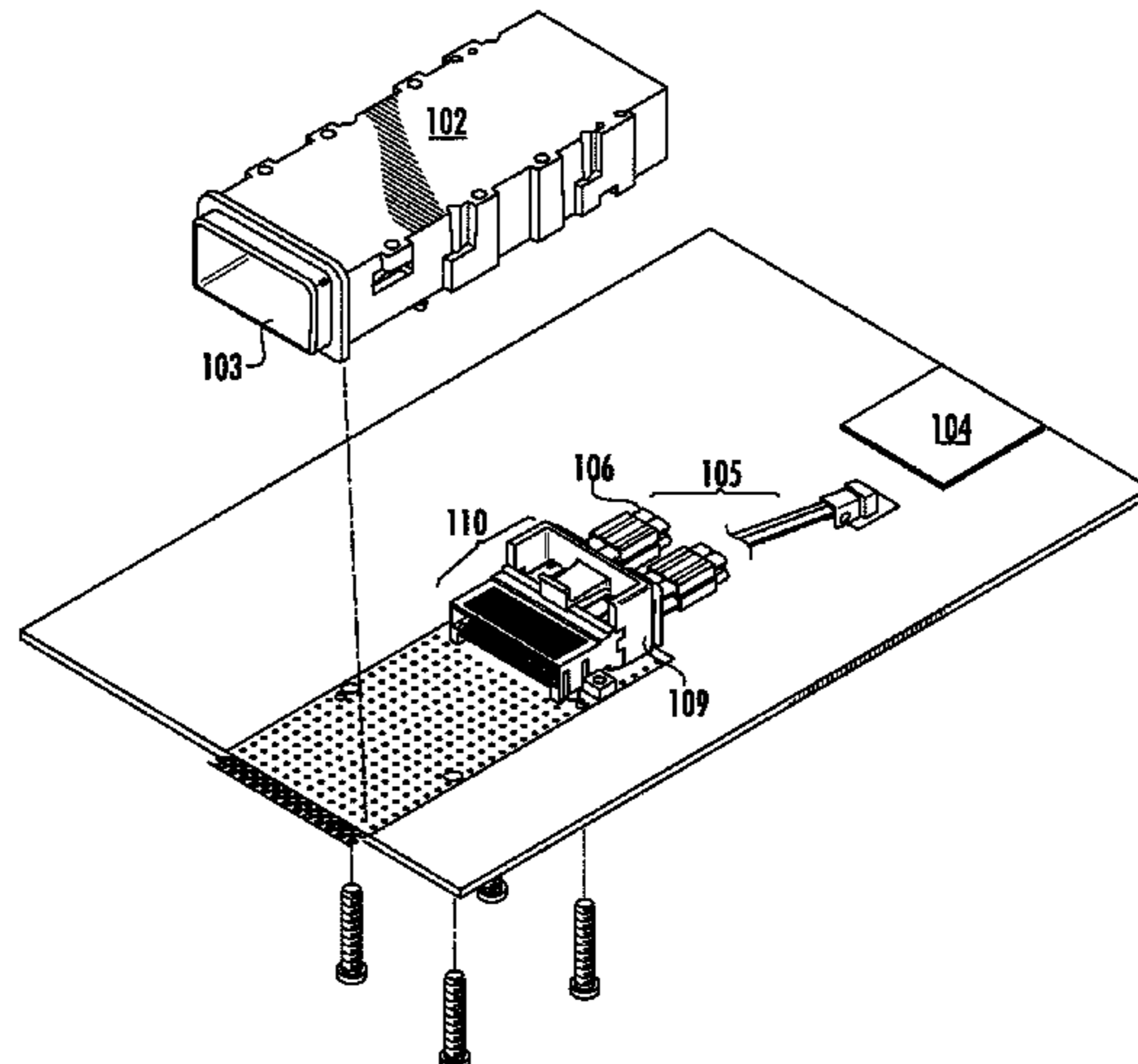
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(57) **ABSTRACT**

A cable bypass assembly is disclosed for use in providing a high speed transmission line for connecting a [board mounted] connector of an electronic device to a chip on the device board. The bypass cable assembly has a structure that permits it, where it is terminated to the [board mounted] connector and the chip member, or closely proximate thereto, to replicate closely the geometry of the cable. The connector terminals are arranged in alignment with the cable signal conductors and shield extensions are provided so that shielding can be provided up to and over the termination between the cable signal conductors and the board connector terminal tails. Likewise, a similar termination structure is provided at the opposite end of the cable where a pair of
(Continued)



terminals are supported by a second connector body and enclosed in a shield collar. The shield collar has an extension that engages the second end of the cable], *to allow signals to be transmitted at greater than 10 GHz with substantially lower loss than a traditional FR4 circuit board.*

17 Claims, 23 Drawing Sheets

Related U.S. Application Data

application for the reissue of Pat. No. 9,011,177, which is a continuation-in-part of application No. PCT/US2010/022738, filed on Feb. 1, 2010.

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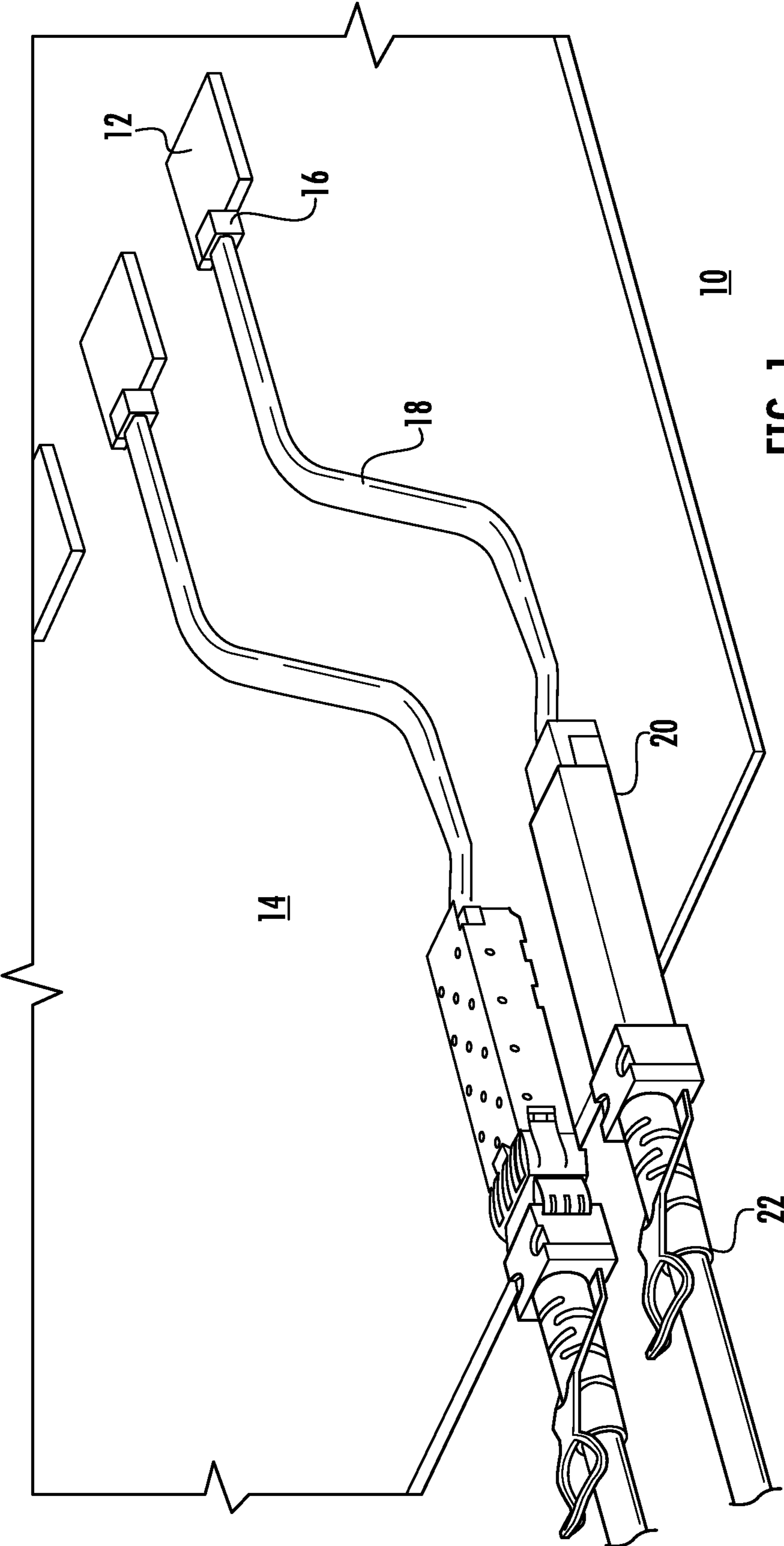
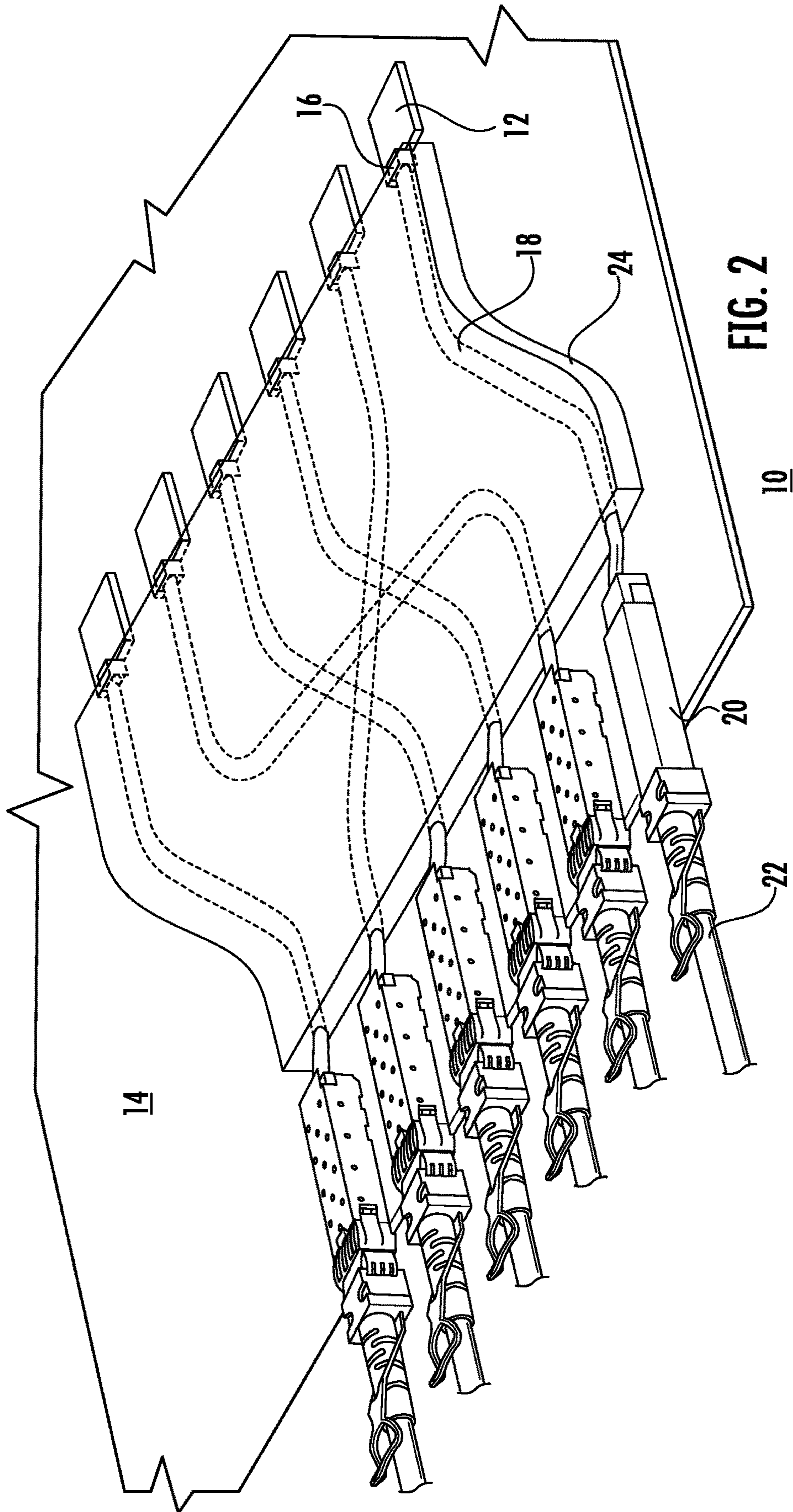


FIG. 1



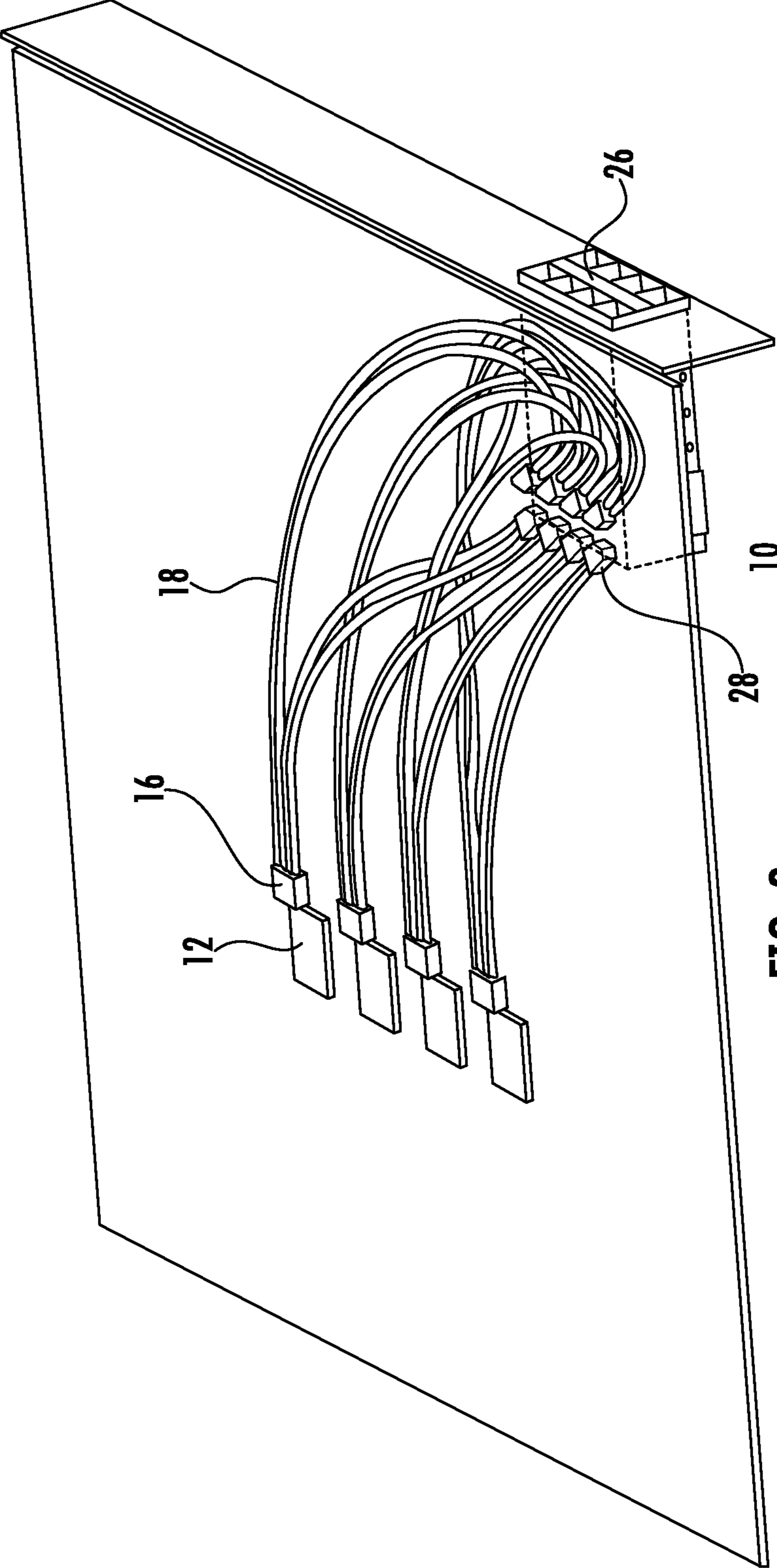
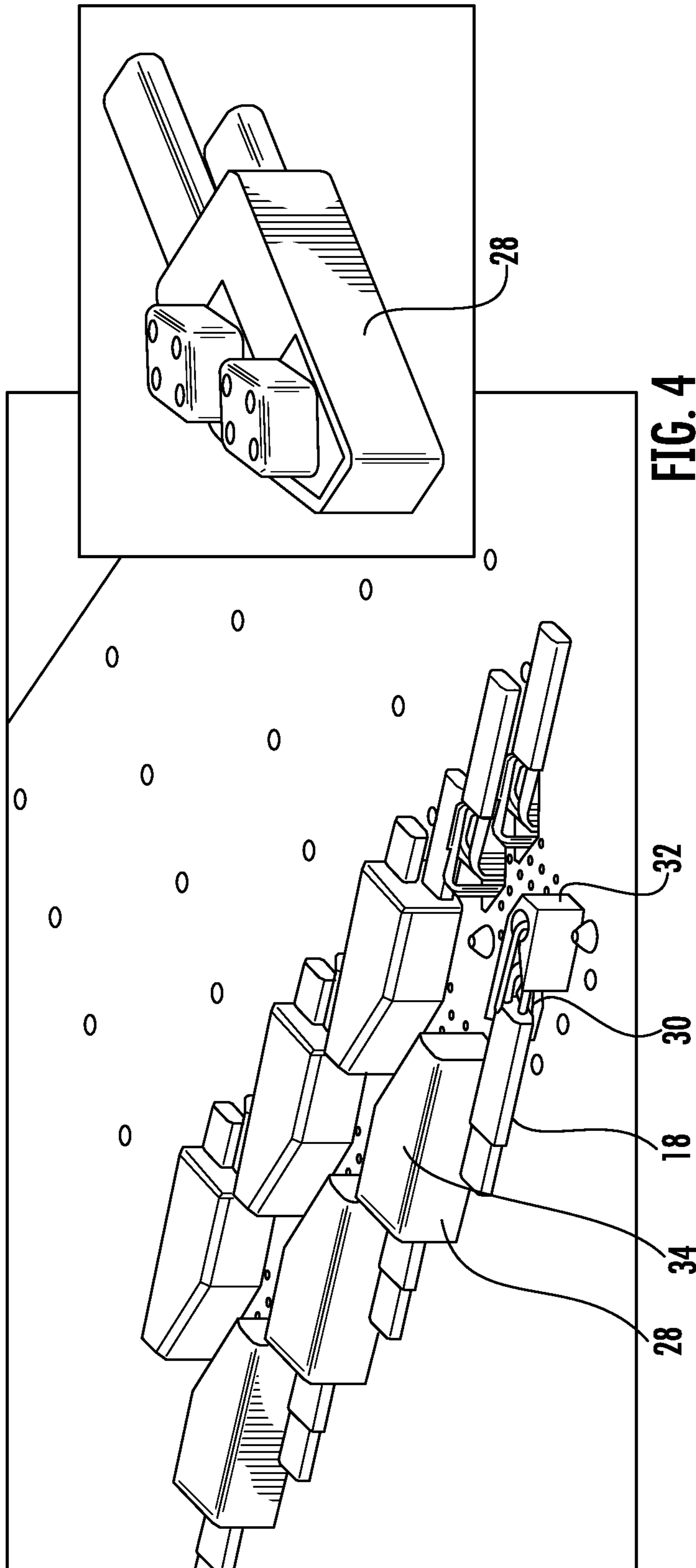


