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(54) **ELECTRICAL CONNECTOR AND CIRCUIT CARD ASSEMBLY**

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(51) **Int. Cl.**
H01R 25/00 (2006.01)

(52) **U.S. Cl.** **439/638**; 439/78

(58) **Field of Classification Search** 439/76.1, 439/638, 654, 78, 635
See application file for complete search history.

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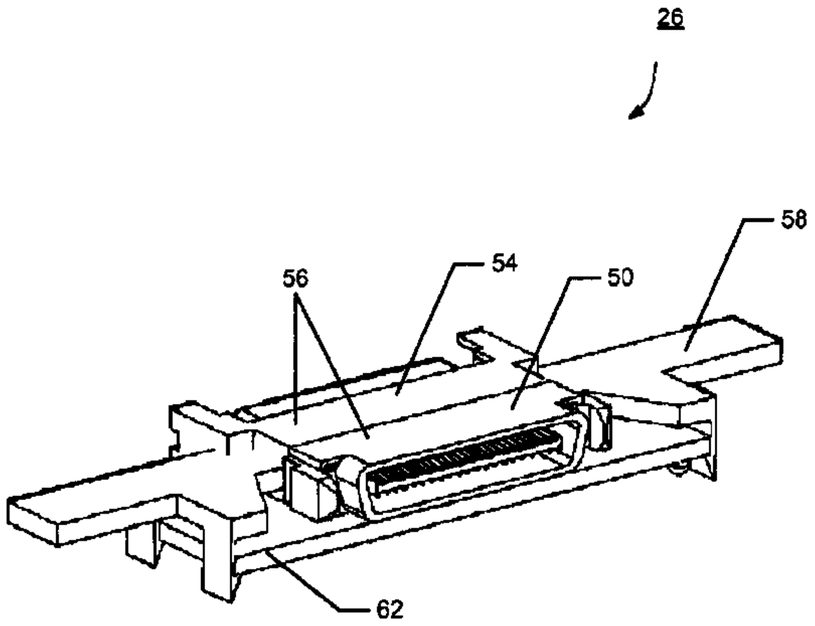
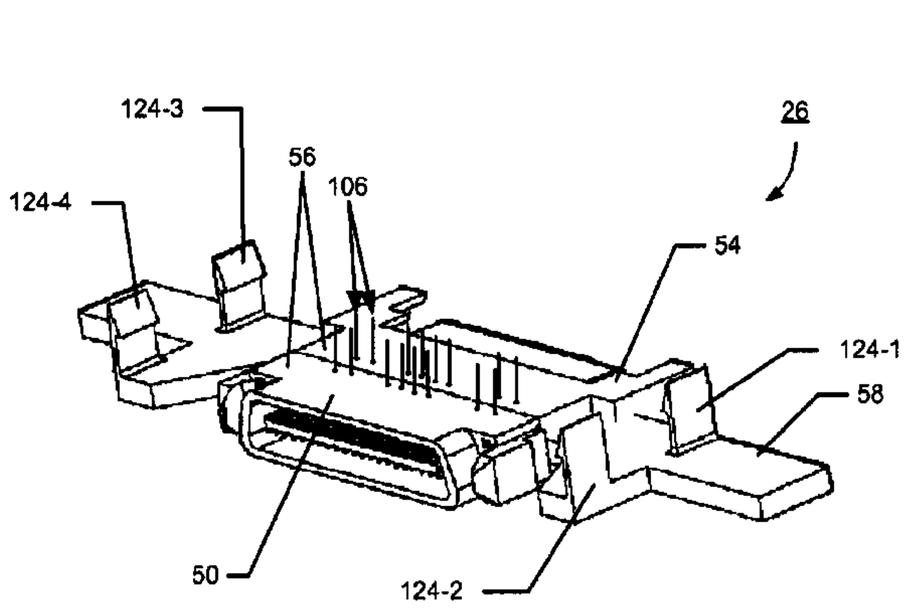
(57) **ABSTRACT**

Described is an electrical connector assembly with an electrical connector having a connector body that includes a receptacle connector portion at a first end and a plug connector portion at a second end opposite the first end. The receptacle connector portion has electrical contacts within an opening for mating with a plug electrical connector at the first end of the connector body. The plug connector portion has electrical contacts within an opening for mating with a receptacle electrical connector at the second end. The connector body has an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from one side of the connector body. A circuit card is disposed adjacent to that one side of the connector body and is in electrical communication with the at least one electrical contact through the electrical conductor extending from the side of the connector body.