FIG. 3



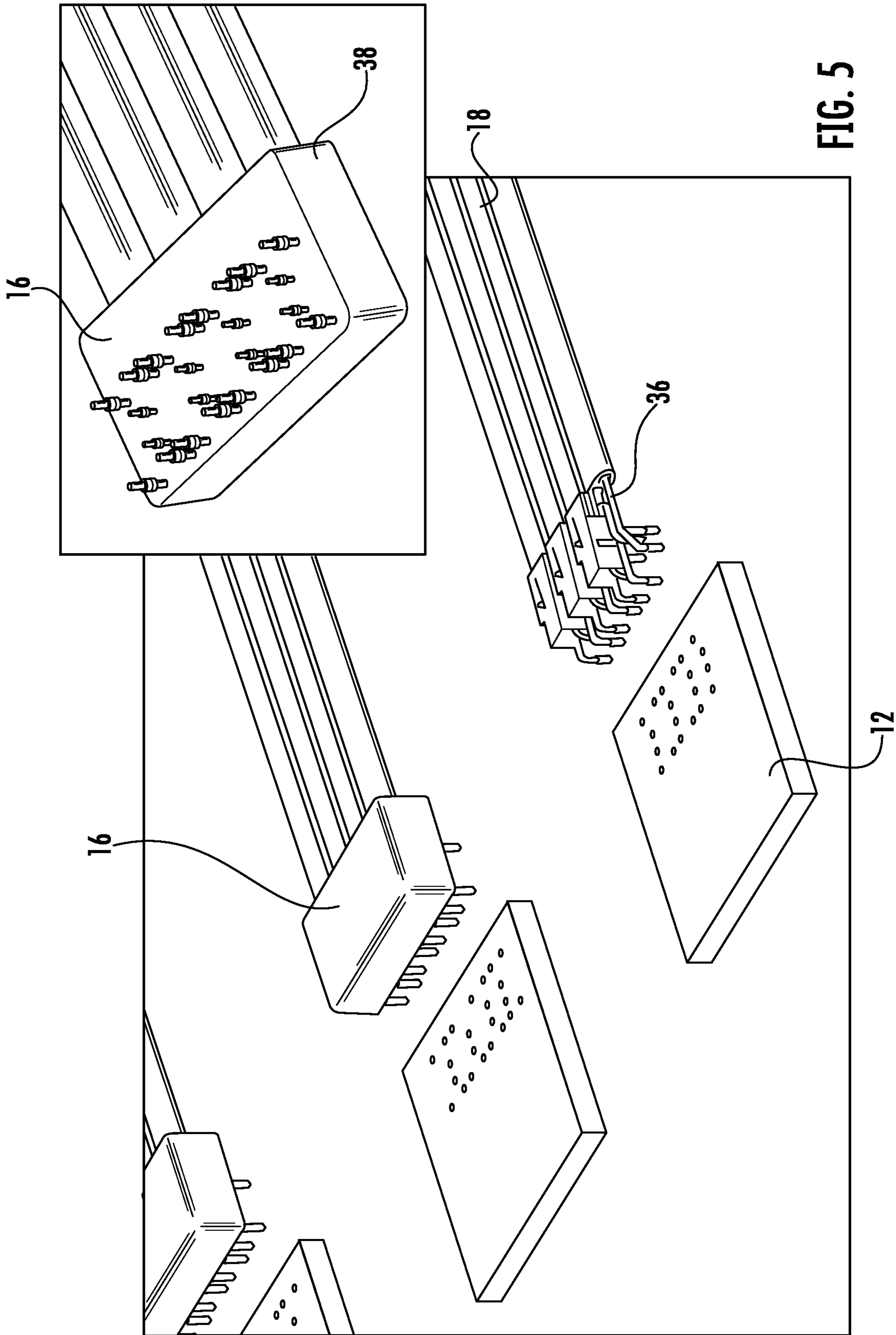


FIG. 5

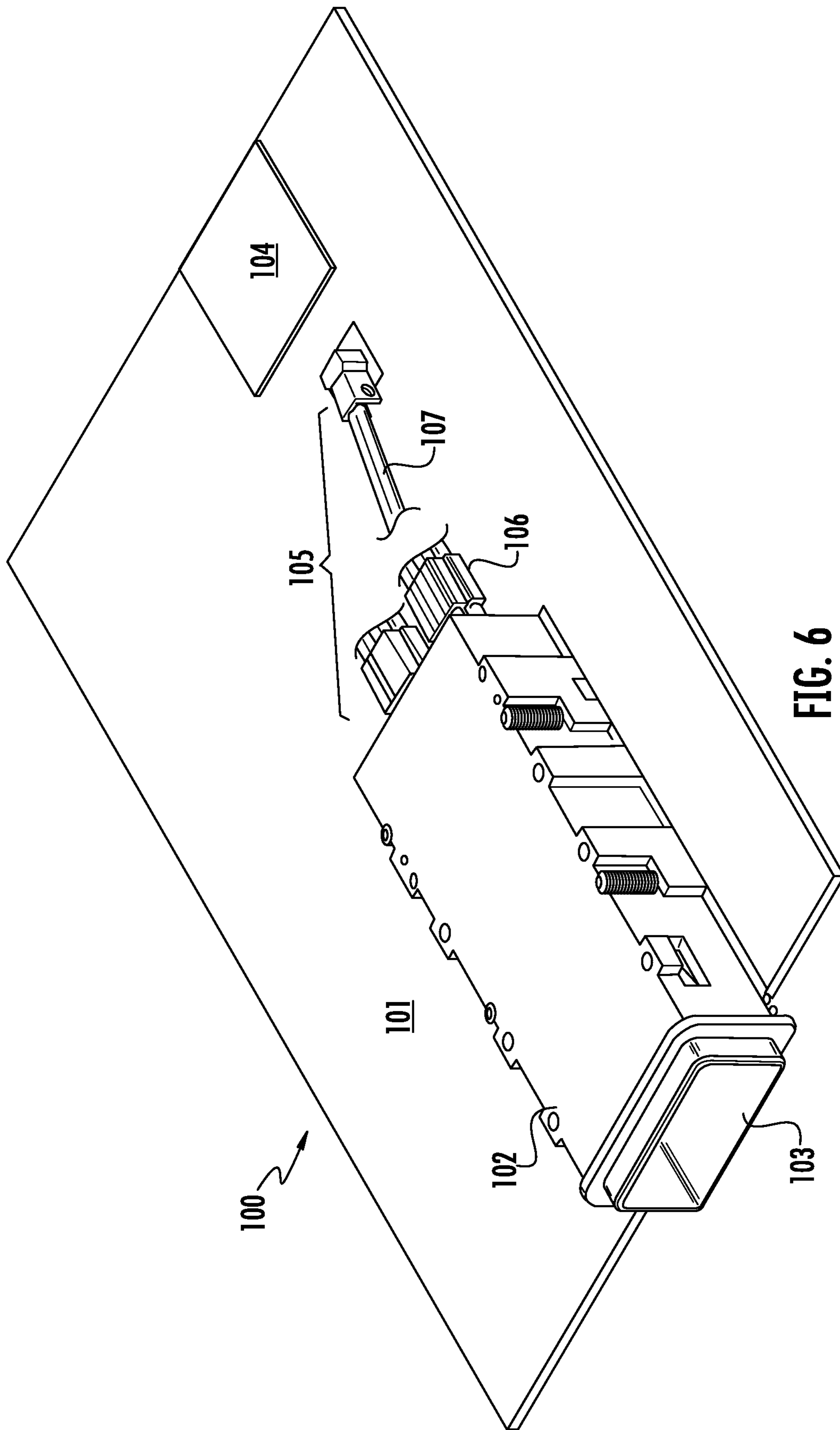


FIG. 6

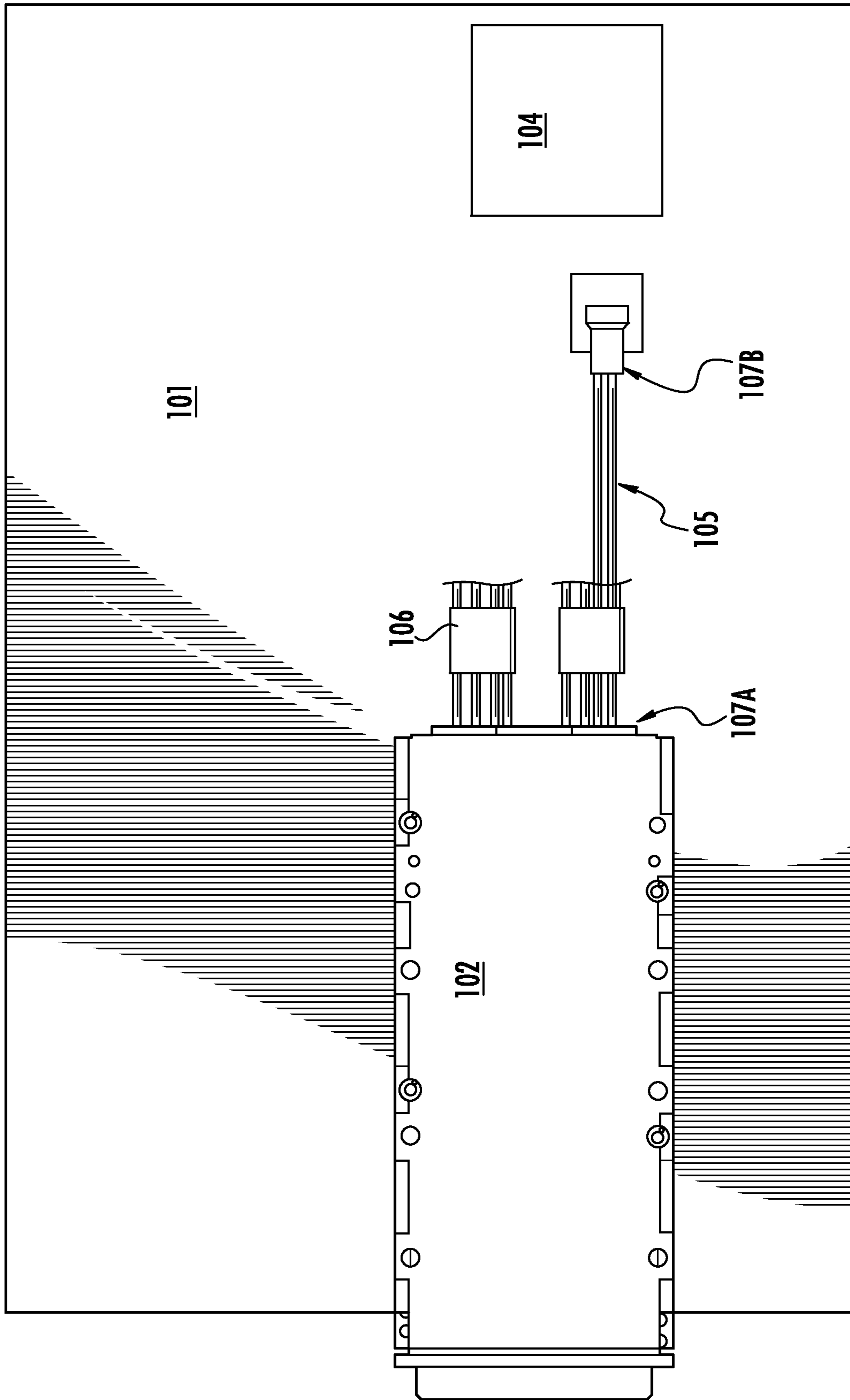


FIG. 7

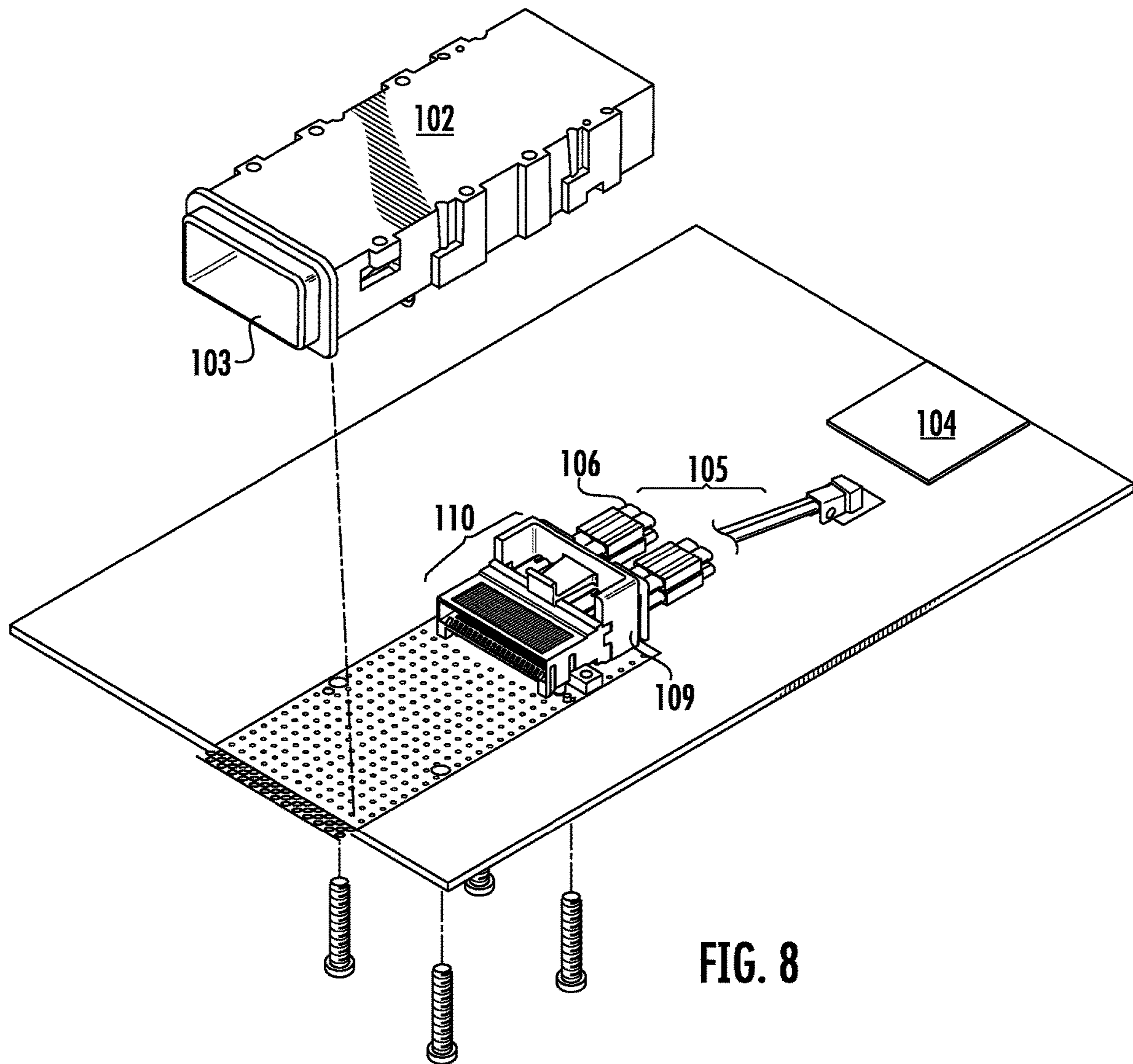


FIG. 8

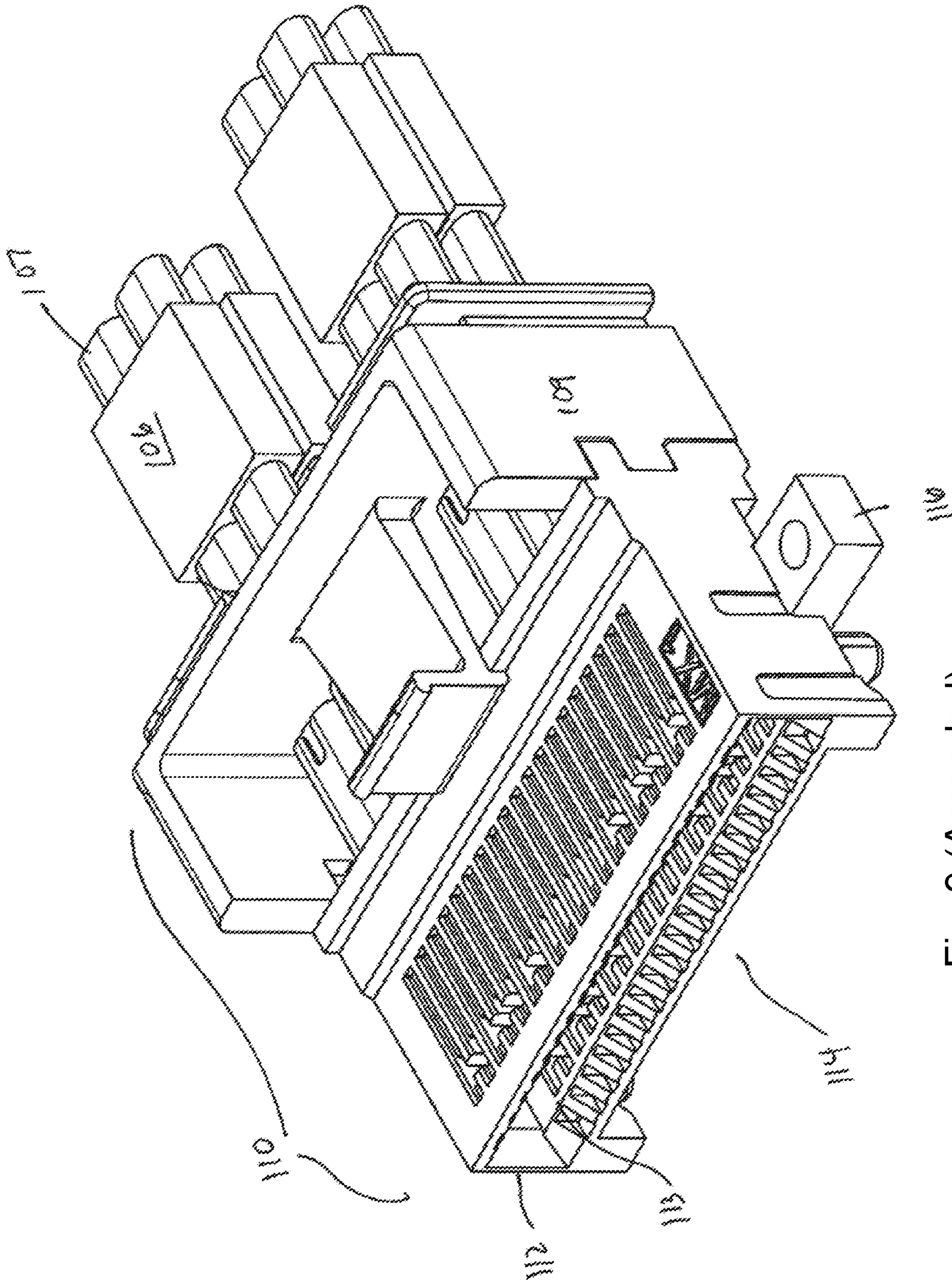


Fig 9 (Amended)

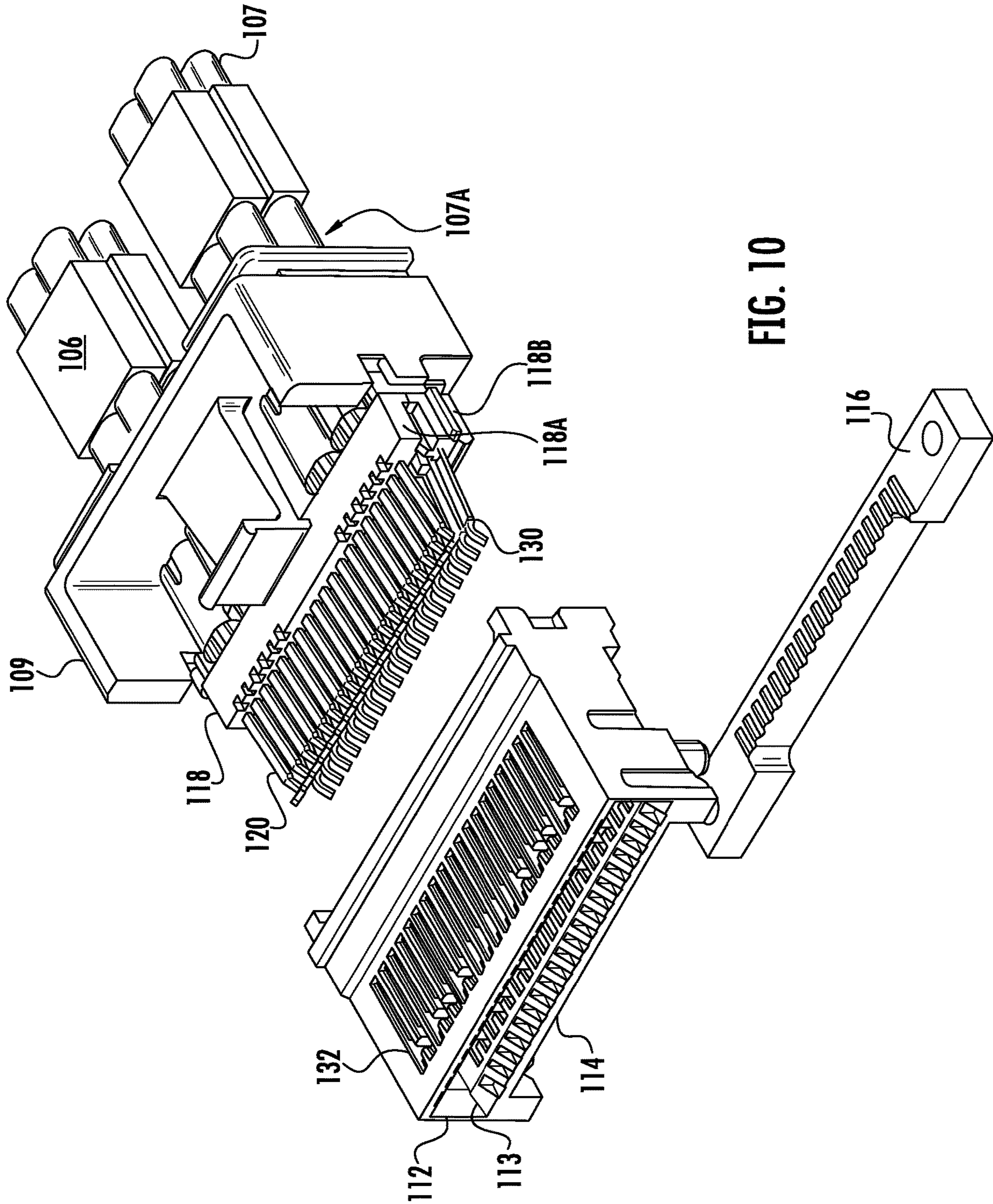


FIG. 10

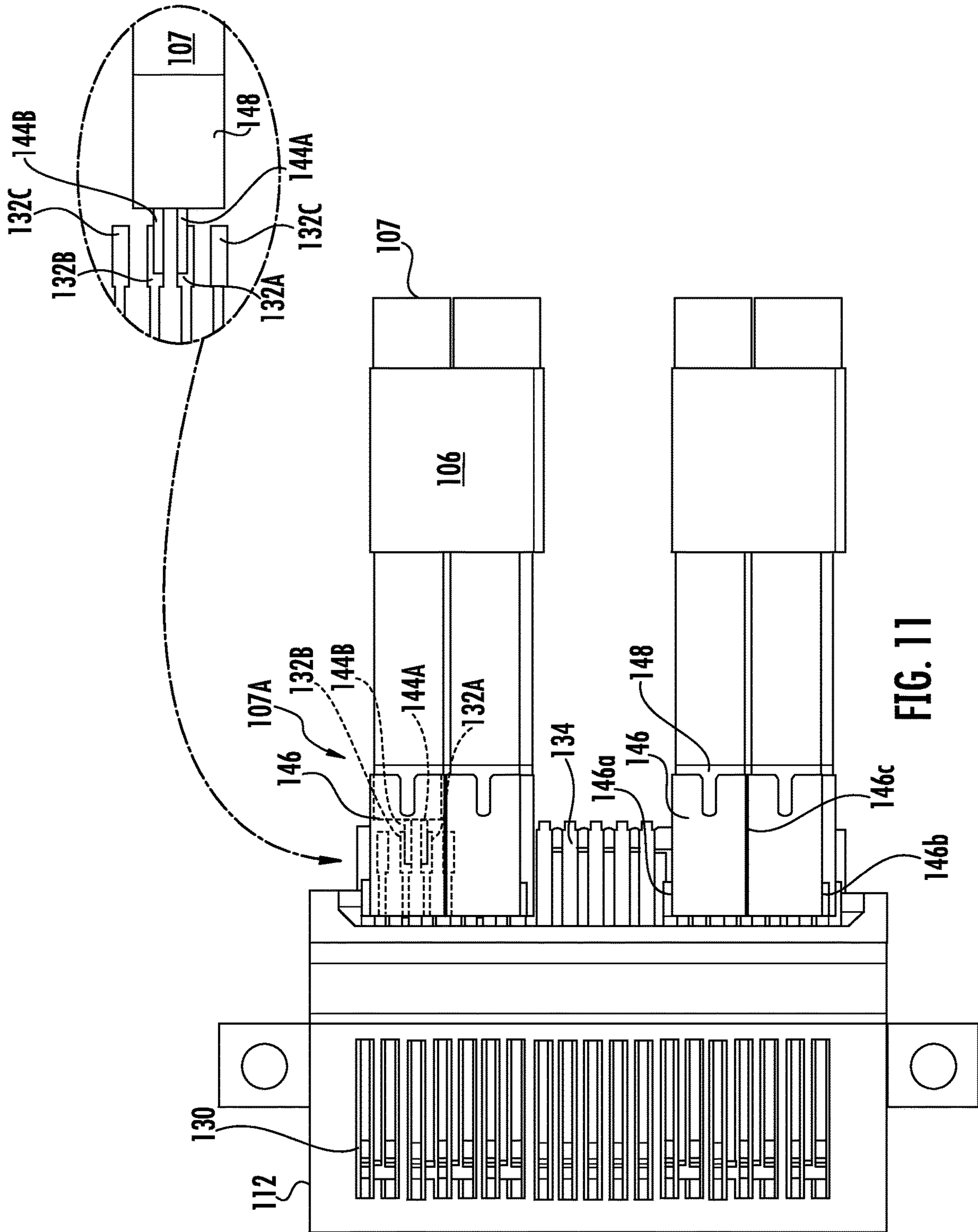


FIG. 11

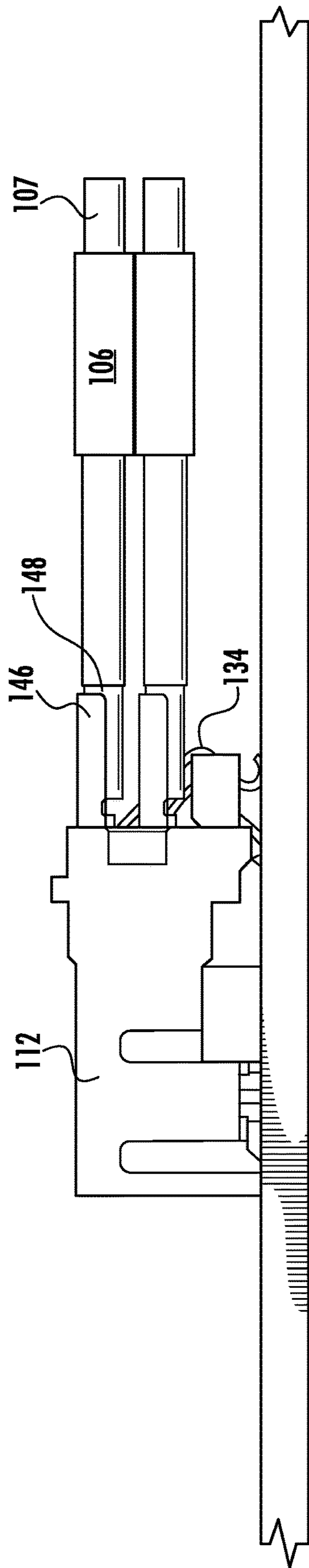


FIG. 11A

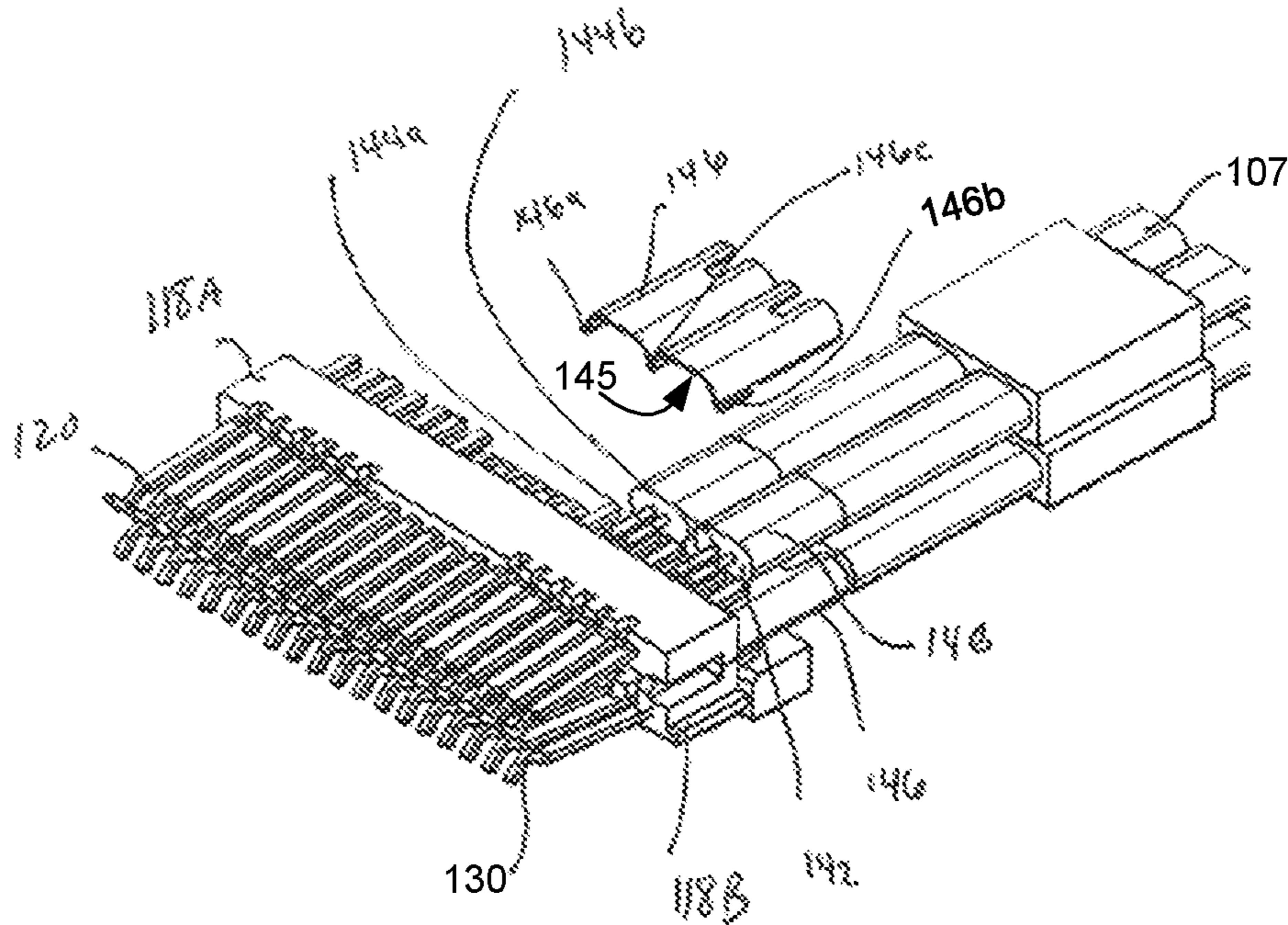


Fig. 12 (Amended)