28 Claims, 17 Drawing Sheets





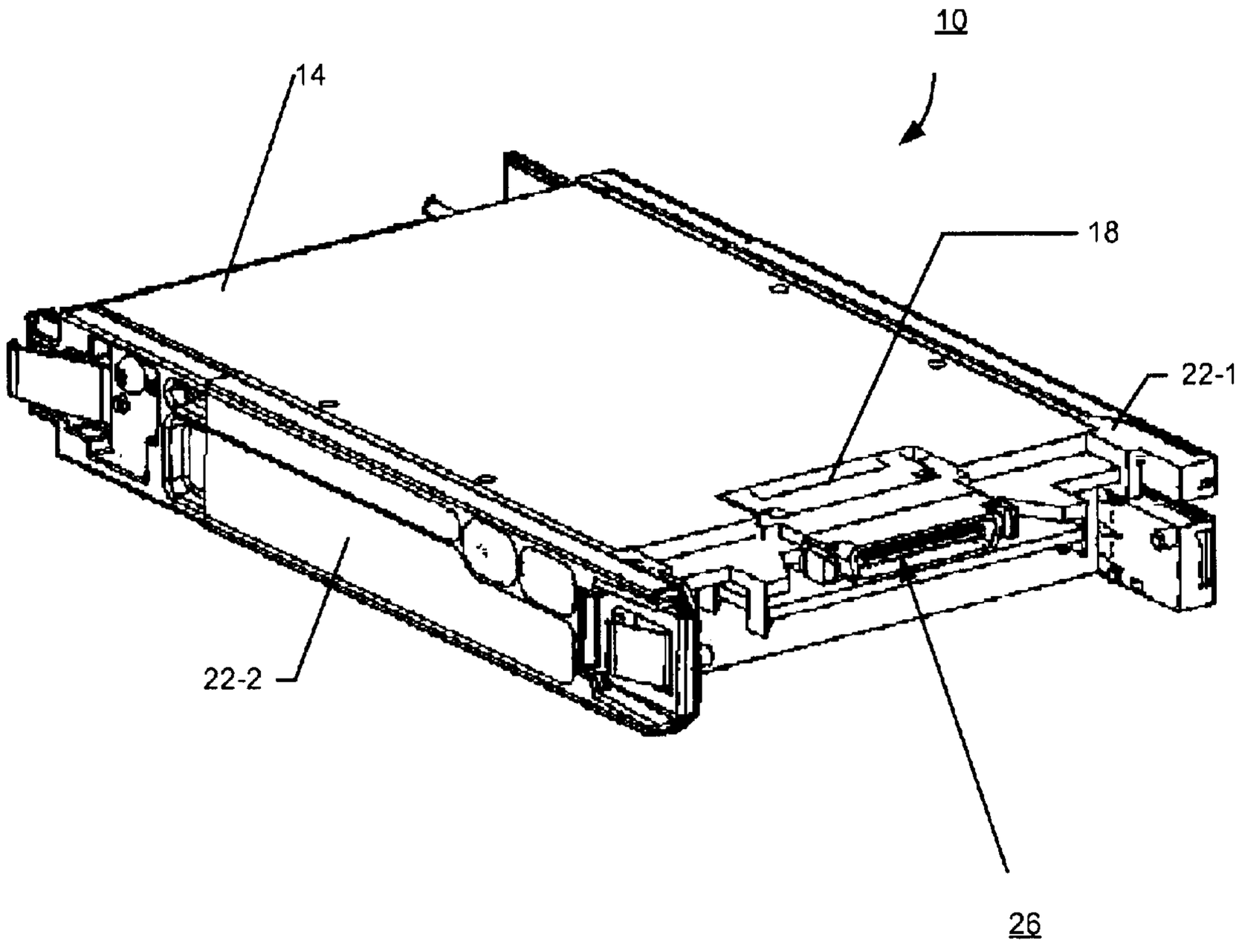


FIG. 1