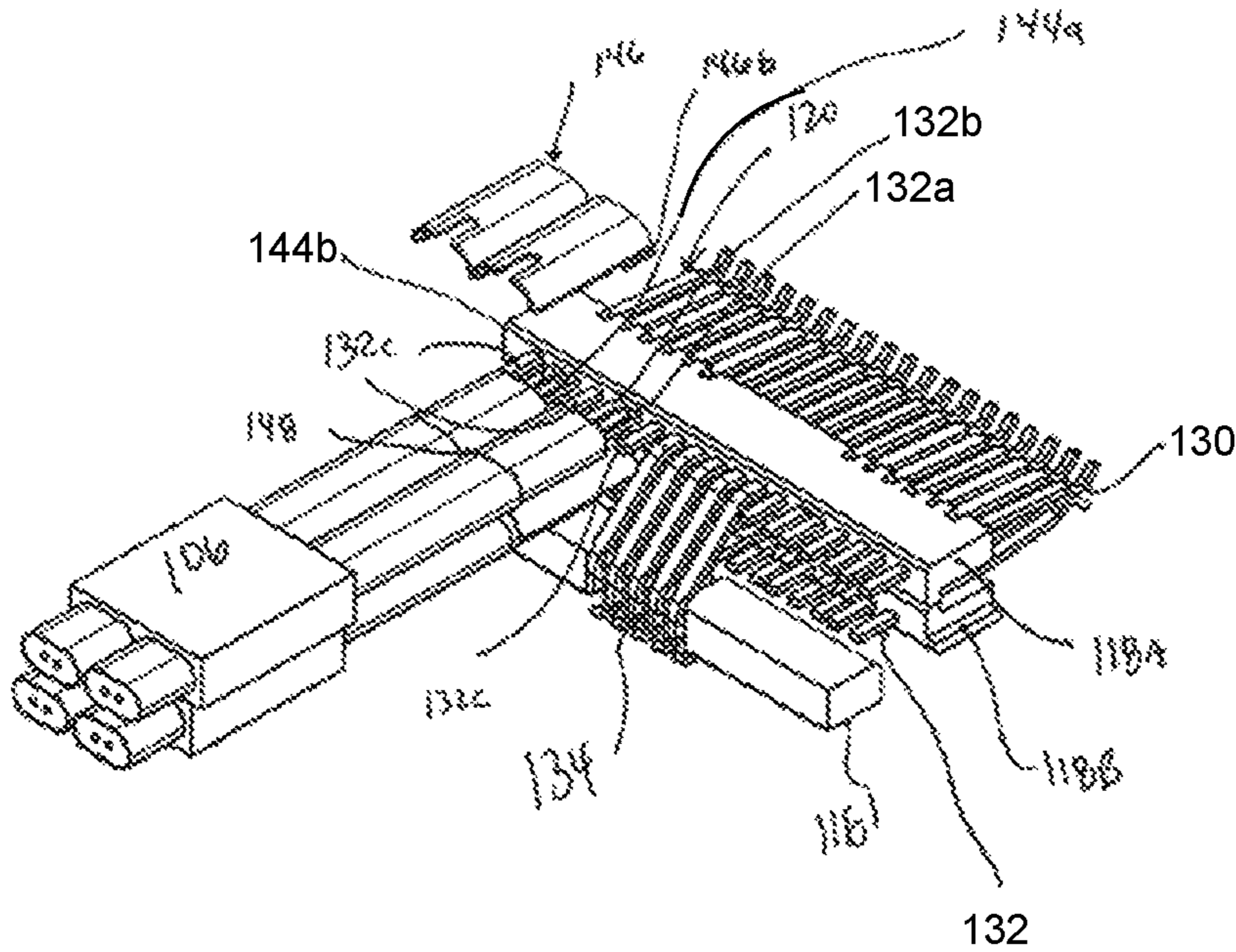


Fig. 12A (Amended)