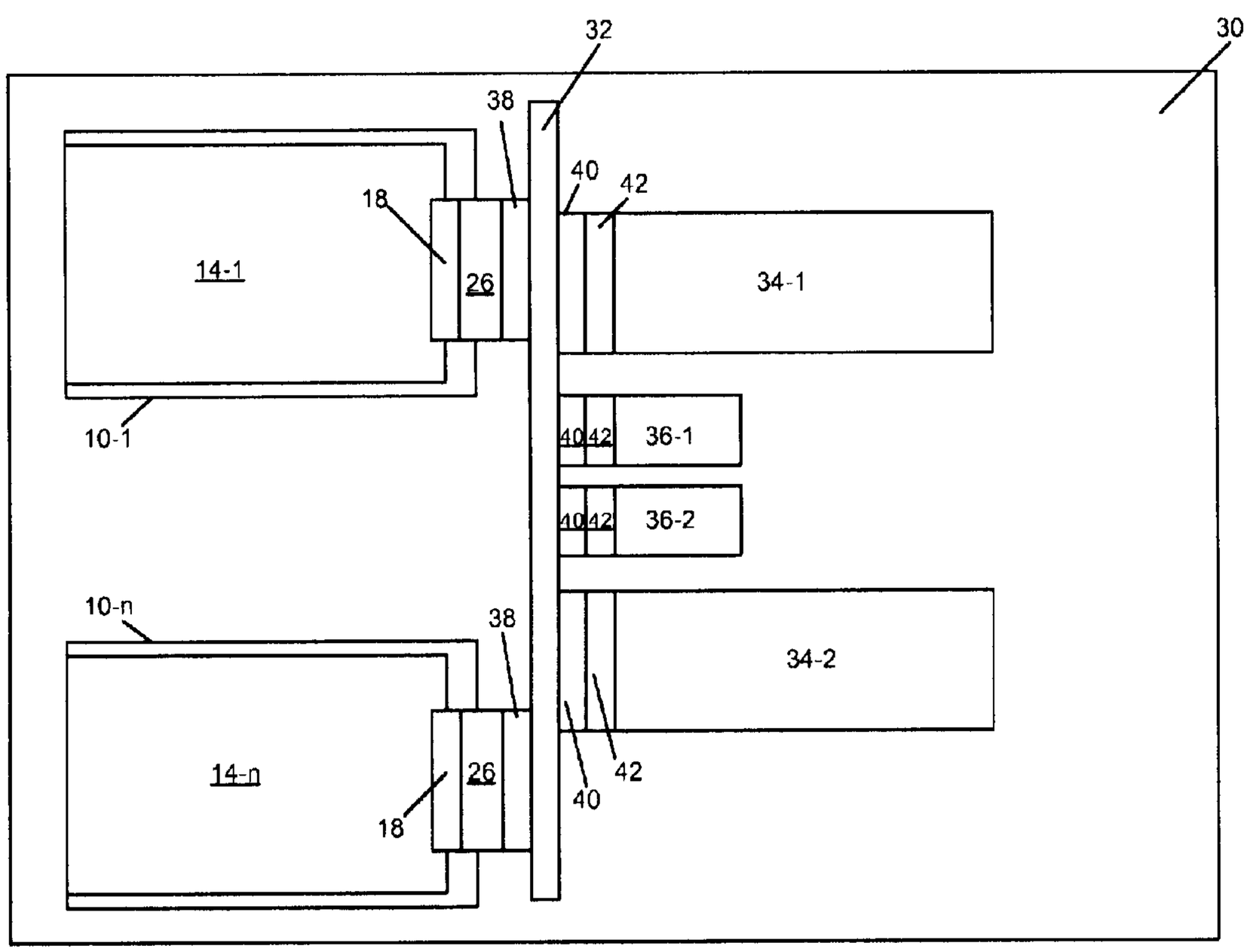

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FIG. 2

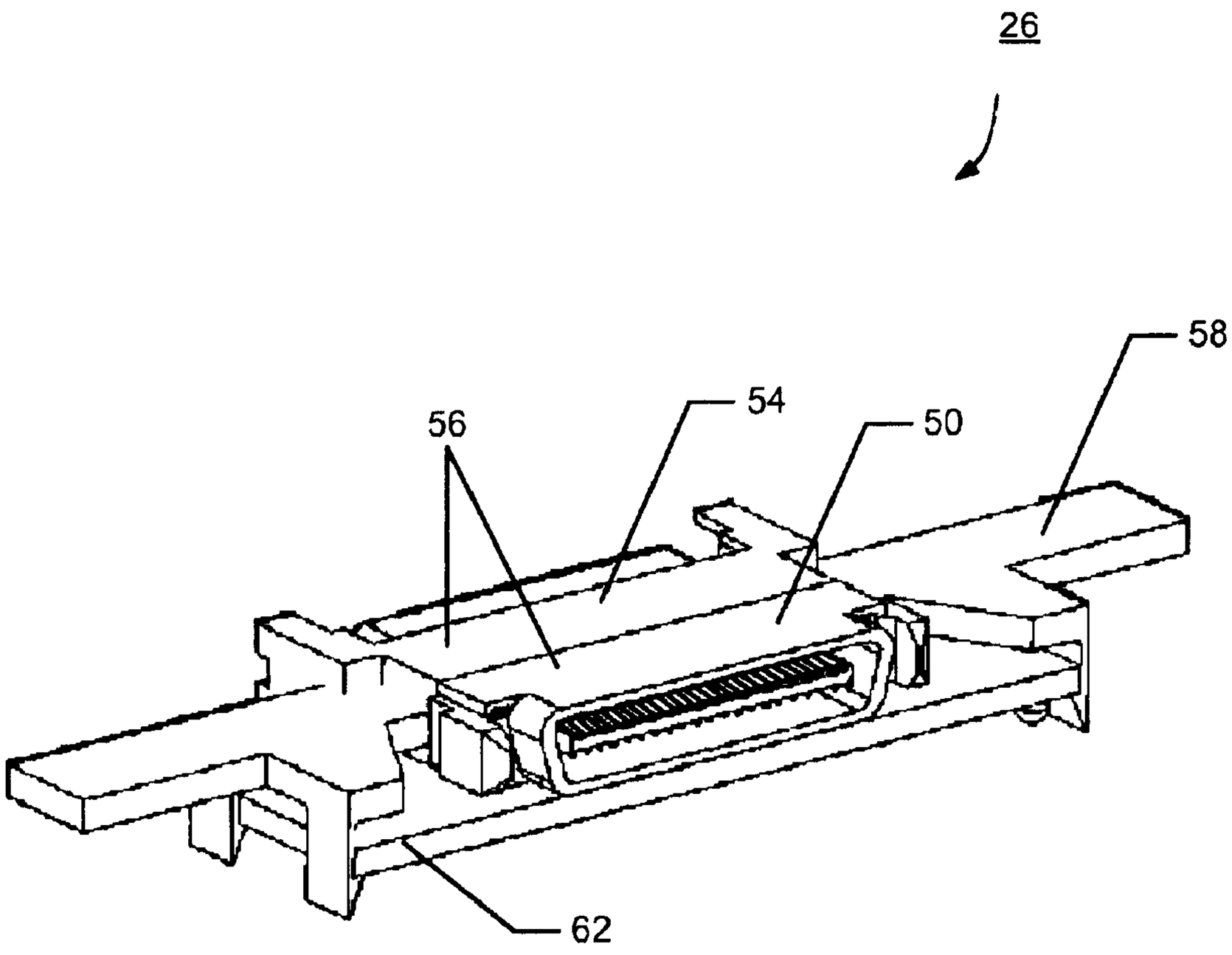

FIG. 3

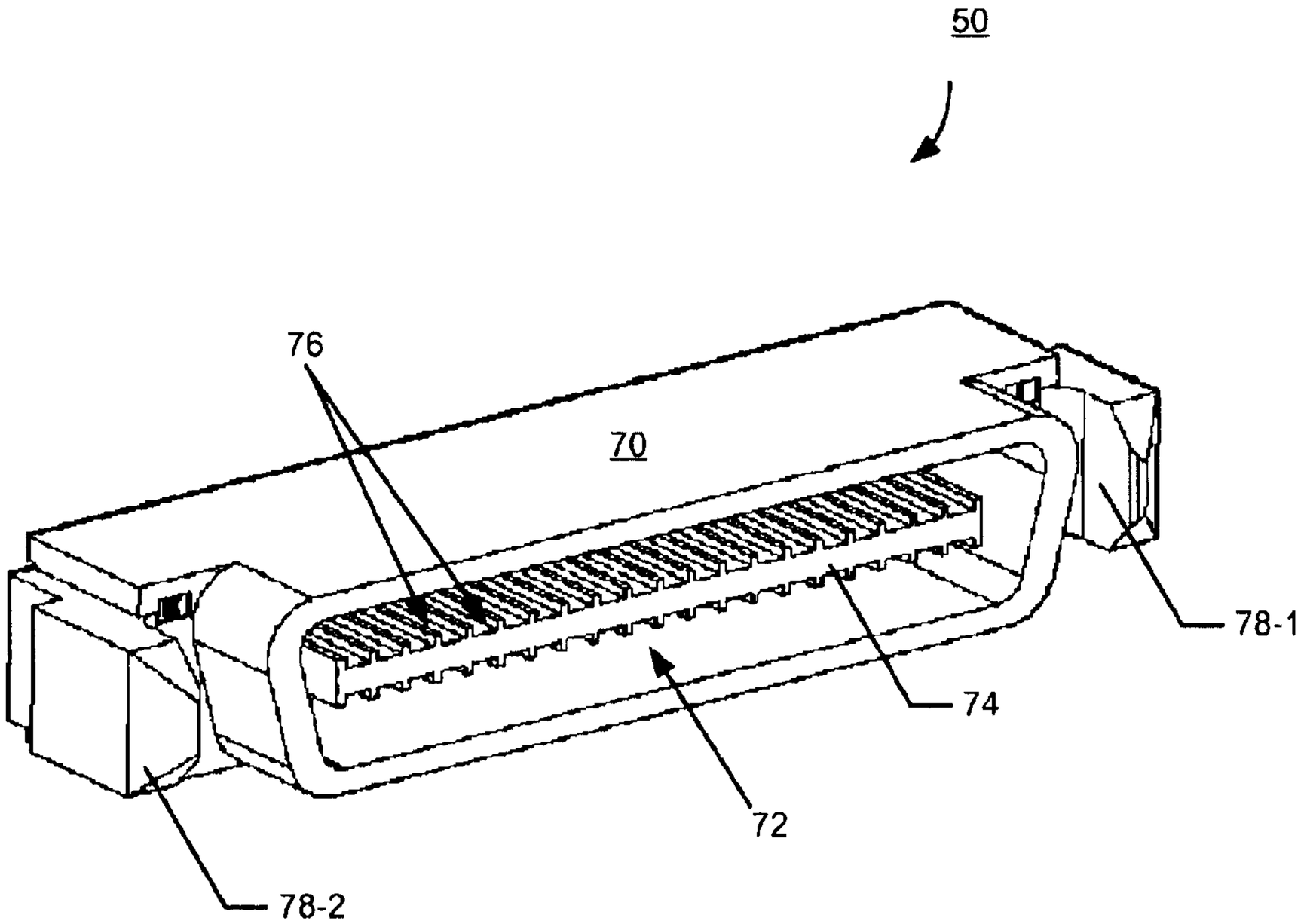