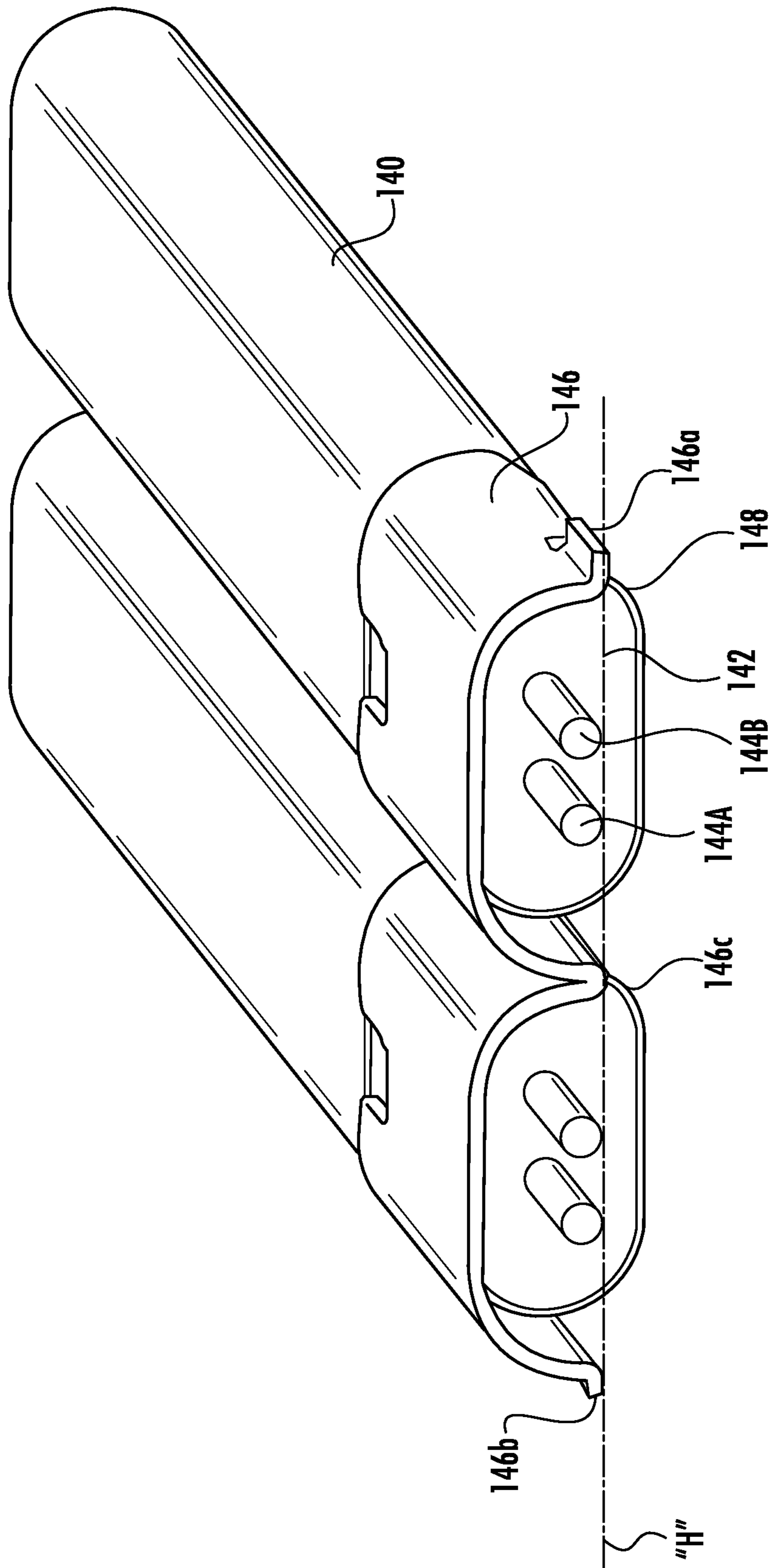


FIG. 12B

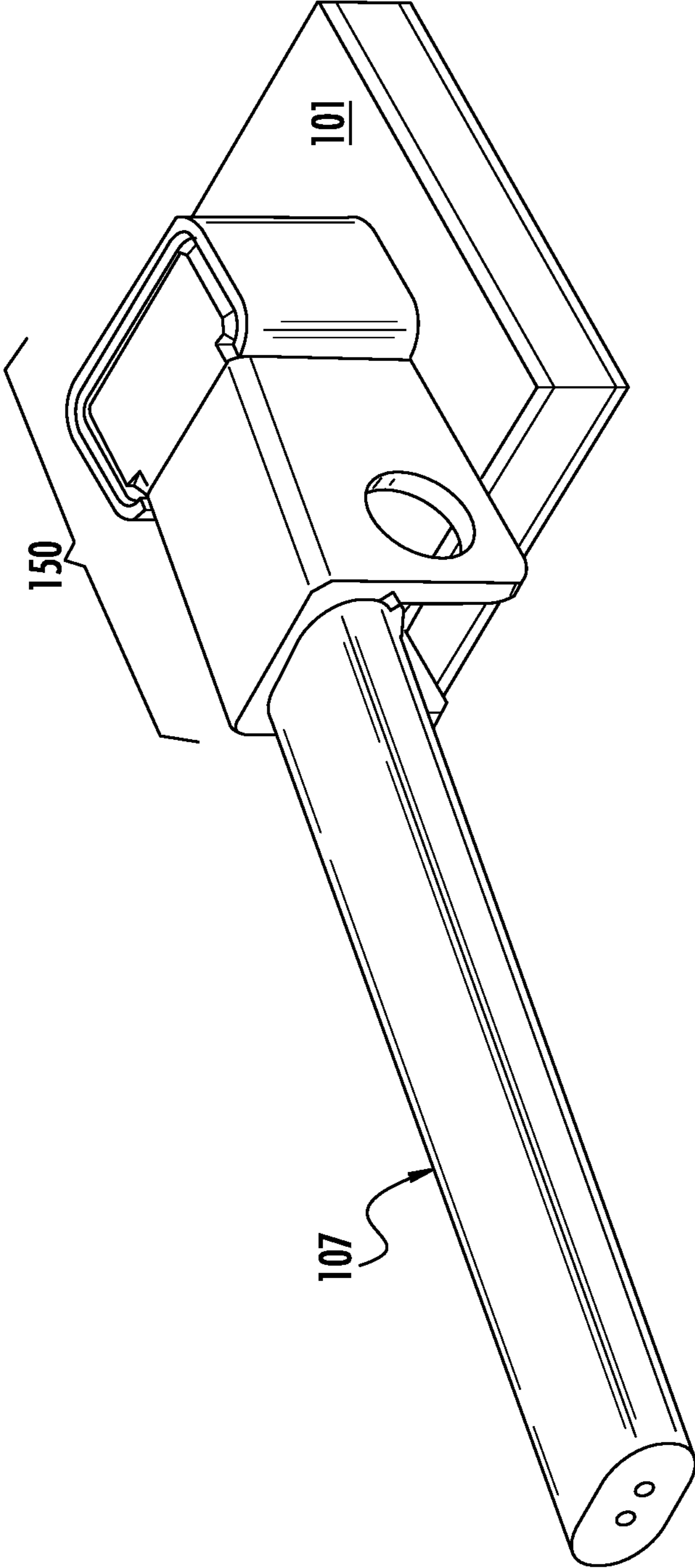


FIG. 13

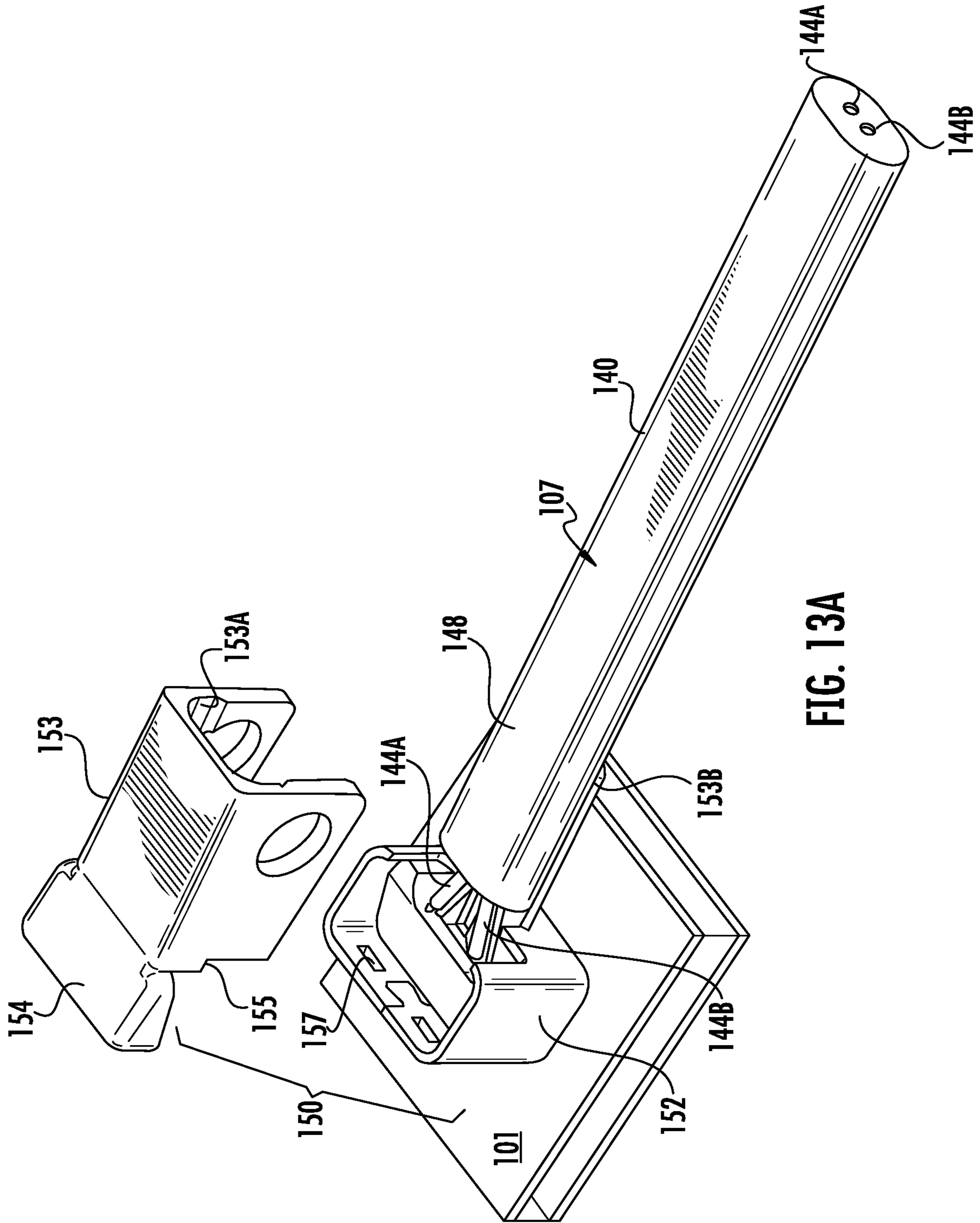


FIG. 13A

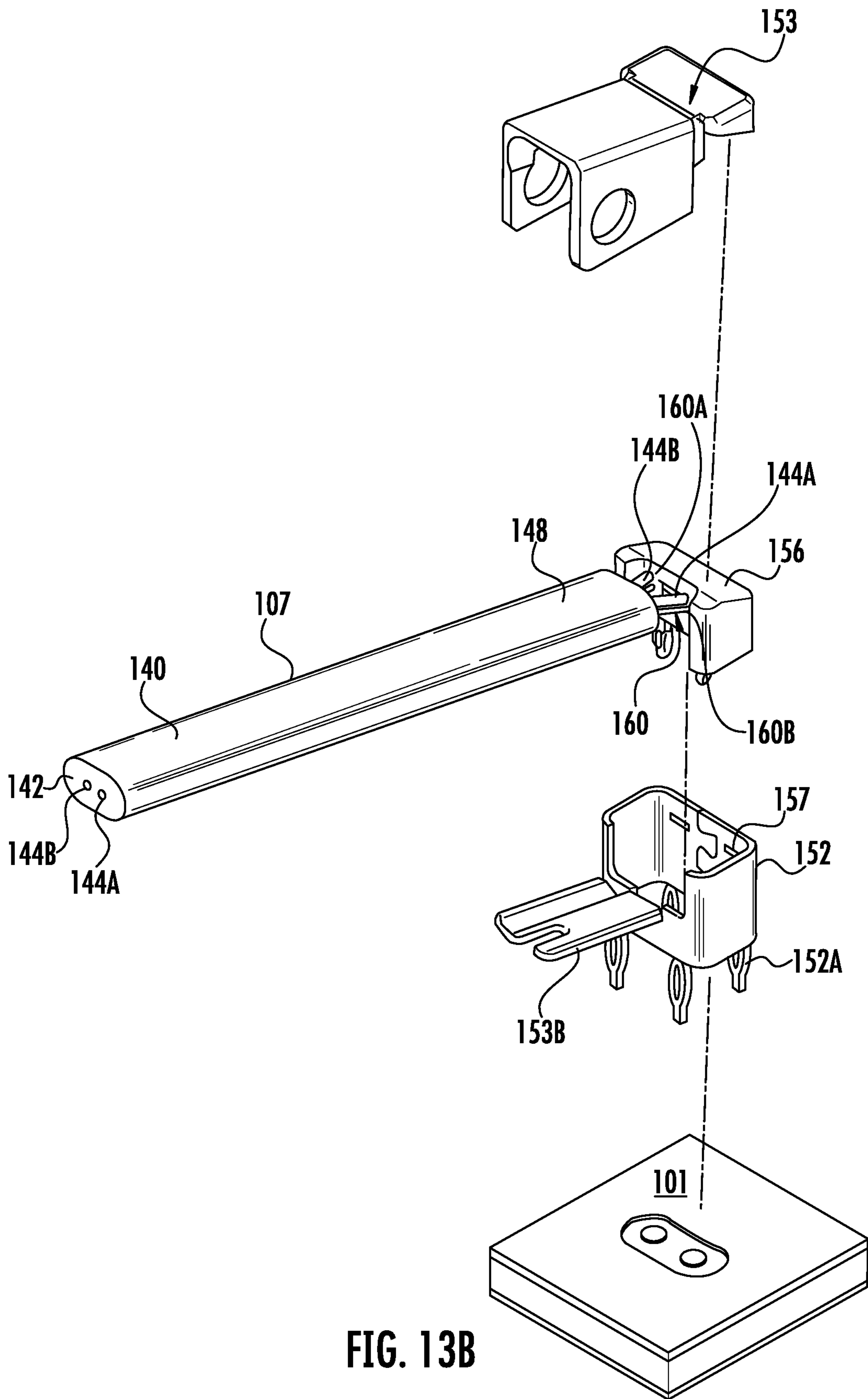


FIG. 13B

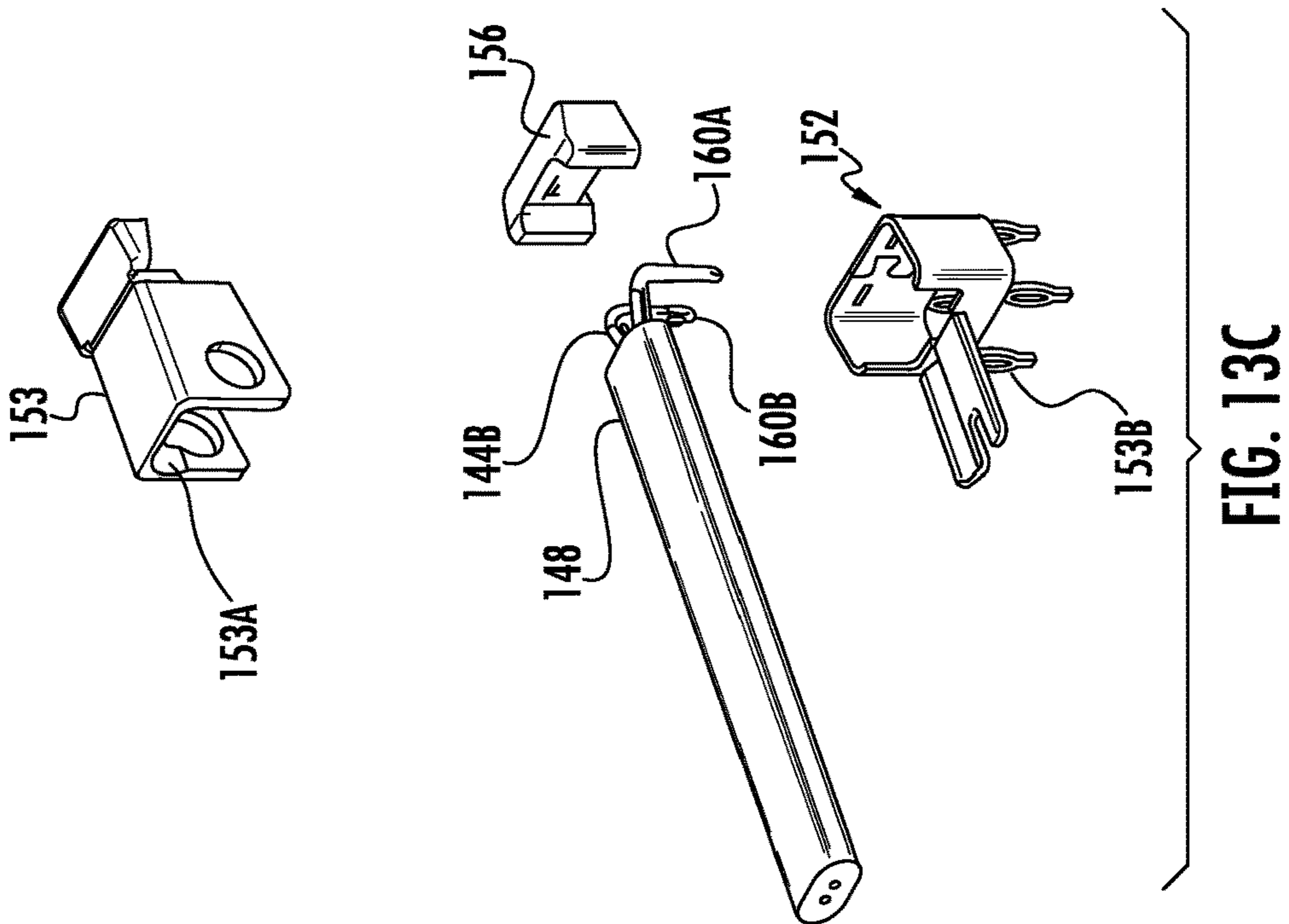


FIG. 13C

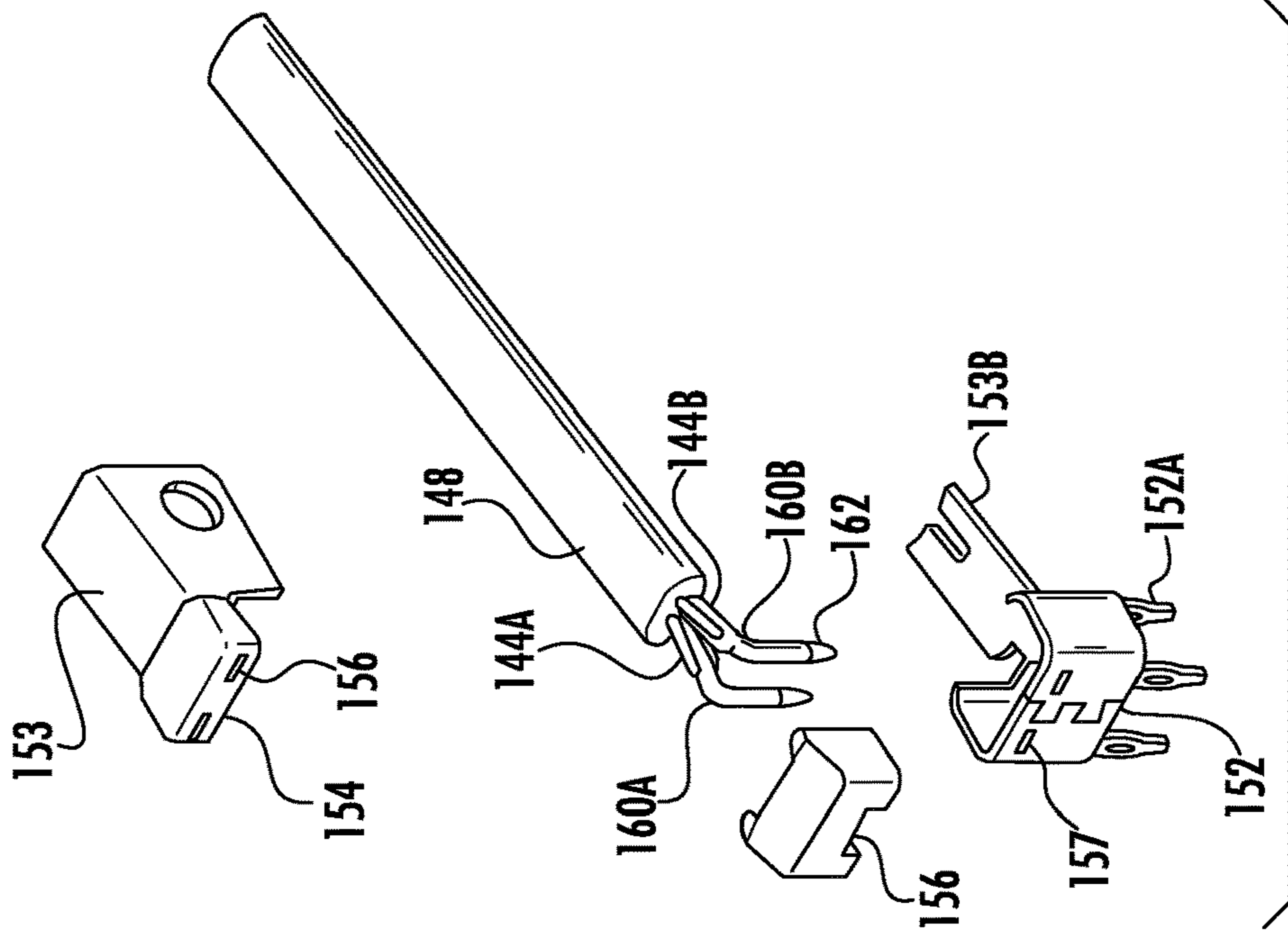


FIG. 13D

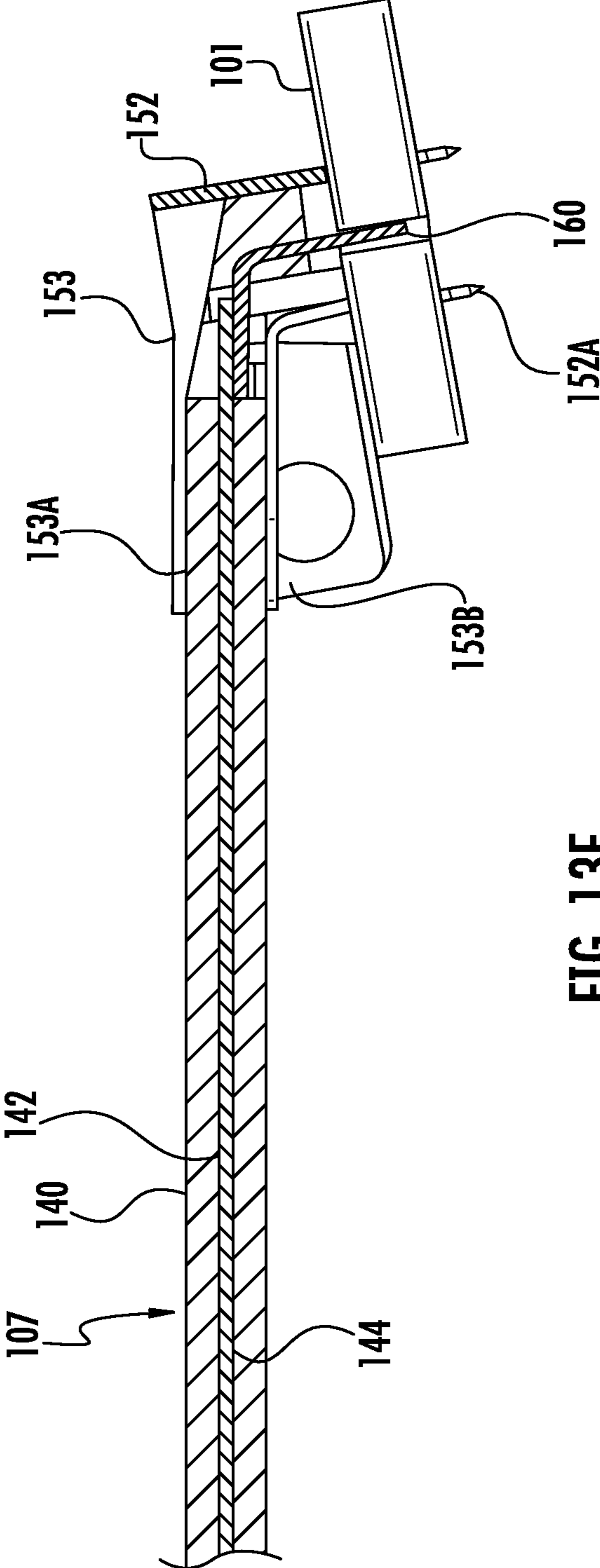


FIG. 13E

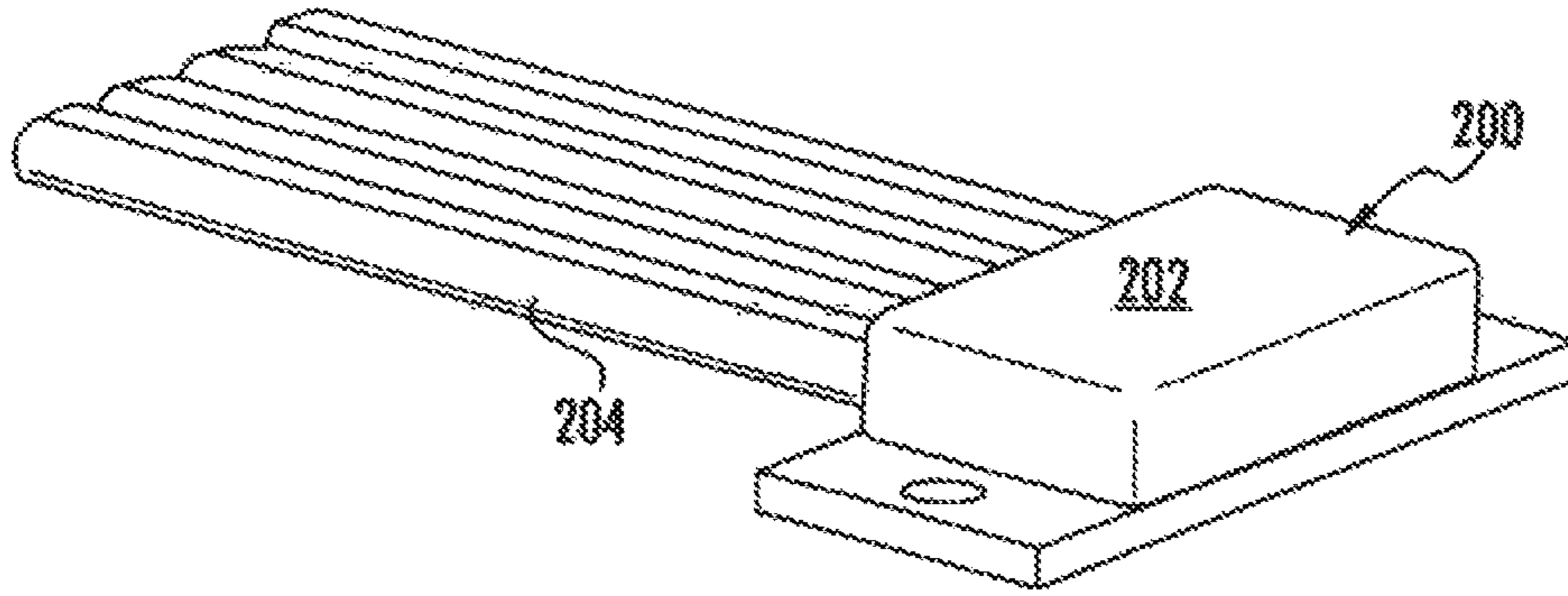


FIG. 14

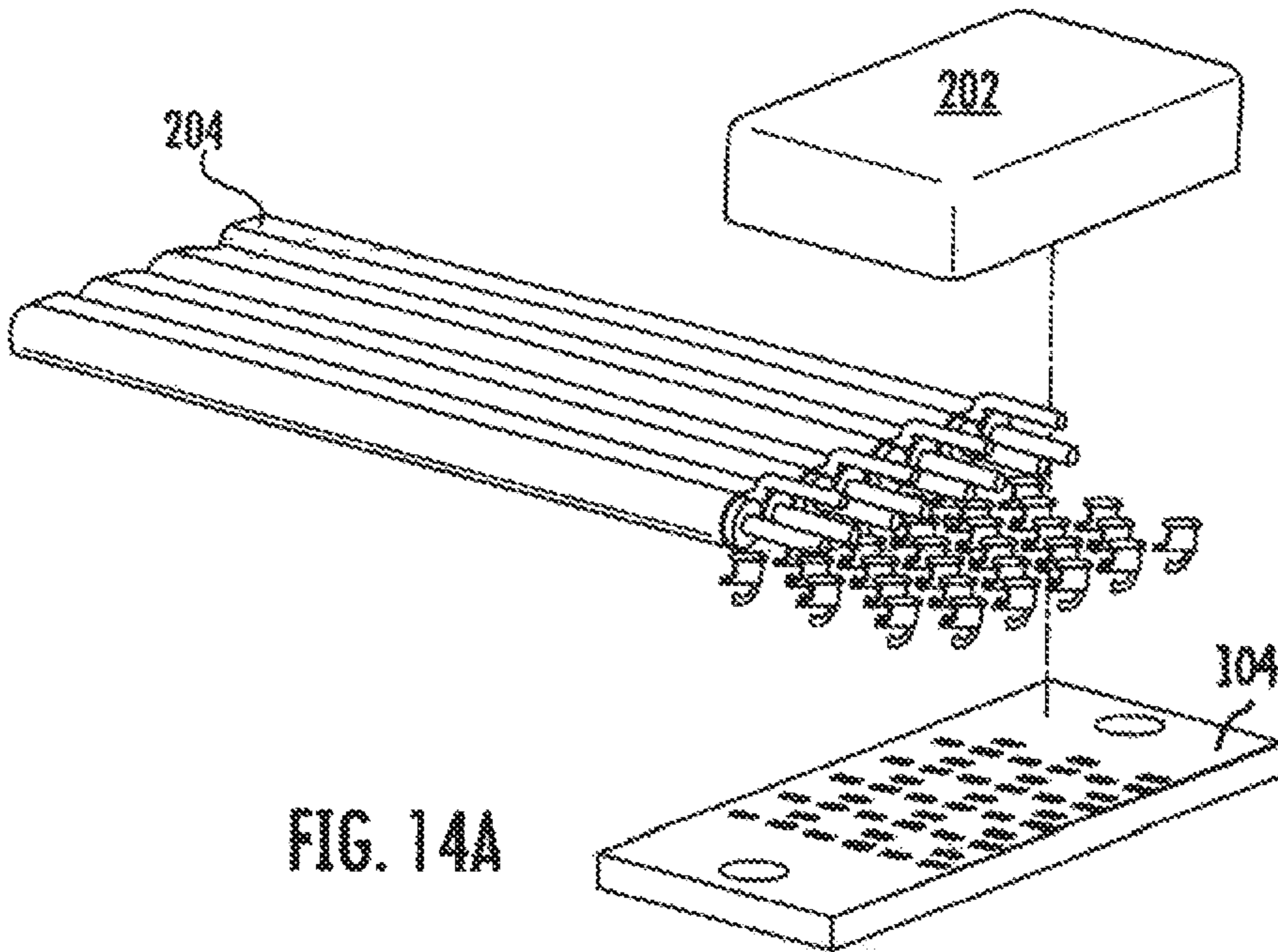


FIG. 14A

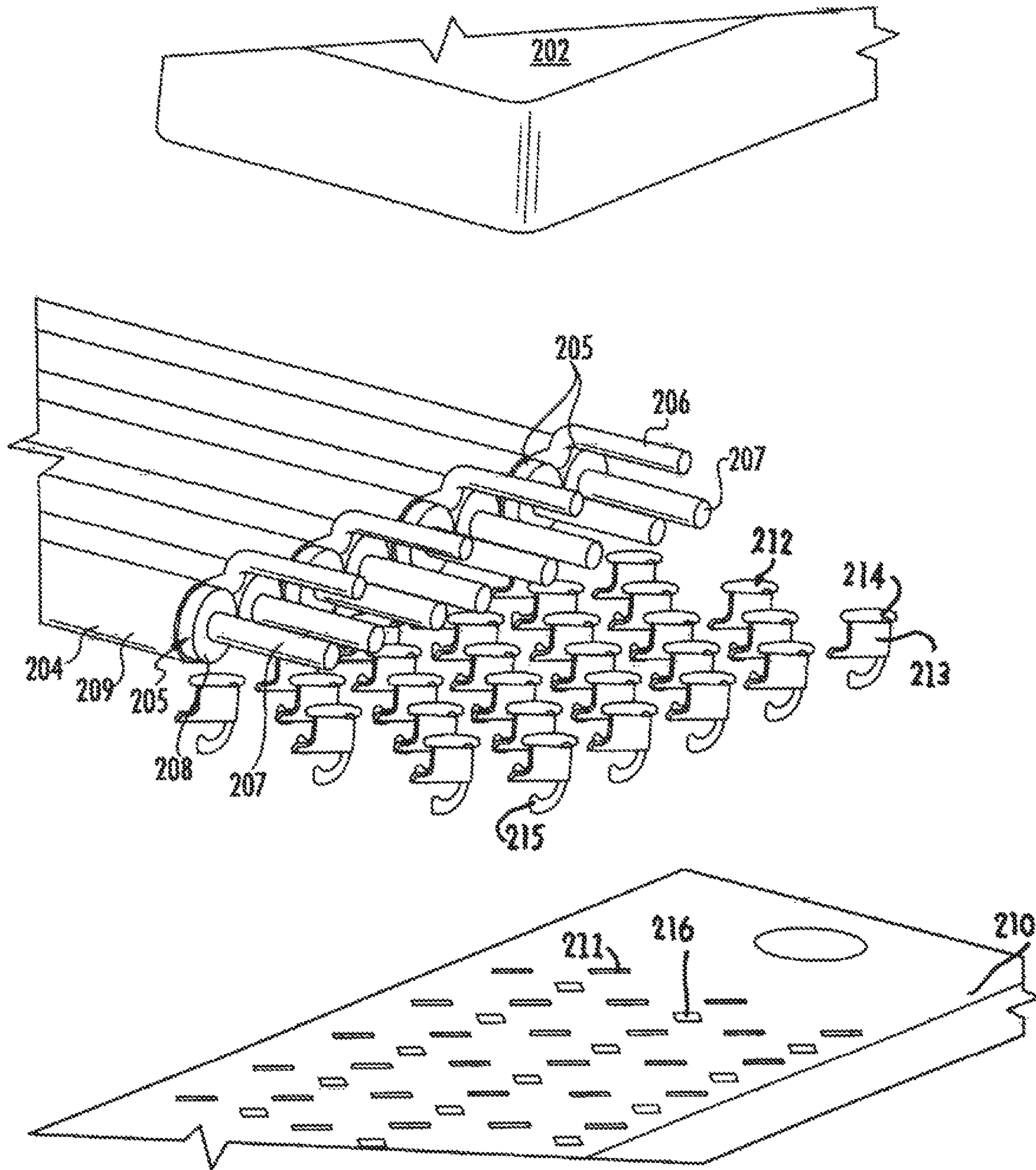


FIG. 14B

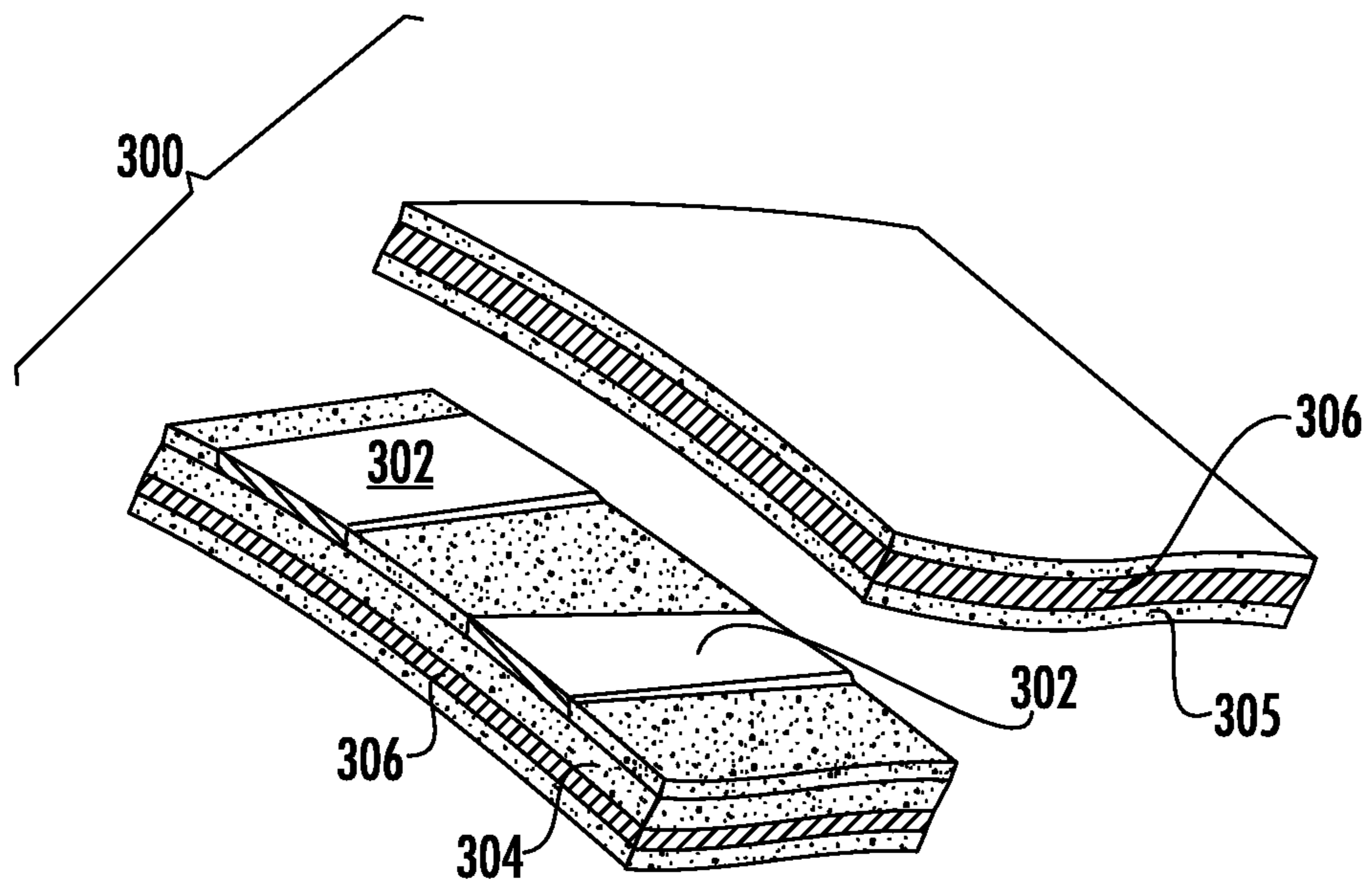


FIG. 15

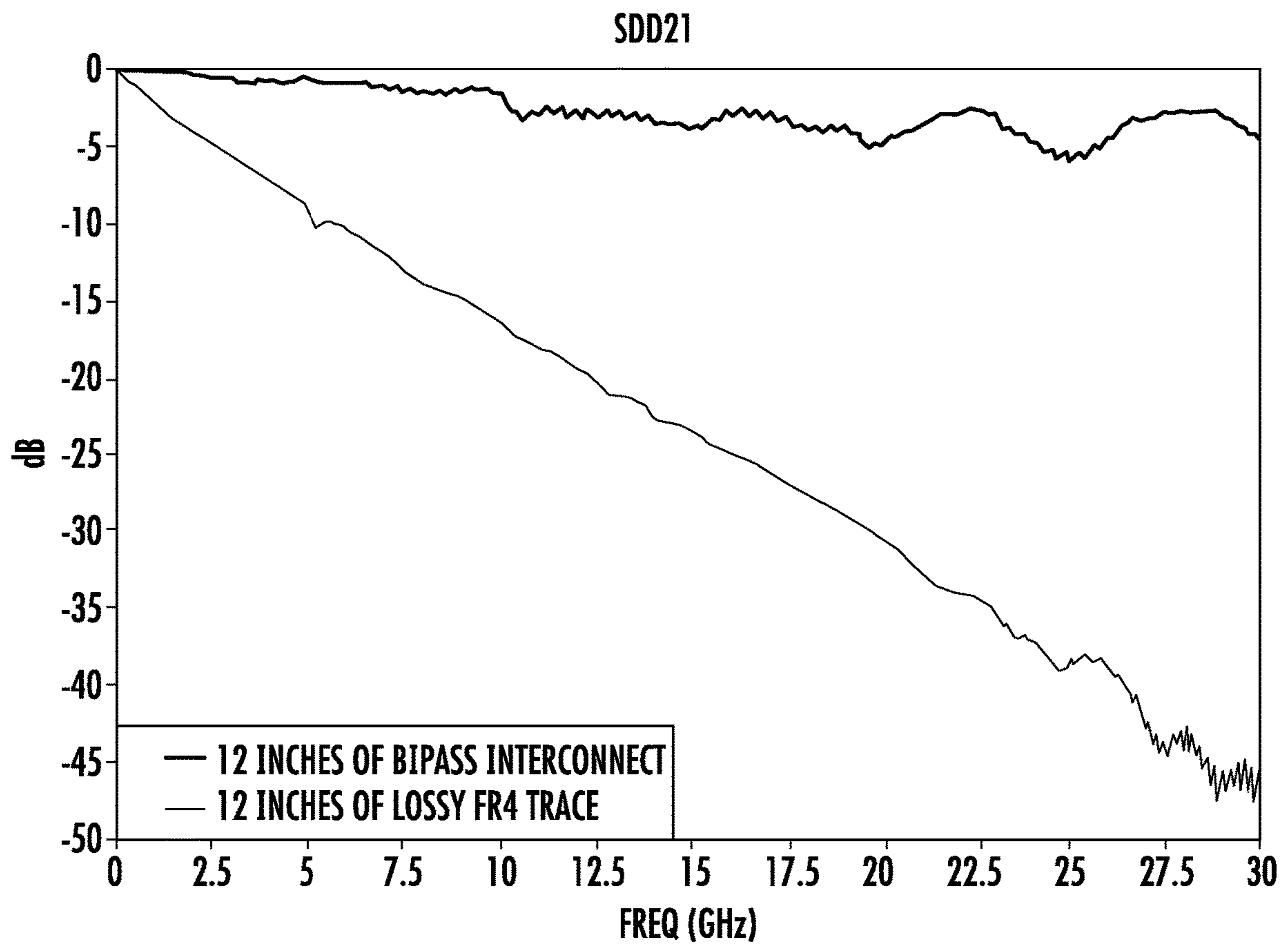


FIG. 16

HIGH SPEED BYPASS CABLE ASSEMBLY

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

REFERENCE TO RELATED APPLICATIONS

[The Present Disclosure] *This application is a reissue continuation of U.S. application Ser. No. 15/271,903, which is a reissue of U.S. Pat. No. 9,011,177, which issued on Apr. 21, 2015 from U.S. application Ser. No. 13/987,296, which is a continuation-in-part of International Application No. PCT/US2010/022738, filed Feb. 1, 2010, entitled "High Speed Interconnect Cable Assembly," filed 01 Feb. 2010 with the U.S. Patent And Trademark Office (USPTO) as Receiving Office for the Patent Cooperation Treaty. The '738 Application claims priority of prior-filed U.S. Provisional Application No. 61/145,685, entitled "High Speed Interconnect Cable Assembly," filed 30 Jan. 2009 also with the USPTO. The contents of each of the above Applications are fully incorporated in their entireties herein.*

BACKGROUND OF THE PRESENT DISCLOSURE

The Present Disclosure relates generally to cable interconnection systems, and more particularly, to bypass cable interconnection systems for transmitting high speed signals at low losses.

Conventional cable interconnection systems are found in electronic devices such as routers and servers and the like, and are used to form a signal transmission line that extends between a primary chip member mounted on a printed circuit board of the device, such as an ASIC, and a connector mounted to the circuit board. The transmission line typically takes the form of a plurality of conductive traces that are etched, or otherwise formed on or as part of the printed circuit board. These traces extend between the chip member and a connector that provides a connection between one or more external plug connectors and the chip member. Circuit boards are usually formed from a material known as FR-4, which is inexpensive. However, FR-4 is known to promote losses in high speed signal transmission lines, and these losses make it undesirable to utilize FR-4 material for high speed applications (10 GHz and above). Custom materials for circuit boards