FIG. 4

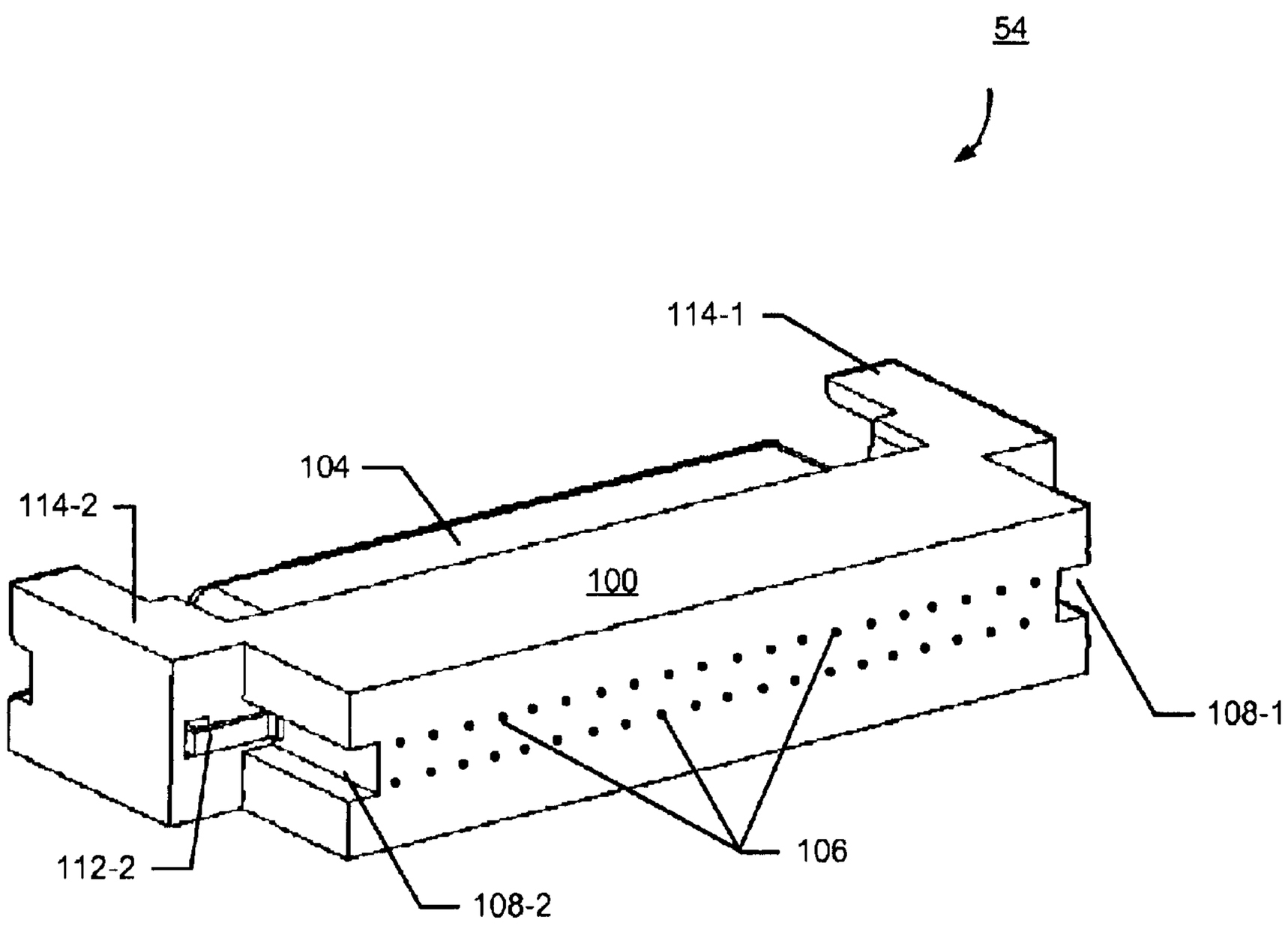

FIG. 5A

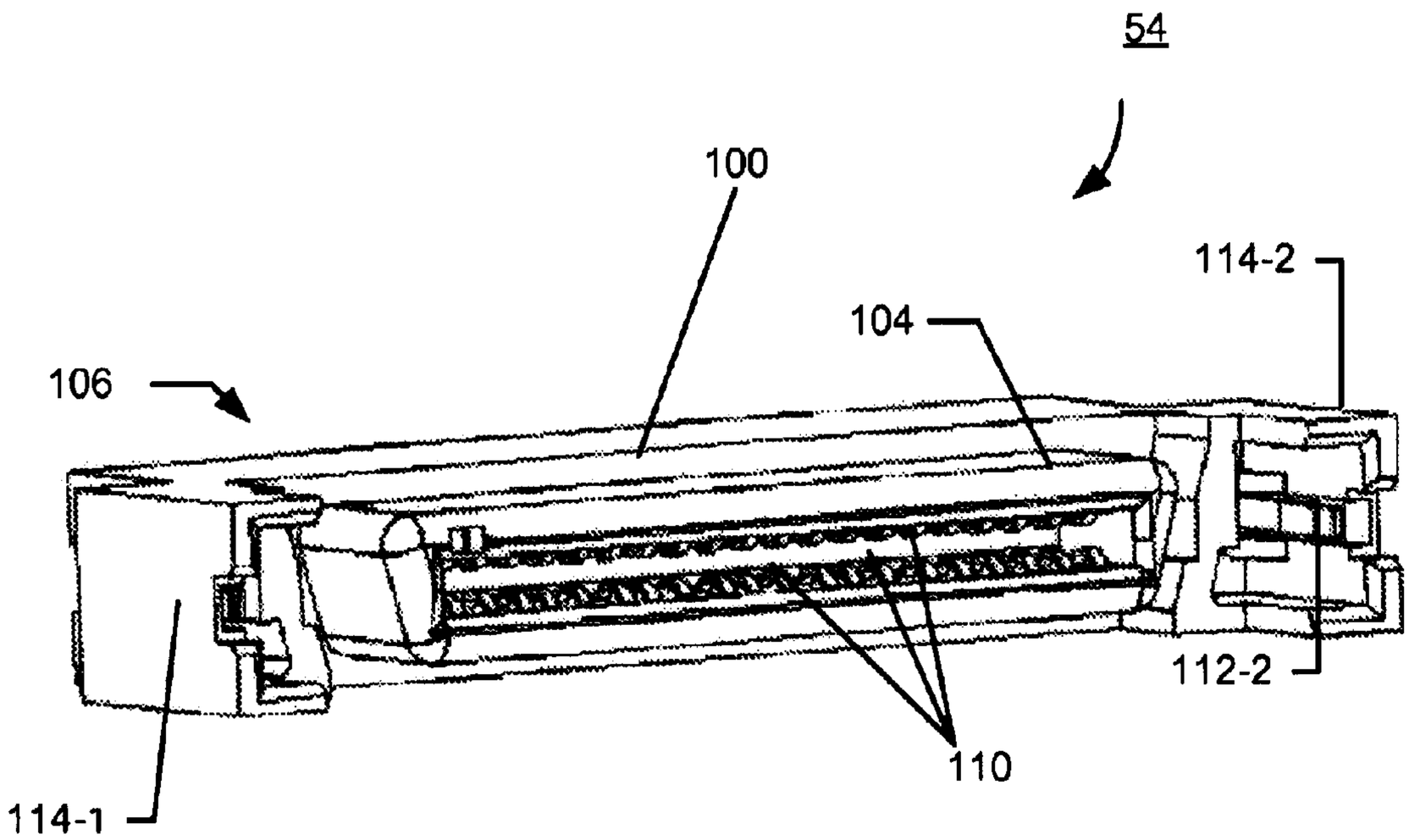

FIG. 5B

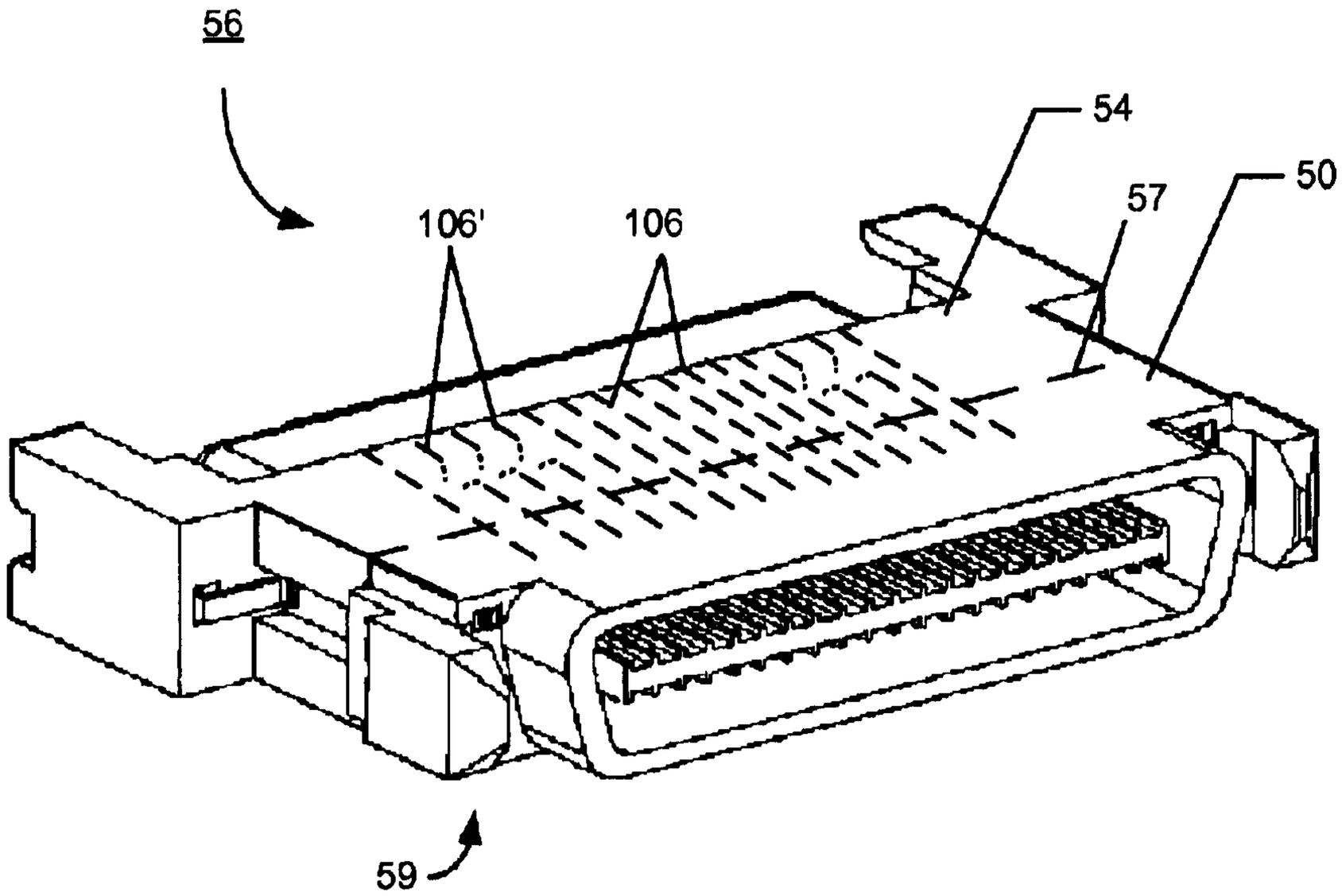

FIG. 6