are available that reduce such losses but the price of these materials severely increase the cost of the circuit board and, consequently, the electronic devices in which they are used. Additionally, when traces are used to form the signal transmission line, the overall length of the transmission line typically may well exceed 10 inches in length. These long lengths require that the signals traveling through the transmission line be amplified and repeated, thereby increasing the cost of the circuit board, and complicating the design inasmuch as additional board space is needed to accommodate these amplifiers and repeaters. In addition, the routing of the traces of such a transmission line in the FR-4 may require multiple turns and the transitions which occur at terminations affect the integrity of the signals transmitted thereby. It becomes difficult to route transmission line traces in a manner so as to achieve consistent impedance and a low signal loss therethrough.

The Present Disclosure is therefore directed to a high speed, bypass cable assembly that defines a transmission line for transmitting high speed signals, 10 GHz and greater that removes the transmission line from on the circuit board and which has low loss characteristics.

SUMMARY OF THE PRESENT DISCLOSURE

Accordingly, there is provided an improved high speed bypass cable assembly that defines a signal transmission line useful for high speed applications at 10 GHz or above and with low loss characteristics.

In accordance with an embodiment as described in the disclosure, an electrical connector assembly is disclosed. The electrical connector assembly comprises a printed circuit board, a chip member, a termination member, a first connector member, a bypass cable member and a second connector member. The chip member and the termination member are mounted on the printed circuit board, with the termination member mounted toward the end of the printed circuit board. The first connector member is in electrical communication with the chip member at a first end, and the bypass cable member electrically connects the first connector member, where it is coupled at a second end thereof, and the termination member, at a first end. The second connector member, disposed at a second end of the termination member, is in electrical communication with the termination member. Generally, the electrical connector is capable of the transmission of high speed signals. As the chip member is located a long length from the board connector, the bypass cable provides a transmission line therebetween that has a consistent geometry and structure that resists signal loss and maintains the system impedance at a consistent level without discontinuities.

In accordance with a second embodiment of the disclosure, the cable bypass assembly provides a transmission line that is separate from the circuit board, and may include one or more associated signal wire pairs, such as is found in "twin-ax" cable. The wires of the bypass cable are configured at their opposite ends in two fashions. At a first end of the bypass cable, the wires are configured for a direct termination to a board mounted connector, and are arranged in a manner such that the conductors of the signal wires extend in alignment with terminal termination ends, or feet, of the board mounted connector. The shielding of the signal wires are rolled back upon the insulative coating of the wires and exterior shield extensions are preferably provided to ensure that the signal wire conductor leads are effectively shielded through the connection. In this manner of connection, the terminal tails need not be attached to the circuit board, either as surface mount or through hole tails, thereby significantly reducing losses and the impedance discontinuity that occurs in the tail to board mounting transition.

At the second end of the bypass cable the signal wires are terminated in a fashion so that they can either be connected directly to the chip member or to the board in close proximity to the chip member. In this regard, and as disclosed in this second embodiment, the signal wire conductors are terminated to associated tail portions that are aligned with the conductors, similar to the termination which occurs at the first end. These tails are maintained in a desired spacing and are further completely shielded by a surrounding conductive enclosure to provide full EMI shielding and reduction of cross talk. The termination of the ends of the bypass cable assembly are done in a manner such that to the extent possible, the geometry of the conductors in the bypass cable

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is maintained through the termination of the cable to the board connector and/or the chip.

These and other objects, features and advantages of the Present Disclosure will be clearly understood through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE FIGURES

The organization and manner of the structure and operation of the Present Disclosure, together with further objects and advantages thereof, may best be understood by reference to the following Detailed Description, taken in connection with the accompanying Figures, wherein like reference numerals identify like elements, and in which:

FIG. 1 illustrates a perspective view of one embodiment of a high speed interconnect cable assembly, developed in accordance with the Present Disclosure;

FIG. 2 illustrates a perspective view of another embodiment of a high speed interconnect cable assembly, developed in accordance with the Present Disclosure;

FIG. 3 illustrates a perspective view of another embodiment of a high speed interconnect cable assembly, developed in accordance with the Present Disclosure;

FIG. 4 illustrates a perspective and inset view of the via transfer connector of the interconnect cable assembly of FIG. 3;

FIG. 5 illustrates a perspective and inset view of the first connector member of the interconnect cable assembly of FIG. 3;

FIG. 6 is a perspective view of a second embodiment of a cable bypass assembly constructed in accordance with the Present Disclosure;

FIG. 7 is a top plan view of the cable bypass assembly of FIG. 6;

FIG. 8 is an exploded view of the assembly of FIG. 6, illustrating in greater detail the board connector to which the cable bypass assembly is terminated;

FIG. 9 is a perspective view of the board mounted connector of FIG. 8, with the first ends of the bypass assembly attached thereto;

FIG. 10 is a partially exploded view of FIG. 9;

FIG. 11 is a top plan view of FIG. 9, with the EMI shield removed for clarity;

FIG. 11A is a side elevational view of FIG. 11;

FIG. 12 is perspective view of four pairs of signal wires terminated to the board connector terminal assembly and with one set of the shielding extensions removed for clarity;

FIG. 12A is the same view as FIG. 12, but taken from the rear thereof;

FIG. 12B is a end view of two pairs of signal wires with an associated shielding extension in place, illustrating the relative alignments of the signal conductors with each other and to the shielding of the cables;

FIG. 13 is a perspective view of one manner of terminating the ends of the cables of the cable bypass assembly which is opposite that of the termination to the board mounted connector;

FIG. 13A is the same view as FIG. 13, but with one of the exterior shielding components removed for clarity;

FIG. 13B is the same view as FIG. 13A but with the lower shielding component removed and the terminal support in place on the terminals attached to the second end of the cable;

FIG. 13C is the same view as FIG. 13B but with the terminal support removed for clarity;

FIG. 13D is the same view as FIG. 13C, but taken from the other end thereof;

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FIG. 13E is a sectional view of FIG. 13;

FIG. 14 is an embodiment of a termination structure for direct connection to a chip member;

FIG. 14A is an exploded view of FIG. 14;

FIG. 14B is an enlarged detail view of FIG. 14A.

FIG. 15 is a partially exploded view of an extent of flexible circuitry which may be used as a signal transmission line in cable bypass assemblies of the disclosure; and,

FIG. 16 is a graph comparing the losses between 12-inch lengths of signal transmission lines incorporated on a circuit board made from FR-4 material and a cable bypass assembly constructed in accordance with the principles of the disclosure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

While the Present Disclosure may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the disclosure is to be considered an exemplification of the principles of the Present Disclosure, and is not intended to limit the Present Disclosure to that as illustrated.

In the embodiments illustrated in the Figures, representations of directions such as up, down, left, right, front and rear, used for explaining the structure and movement of the various elements of the Present Application, are not absolute, but relative. These representations are appropriate when the elements are in the position shown in the Figures. If the description of the position of the elements changes, however, these representations are to be changed accordingly.

While the Present Disclosure may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the disclosure is to be considered an exemplification of the principles of the Present Disclosure, and is not intended to limit the Present Disclosure to that as illustrated.

FIGS. 1-5 provide various perspective views of some basic components of a high speed interconnect cable assembly, developed in accordance with the teachings and tenets of the Present Disclosure.

Referring more specifically to FIG. 1, high speed interconnect cable assembly 10 generally comprises chip member 12 mounted on printed circuit board member 14, first connector member 16 interfacing between chip member 12 and bypass cable member 18, and termination member 20 interfacing between bypass cable member 18 and second connector member 22 disposed at the edge of printed circuit board member 14.

Preferably, chip member 12 may comprise a PHY Chip, or any other surface-mounted, physical layer device, known in the art, from which a high speed signal is generated, such as an ASIC and transmitted to a cable assembly. Chip member 12 is mounted to any currently-known printed circuit board, using preferably any of the various currently-known mounting means. Preferably, an FR-4 type printed circuit board is used, in an effort to take advantage of its low cost and wide usage. For purposes of the Present Disclosure, the generated high speed signal may be any type of signal, but typically a data signal, generally having a frequency of 5 GHz and above, and most preferably and is a data signal having a frequency of 10 GHz or more.

Bypass cable member 18 is connected to chip member 12 by means of first connector member 16. First connector

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member 16 is capable of transmitting a signal greater than 10 GHz between chip member 12 and bypass cable member 18. The interface between first connector member 16 and chip member 18 may be by any known means, including, for example, a plug-receptacle connection, a friction-based connection or the like. It is preferred that the interface be removable. First connector member 16 is preferably capable of receiving the high speed signal generated by the chip member and transmitting it to the bypass cable member without need for a repeater or an amplifier, and without having to use the conductive properties of printed circuit board 14.

Bypass cable member 18 comprises a flexible circuit member, such as a cable, extending from first connector member 16 to termination member 20. Preferably, bypass cable member 18 is capable of receiving and carrying signals above 10 GHz. Preferably, bypass cable member 18 includes one or more wire pairs that transmit differential signals at high speeds. Each such wire pair may have a ground, or drain, wire associated with it. Further, the pairs may be enclosed within bypass cable member 18 and within an associated cable shield. Like first connector member 16, bypass cable member 18 is preferably capable of receiving the high speed signal generated by first connector member 18 and transmitting it to termination member 20 without need for a repeater or an amplifier, and without having to use the conductive properties of printed circuit board 14.

Termination member 20 is electrically connected to bypass cable member 18, and receives the signal from bypass cable member 18. Like all other elements in interconnection assembly 10, termination member 20 is capable of receiving signals greater than 10 GHz. Preferably, termination member 20 is located at or near the edge of printed circuit board 14. Termination member 20 may be mounted to the edge of printed circuit board 14. Alternatively, termination member 20 may be "freestanding," and not connected to any aspect of assembly 10. Termination member 20 may receive bypass cable member 18 through any methods and means as currently described in the art.

Second connector member 22 preferably provides one end of a male-female relationship with termination member 20 (with termination member 20 providing the second end). It is not imperative that second connector member 22 (or termination member 20) be specifically relegated to the male or female end, as the teachings of the Present Disclosure will nevertheless be realized.

Second connector member 22 is preferably not disposed on any other aspect of interconnection assembly 10 of the Present Disclosure, i.e., second connector member 22 is not mounted on printed circuit board 14. Second connector member 22 receives the signal from termination member 20, and transmits the signal to its next or final destination.

The discussion above focused on a single interconnection assembly. Nevertheless, a plurality of interconnection assemblies may be used on a single printed circuit board, each generally comprising the above-referenced elements. A plurality of assemblies is generally illustrated in FIG. 1. Further, in a second embodiment, which is illustrated in FIG. 2, lamination member 24 may encompass all or part of multiple bypass cable members 18 for ease in assembly, as well as to maintain order on printed circuit board 14 and reduce the cost of assembly 10. Preferably, lamination member 24 may comprise a rigid, formable polymer material that can be molded over both first connector member 16 and bypass cable member 18.

Further, in another embodiment, a plurality of interconnection assemblies, used on a single printed circuit board,

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may be channeled to a single termination member 26 for transmission of signals beyond the printed circuit board. As illustrated in FIG. 3, bypass cable members 18 extend from chip members 12, via first connector member 16, towards first via transfer connectors 28. Each via transfer connector 28 allows the signal being carried in bypass cable members 18 to pass through holes (or vias) in the printed circuit board where they connect with termination member 26.

FIG. 4 illustrates a perspective close up of the connection of via transfer connectors 28 to termination member (not shown in FIG. 4). As illustrated, each via transfer connector 28 houses the termination of bypass cable members 18. Individual wires 30 extending from bypass cable members 18 are mounted within connector housing 32. Connector housing 32, along with individual wires 30 and a portion of bypass cable members 18, are overmolded with terminal housing 34. Terminal housing 34 is then inserted into the via hole of the printed circuit board, where it couples to termination member.

FIG. 5 illustrates a perspective close up of first connector member 16. As illustrated, each first connector 16 houses the termination of bypass cable members 18. Individual wires 36 extending from bypass cable members are overmolded with terminal housing 38. Terminal housing 38 is then coupled to chip member 12.

FIGS. 6-13E illustrate another embodiment of a bypass cable assembly 100 constructed in accordance with the principles of the Present Disclosure. As shown in FIG. 6, a circuit board 101 that is used in an electronic device (not shown) has mounted thereon a chip member 104, such as an ASIC, at one location and a shielding cage 102 mounted to the circuit board at another location, remote from the one location. The shielding cage 102 houses a receptacle connector assembly 110 that includes a receptacle connector 112 configured to receive the mating blade (typically the leading edge of a circuit card) of an opposing, mating connector (not shown) in an elongated card-receiving slot 113. The connector 112 may also include a channel 114 disposed underneath the card slot 113 to receive a polarizing member of the mating connector. The connector 112 is accessible through an opening 103 at one end of the shielding cage 102. A portion of the shielding cage 102 extends past the edge of the circuit board 101 and out of the enclosure which houses the circuit board 101. This opening 103 permits access to the connector 112 from the exterior of the device and permits the insertion of a mating connector, typically in the form of a plug connector, therein in order to connect the device to another device and permit the transfer of signals between them.

A bypass cable assembly 105 is provided to connect together, the connector 112 and the chip member 104, in order to form a signal transmission line extending therebetween for transmitting signals at high speeds of approximately 5 GHz and greater and preferably of approximately 10 GHz and greater. The cable assembly 105 includes a preselected length of cable 107 that has at a first end 107a thereof, a first termination assembly and at a second and opposite end 107b thereof, a second termination assembly. As shown best in FIG. 12B, each cable 107 may be of the "twin-ax" type, in which a pair of signal conductors 144A, 144B are positioned in spaced-apart relationship within an insulative body 142. This cable body 142 is surrounded by an outer conductive shielding layer 148 that is located underneath an exterior, insulative covering 140 and all of the cable elements may be formed as the single component illustrated. The structure of this particular type of twin-ax cable lends itself to uniformity throughout its length so that

a consistent impedance profile is attained for the length of the cable. The cable assemblies **105** of this disclosure may include as few as one or two cables, or they may include greater numbers, such as the eight cables shown in FIGS. **6**, **9** & **11**.

In order to avoid losses that normally occur in the use of signal transmission lines in the circuit board **101** using FR-4 as the board material, the cables **107** are used as the signal transmission lines. As noted above, the cables **107** are made in a manner that controls their size, thickness and the position and spacing of the signal conductors **144A**, **144B** so as to define a constant impedance profile throughout the lengths of the cables. Accordingly, twin-ax type of cable is desirable as well as flexible circuitry where positioning of the conductors and insulators may be controlled to a high degree of tolerance. Problems with impedance profiles typically occur at the termination points of cables where the geometry of the cable disrupted in order to effect a termination. One such solution to this problem is disclosed in U.S. Pat. No. 6,454,605, issued Sep. 24, 2002 and assigned to the assignee of the Present Disclosure and which is hereby incorporated by reference, in its entirety.

The cable assemblies of the Present Disclosure are terminated at their opposite ends **107A**, **107B** in a manner that seeks to reduce the modification of the cable geometry in order to reduce the magnitude of the aforementioned discontinuities and to prevent to the extent possible excessive loss, noise and crosstalk. Returning to the drawings and in particular FIGS. **12** & **12A**, it can be seen that the terminals **120** of the receptacle connector **112** have tail portions **132** that extend outwardly from the rear face of the terminal assembly supports **118A**, **118B** and contact portions **130** that extend forwardly within the card-receiving slot **113** of the body of the receptacle connector **112**. The terminal contact and tail portions **130**, **132a**, **132b**, extend in a continuous, generally horizontal extent through the connector without any vertical terminal extents that would provide an interruption of the horizontal extent. Consequently, as used herein, the term uninterrupted means a generally horizontal extent without any vertical portions. Similarly, "generally horizontal extent" also means that there are no vertical portions of the terminals that change the levels of the terminal contact and tail portions as would be found in terminals configured for surface mounting such as the low speed, power and status terminals **134** that are interposed between the high speed terminal sets. These non-high speed terminals **134** may be positioned with the use of a tail aligner block **116** or the like. In order to provide strain relief and to facilitate assembly, two cables may be held together by a block **106** applied to the cables **107** downstream of the termination areas.

In this manner, a "direct connection" is effected between the cable first end **107A** and the connector **112**, in a manner such that the signal terminal tail portions **132a**, **132b** are aligned with the exposed leads of the cable conductors **144A**, **144B** so that the exposed leads may be placed on the flat surfaces which the terminal tail portions **132a**, **132b** preferably provide. The inner shielding **148** of each cable **107** is pulled back over the exposed end of the cable and a shield extension **146** is provided for engaging these cable ends. The extension **146** is shown as a dual extension that can accommodate two cables. The shield extension **146** has what may be considered a cup portion **145** that is formed in a configuration that is generally complementary to the exterior configuration of the cable **107**, and it is provided

with contact feet **146a-c** for contacting the associated terminal tail portions **132c** of ground terminals in the receptacle connector **112**.

The dual shield extension **146** shown in the drawings has two such cup portions **145** and three contact feet. Two contact feet **146a**, **146b** are formed along the outer edges of the cup portion **145**, while the third contact foot **14c** is formed between the cup portions **145**. The contact surfaces **147** formed on the bottom of the contact feet are preferably aligned with each other along a common plane, shown as "H" in FIG. **12B**. The conductors **144A**, **144B** of the cable **107** are also preferably aligned with the contact feet, along H as illustrated best in FIG. **12B**. In this manner a "direct" connection is effected between first ends **107A** of the cables **107** and the board mounted connector **112**, thereby eliminating the need for surface mounting or through hole mounting of the connector high speed terminal tails, all of which contribute to loss, noise and crosstalk at high speeds. Terminals of the connector **112** for which high speed performance is not an issue, such as low speed signal terminals and/or power and status terminals **134**, may be terminated in conventional manners mentioned above and they are shown in FIGS. **12** & **12A** as surface mounted, and such terminals may be disposed between sets of high speed terminals as illustrated for additional separation between the high speed terminal sets. Removing the high speed signals of the receptacle connector from attachment directly to the board, reduces the cost in formation and manufacture of the circuit board **102**. Additionally, the termination style shown in the drawings mirrors the geometry of the cable and provides generally complete shielding at the direct connection.

The shield extensions **146** provide as close as can be attained complete shielding at the direct termination to the board connector and they extend forwardly to completely cover the exposed ends of the cable signal conductors **144A**, **144B** as shown in FIG. **11**. The shield extension mounting feet **146a-c** thereof are spaced apart and contact opposing tail portions of ground terminals of the first connector **112**. The shield extension feet **146a-c** and the conductors **144A**, **144B** of the cables **107** can be soldered or welded in their attachment to the connector terminals and the shield extensions **146** may be attached to the cables **107** by contact, a conductive adhesive, soldering or other suitable means. In this manner, the cable geometry is closely replicated in the termination area and more effective shielding is provided than just an ordinary ground wire to ground terminal connection. An EMI housing **109** may be utilized to provide an enclosure, in combination with the shielding cage **102** about the cable termination area.