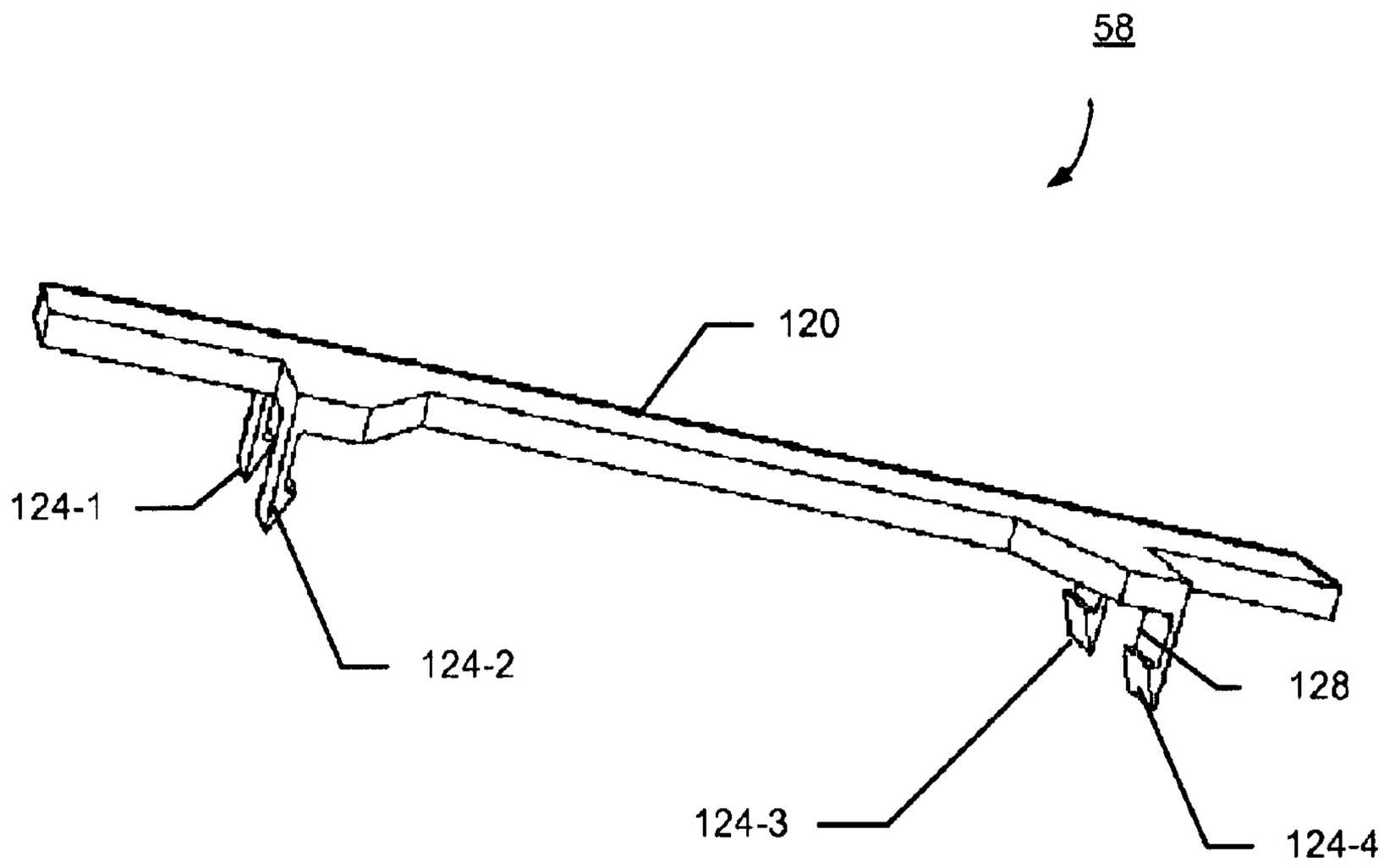

FIG. 7

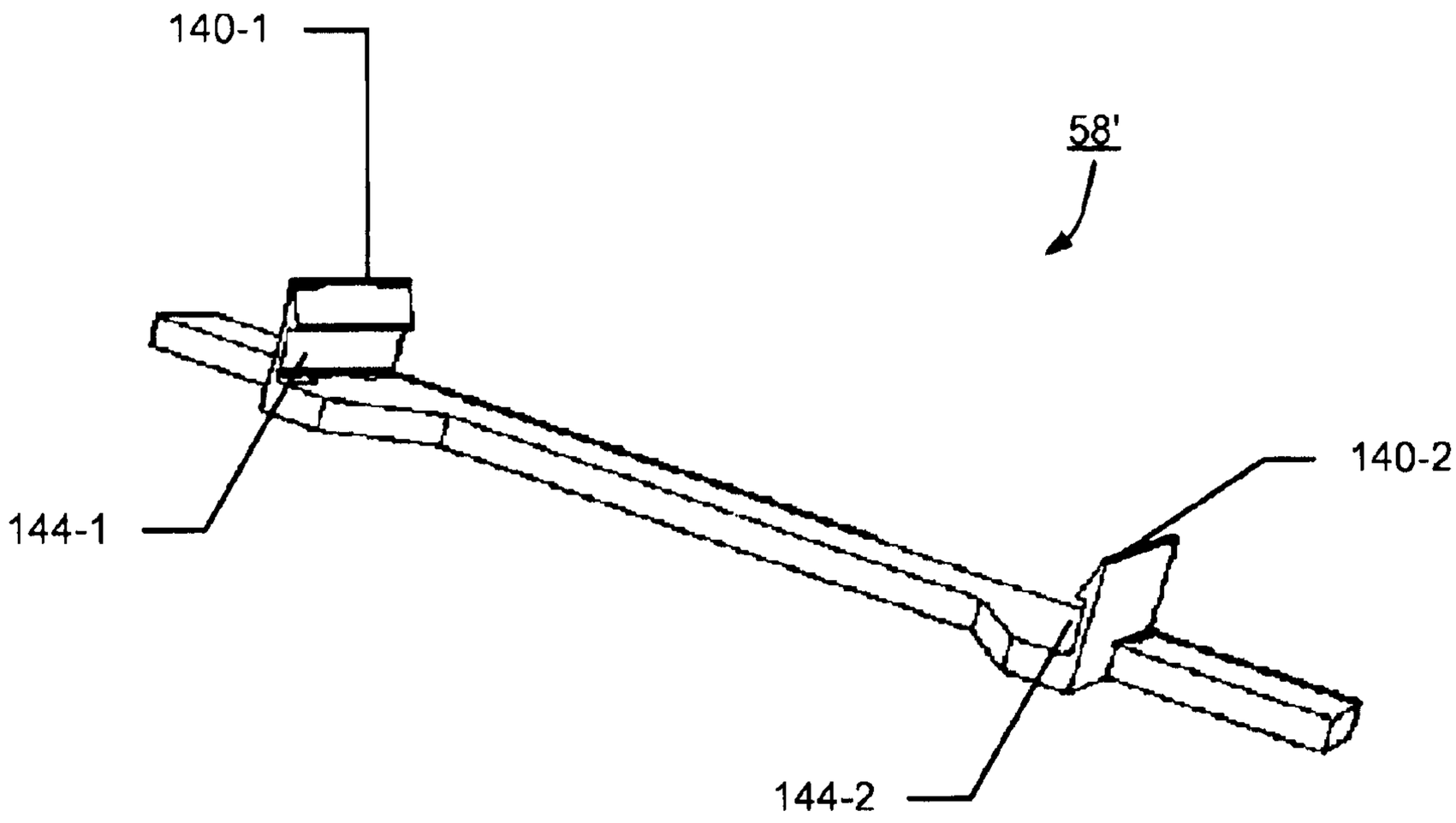

FIG. 8