FIGS. **13A-D** illustrate one form of termination that may be applied to the second ends of the cables **107**, which may be either connected directly to the chip member or to the circuit board **101** in close proximity thereto. As illustrated in FIGS. **13B-D**, the exposed leads of the cable conductors **144A**, **144B** are attached to signal terminals **160**, shown as a pair of signal terminals **160A**, **160B**. These terminal preferably have flat tail portions **163** and through hole contact portions **162**. The flat tail portions **163** preferably provide a flat surface to which the exposed conductors **144A**, **144B** may be contacted and attached via solder, welding or the like. The signal terminal **160** may be held in by an insulative support **156** that as shown is molded over body portions of the terminal **160**, leaving the tail and contact portions **163**, **162** exposed for termination purposes. A shield collar **152** is provided that houses the signal terminal support **156** and substantially encloses the signal terminals with a conductive shield. The shield collar **152** has

a shield extension 153B that is similar in configuration to cable first end shield extensions 146 in that it has a cup portion 145 that contacts and receives the cable 107 and its inner shielding 148 therein. A cap member 153 is also provided and the cap member includes a block portion 154 that preferably abuts the terminal support 156 and which further preferably engages the shield collar 152 by way of tabs 156 that engage like holes 157 in the walls of the collar 152.

FIGS. 14-14B illustrate another embodiment of a manner or termination to a second connector. In this embodiment, the second connector 200 is one that is used to attach directly to the chip member 104, and typically to a top surface thereof. In this regard, the second connector 200 has a housing 202 that receives a plurality of cables 204, and the type of cables illustrated are of a different twin-ax structure, namely one in which each cable 204 contains a pair of signal wires 205 and a drain (ground) wire 206. The signal wires 205 have signal conductors 207 running their length and surrounded by an outer insulative covering 208 and an outer covering 209 is provided that encloses a pair of the signal wires 205 and an associated drain wire 206. A perforated base portion 210 of the housing 202 has a plurality of slots, or cavities 211, each of which is configured to receive a single terminal 212 therein. LGA-style terminals are illustrated and each such terminal 212 includes a body portion 213 that engages the housing cavity 211, a tail portion or mounting stub 214 that extends out of the cavity 211 and into contact with an exposed conductor 207 of the signal wires 205, and a contact portion 215 that extends out of the opposite end of the cavity 211. The second connector 200 also includes second cavities 216 that receive ground terminals (not shown) that are connected at their upper ends to the drain wires 206 and at their lower ends to the chip member 104. The termination arrangement of this connector 200 also maintains, to the extent possible the geometry of the cables 204 through the connector termination, in the sense that the triangular arrangement of the three wires of each cable is maintained until the point where the drain wire is attached to the ground terminal and then the extent of the ground terminal is spaced from the ends of the signal wire terminals 212 as evidenced by the pattern of the first and second terminal cavities 211, 216.

FIG. 15 illustrates an alternate construction for use as a signal transmission line in accordance with the disclosure and takes the form of an extent of flat flexible circuitry 300. The extent includes a pair of signal conductors 302 that are spaced apart from each other and which run lengthwise between opposite ends of the cable 300. The conductors 302 are surrounded on their top and bottom surfaces and sides by insulative portions 304, 305. Ground shields 306 are provided to enclose the signal conductors 302, and although shown only as above and below the signal conductors 302, it will be understood that they may be disposed alongside of the signal conductors. With this sort of structure, the signal conductors may be exposed and aligned with terminal tails, while the ground shield extended to cover the termination areas in a manner similar to that shown above.

FIG. 16 is a graph comparing the loss between two 12-inch lengths of signal transmission lines, with one of the transmission lines comprising a pair of circuit traces formed in or on FR-4 circuit board material and the other transmission line comprising cables of the Present Disclosure. It can be seen from FIG. 16 that the use of the cable of the Present Disclosure leads to a very low loss transition that only breaks past the 5 dB mark at approximately the 20 GHz frequency. Within the range of testing error, we believe that

the cables of the Present Disclosure have low loss characteristics of no greater than between about 5 dB and about 8 dB at frequencies greater than about 19 GHz.

While a preferred embodiment of the Present Disclosure is shown and described, it is envisioned that those skilled in the art may devise various modifications without departing from the spirit and scope of the foregoing Description and the appended Claims.

What is claimed is:

[1. A cable bypass assembly, the cable bypass assembly comprising:

a first connector, the first connector being configured for mounting to a circuit board, the first connector including a connector body, the connector body supporting a plurality of conductive terminals, the conductive terminals including contact portions and tail portions, the contact portions being held within the connector body for contacting a mating blade of an opposing, mating connector, the tail portions extending out from the connector body;

an elongated cable, the elongated cable including:

a pair of signal conductors, the signal conductors being disposed within an insulative body portion of the elongated cable, the signal conductors extending, in a spaced-apart relationship, lengthwise through a body portion of the elongated cable,

a conductive shield, the conductive shield extending over an exterior of the elongated cable body portion, an insulative outer covering, the insulative outer covering extending over the conductive shield, and opposing first and second free ends, the first free end terminating directly to selected terminal tails of the first connector in a manner so that the signal conductors are in electrical communication with a pair of signal terminal tails;

a shield extension member, the shield extension member being configured to engage a first length of the conductive shield exposed at the first free end and extending therefrom over the signal conductors attached to the pair of signal terminal tails, the shield extension member including at least two spaced apart mounting feet; and

a second connector, the second connector including:

an insulative body, the insulative body supporting at least a pair of conductive signal terminals in a spaced-apart relationship, each conductive signal terminal including contact and tail portions, and

a shielding collar, the shielding collar enclosing a body portion of the second connector, the shielding collar includes an extension portion, the extension portion engaging and receiving the conductive shield exposed at the second free end.]

[2. The cable bypass assembly of claim 1, further including a second cable, the second cable including a pair of signal conductors, the second cable signal conductors disposed lengthwise therethrough in a spaced-apart relationship, the second cable signal conductors being attached to corresponding signal terminal tails of the first connector alongside the elongated cable.]

[3. The cable bypass assembly of claim 1, wherein the shield extension member further includes a cup portion, the cup portion being configured to receive the first free end therein.]

[4. The cable bypass assembly of claim 2, wherein the shield extension member further includes a pair of cup portions, each cup portion receiving ends of the two cables therein.]

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[5. The cable bypass assembly of claim 4, wherein the shield extension member includes at least three mounting feet, two of the mounting feet being disposed on opposing side edges of the shield extension member and a third of the three mounting feet being disposed between the cup portions.]

[6. The cable bypass assembly of claim 5, wherein the mounting feet and the two cable signal conductors are aligned with each other.]

[7. The cable bypass assembly of claim 1, wherein the tail and contact portions extend uninterruptedly lengthwise in a general horizontal plane through the first connector body.]

[8. The cable bypass assembly of claim 1, wherein the elongated cable includes a preselected length of flexible circuitry.]

[9. The cable bypass assembly of claim 1, wherein the shielding collar further includes at least one through-hole terminal, the through-hole terminal extending from the shielding collar and engaging a through-hole of the circuit board.]

[10. The cable bypass assembly of claim 1, wherein the shielding collar further includes a cap portion, the cap portion having a cup portion formed therein, the cup portion being configured to receive an exposed second end of the cable therein and contact a length of exposed cable shielding.]

[11. The cable bypass assembly of claim 1, wherein the second connector is configured to connect directly to a chip member.]

[12. A cable bypass assembly with low loss performance at high data frequencies, the cable bypass assembly comprising:

a first connector, the first connector being configured for mounting to a circuit board, the first connector including a connector body, the connector body supporting a plurality of conductive terminals, the conductive terminals including contact portions and tail portions, the contact portions being held within the connector body for contacting a mating blade of an opposing, mating connector, the tail portions extending out from the connector body;

an elongated cable having, the elongated cable including: first and second opposing ends,

a pair of signal conductors, the signal conductors being disposed within the elongated cable in a spaced-apart relationship and extending lengthwise through the elongated cable, and

at least one conductive shield, each conductive shield extending lengthwise through the elongated cable and substantially enclosing the signal conductors, the signal conductors, at the first end, being terminated directly to selected terminal tails of the first connector in a manner so that the signal conductors are in electrical communication with a pair of signal terminal tails along a horizontal extent thereof;

a shield, the shield extending over the signal conductors attached to the signal terminal tails, the shield including a pair of ground shields; and

a second connector, the second connector including an insulative body, the insulative body supporting at least a pair of conductive signal terminals in a spaced-apart relationship, each conductive signal terminal including contact and tail portions, the cable signal conductors at the second end thereof being terminated to the contact portions, and the cable conductive shield being terminated to selected terminals of the second connector designated for ground purposes.]

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[13. The cable bypass assembly of claim 12, wherein the cable is an extent of flexible circuitry, the signal conductors including two signal conductors.]

[14. The cable bypass assembly of claim 13, wherein the ground shields are disposed on opposite sides of the signal conductors.]

15. A cable bypass assembly, comprising:

a cage that defines a port;

a first connector positioned in the cage, the first connector including a first body with a card-slot, the first body supporting a plurality of terminals, each terminal of the plurality of terminals including a contact portion positioned in the card slot and a tail, wherein two terminals of the plurality of terminals are adjacent each other and form a first terminal pair and another terminal of the plurality of terminals is a first ground terminal, the first ground terminal positioned adjacent the first terminal pair;

a cable with a first end and a second end that defines a length, the cable including a pair of signal conductors disposed within an insulative body portion of the cable, the signal conductors extending in a spaced-apart relationship through the insulative body portion along the length, the cable further including a conductive shield extending over an exterior of the insulative body portion and an insulative outer covering extending over the conductive shield, the first end being terminated directly to the tails of the first terminal pair so that the pair of signal conductors are in electrical communication with the first terminal pair, and wherein the conductive shield is connected to the first ground terminal; and

a second connector connected to the second end, the second connector including a second body that supports a second pair of terminals, each terminal of the second pair of terminals including a contact portion and a tail portion, the tail portion of each terminal of the second pair of terminals connected to one of the signal conductors of the pair of signal conductors and the second connector further including a ground terminal connected to the ground shield, wherein the cable bypass assembly is configured to support a signaling frequency of 10 GHz.

16. The cable bypass assembly of claim 15, wherein the plurality of terminals in the first connector are supported by two terminal assembly supports that align a portion of the terminals on both sides of the card slot so that in operation, during mating with an opposing mating connector the contacts portions on both sides of the card slot are deflected in opposing directions.

17. The cable bypass assembly of claim 15, wherein the second connector is configured to be press-fit into a circuit board adjacent a chip member.

18. A cable bypass assembly, comprising:

a cage that defines a port with a front opening;

a first connector positioned in the cage and including a first body with a card-slot, the first body supporting a plurality of terminals, each terminal of the plurality of terminals including a contact portion positioned in the card slot and a tail, wherein two terminals of the plurality of terminals are adjacent each other and form a first terminal pair;

a cable with a first end and a second end that defines a length, the cable including a pair of signal conductors disposed within an insulative body portion of the cable, the signal conductors extending in a spaced-apart relationship through the insulative body portion along

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the length, the first end being terminated directly to the tails of the first terminal pair so that the pair of signal conductors are in electrical communication with the tails of the first terminal pair; and

a second connector connected to the second end, the second connector including a second body that supports a second plurality of terminals that form a second terminal pair, each terminal of the second terminals pair including a contact portion and a tail portion, the tail portion of each terminal of the second terminal pair connected to one of the signal conductors, wherein the cable bypass assembly is configured to support a signaling frequency of 10 GHz.

19. *The cable bypass assembly of claim 18, wherein the plurality of terminals in the first connector are supported by two terminal assembly supports that align a portion of the terminals on both sides of the card slot so that in operation, during mating with an opposing mating connector the contacts portions on both sides of the card slot are deflected in opposing directions.*

20. *The cable bypass assembly of claim 18, wherein the card slot is recessed a substantial distance from the front opening.*

21. *The cable bypass assembly of claim 18, wherein the second connector is configured to be press-fit into a circuit board adjacent a chip member.*

22. *The cable bypass assembly of claim 18, wherein the second connector is configured to be connected directly to a chip member.*

23. *The cable bypass assembly of claim 18, wherein the cable includes a drain wire and the first and second connectors each include a ground terminal, the ground terminals electrically connected together by the drain wire.*

24. *A cable bypass assembly, comprising:*
a cage that defines a port with a front opening and a rear side;

a first connector positioned in the cage, the first connector defining a card-slot, the first connector supporting a first plurality of terminals, each terminal of the first plurality of terminals including a contact portion positioned in the card slot and a tail, the first plurality of terminals including terminals arranged on two opposing sides of the card slot so that, in operation, insertion of a mating blade causes the terminals on two opposing sides to deflect in opposite directions, wherein two terminals of the first plurality of terminals are adjacent each other and form a first terminal pair;

a cable with a first end and a second end that defines a length, the cable extending from the rear side and including a pair of signal conductors disposed within an insulative body portion of the cable, the pair of signal conductors surrounded by a conductive shield, the signal conductors extending in a spaced-apart relationship through the insulative body portion along the length, the first end being terminated directly to the tails of the first terminal pair so that the pair of signal conductors are in electrical communication with the tails of the first terminal pair; and

a second connector connected to the second end, the second connector including a second body that supports a second plurality of terminals, the second plurality of terminals including a second terminal pair, each terminal of the second terminal pair including a tail portion, the tail portion of each terminal of the second terminal pair connected to one of the signal conductors of the pair of signal conductors, wherein

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the cable bypass assembly is configured to support a signaling frequency of 10 GHz.

25. *The cable bypass assembly of claim 24, wherein the plurality of terminals includes a set of terminals that are configured to be directly connected to a supporting circuit board.*

26. *The cable bypass assembly of claim 25, wherein the set of terminals are configured to be surface mount attached to the supporting circuit board.*

27. *The cable bypass assembly of claim 26, wherein the set of terminals are arranged between separate high speed pairs of terminals.*

28. *A cable bypass assembly, comprising:*

a cage with a front opening, the cage defining a port;

a first connector assembly positioned in the cage and configured to engage a module that is releasably inserted into the port, the first connector assembly including a receptacle connector with a card-slot, the receptacle connector supporting a first and second terminal assembly support, each of the first and second terminal assembly supports supporting a plurality of terminals in a row, the terminals in each row having a contact and a tail that are supported in a cantilever fashion by the terminal assembly supports, wherein the contacts of the plurality of terminals supported by the first and second terminal assembly supports are respectively arranged on opposite sides of the card-slot, wherein two terminals of the plurality of terminals are positioned in of the rows adjacent each other and form a first terminal pair;

a cable with a first end and a second end that defines a length, the cable including a pair of signal conductors disposed within an insulative body portion of the cable, the pair of signal conductors surrounded by a conductive shield, the signal conductors extending in a spaced-apart relationship through the insulative body portion along the length, the first end being terminated directly to the tails of the first terminal pair so that the pair of signal conductors are in electrical communication with the tails of the first terminal pair; and

a second connector connected to the second end, the second connector including a second body that supports a second plurality of terminals that include a second terminal pair, each terminal of the second terminals pair including a tail portion, the tail portion of each terminal of the second terminal pair connected to one of the signal conductors of the pair of signal conductors, wherein the cable bypass assembly is configured to support a signaling frequency of 10 GHz.

29. *The cable bypass assembly of claim 28, wherein the terminals positioned on opposite sides of the card-slot are configured to deflect in opposite directions in response to insertion of a mating connector.*

30. *The cable bypass assembly of claim 28, wherein the cage is positioned in an enclosure and a portion of the cage extends out of the enclosure.*

31. *A cable bypass assembly, comprising:*

a cage with a front opening, the cage defining a port;

a first connector assembly positioned in the cage and configured to engage a module that is releasably inserted into the port, the first connector assembly including a receptacle connector with a card-slot, the receptacle connector supporting a first and second terminal assembly support, each of the first and second terminal assembly supports supporting a plurality of terminals in a row, the terminals in each row having a contact and a tail that are supported in a cantilever

fashion by the terminal assembly supports, wherein the contacts of the plurality of terminals supported by the first and second terminal assembly supports are respectively arranged on opposite sides of the card-slot, wherein two terminals of the plurality of terminals are positioned in of the rows adjacent each other and form a first terminal pair; 5

a cable with a first end and a second end that defines a length, the cable including a pair of signal conductors disposed within an insulative body portion of the cable, the pair of signal conductors surrounded by a conductive shield, the signal conductors extending in a spaced-apart relationship through the insulative body portion along the length, the first end being terminated directly to the tails of the first terminal pair so that the pair of signal conductors are in electrical communication with the tails of the first terminal pair; and 10

a second connector connected to the second end, the second connector including a second body that supports a second plurality of terminals that include a second terminal pair, each terminal of the second terminals pair including a tail portion, the tail portion of each terminal of the second terminal pair connected to one of the signal conductors of the pair of signal conductors, wherein the terminals positioned on opposite sides of the card-slot are configured to deflect in opposite directions in response to insertion of a mating connector and wherein the cable bypass assembly is configured to support 19 GHz signaling frequency with not more than 8 dB of insertion loss. 15 20 25 30

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