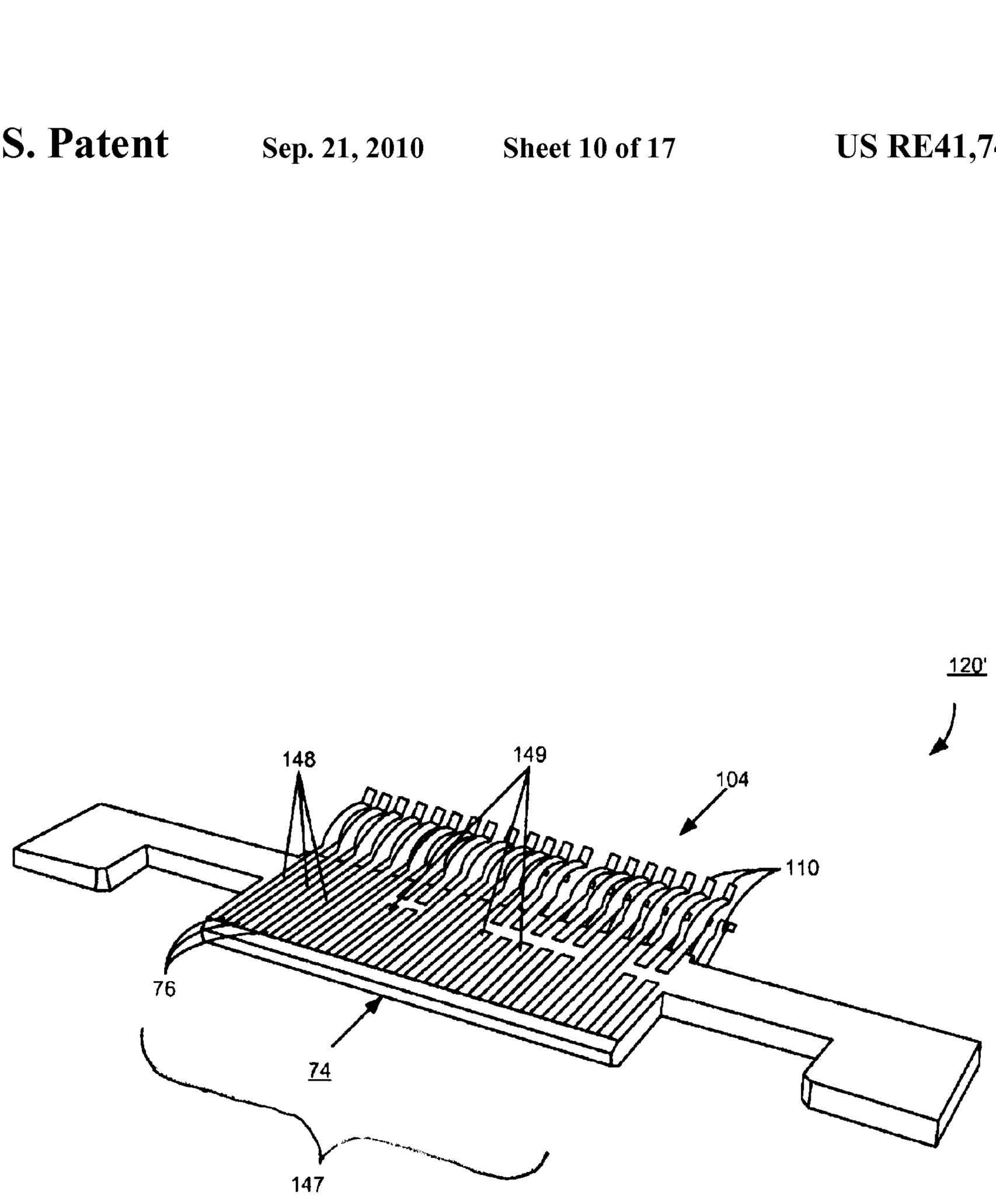

FIG. 9

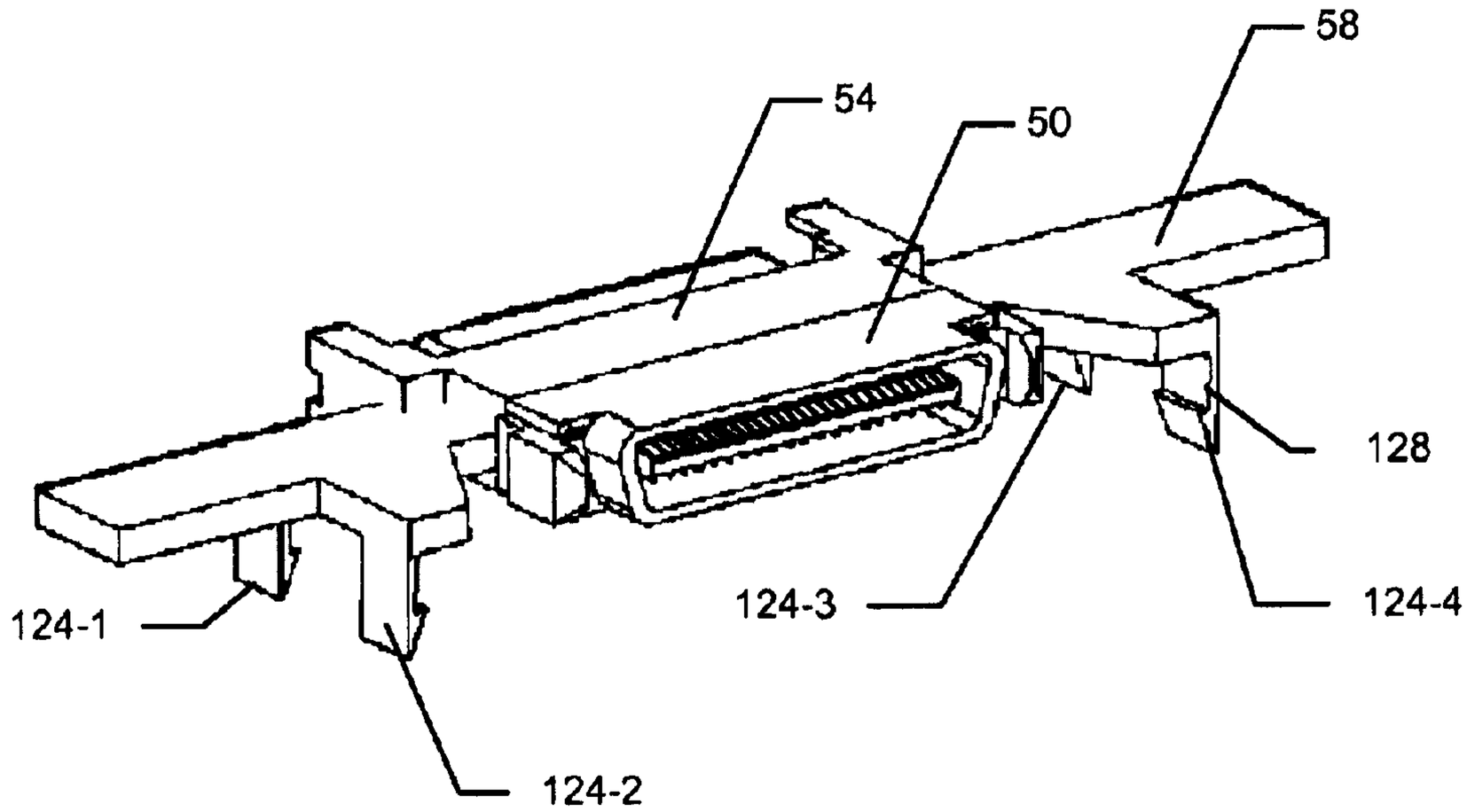

FIG. 10

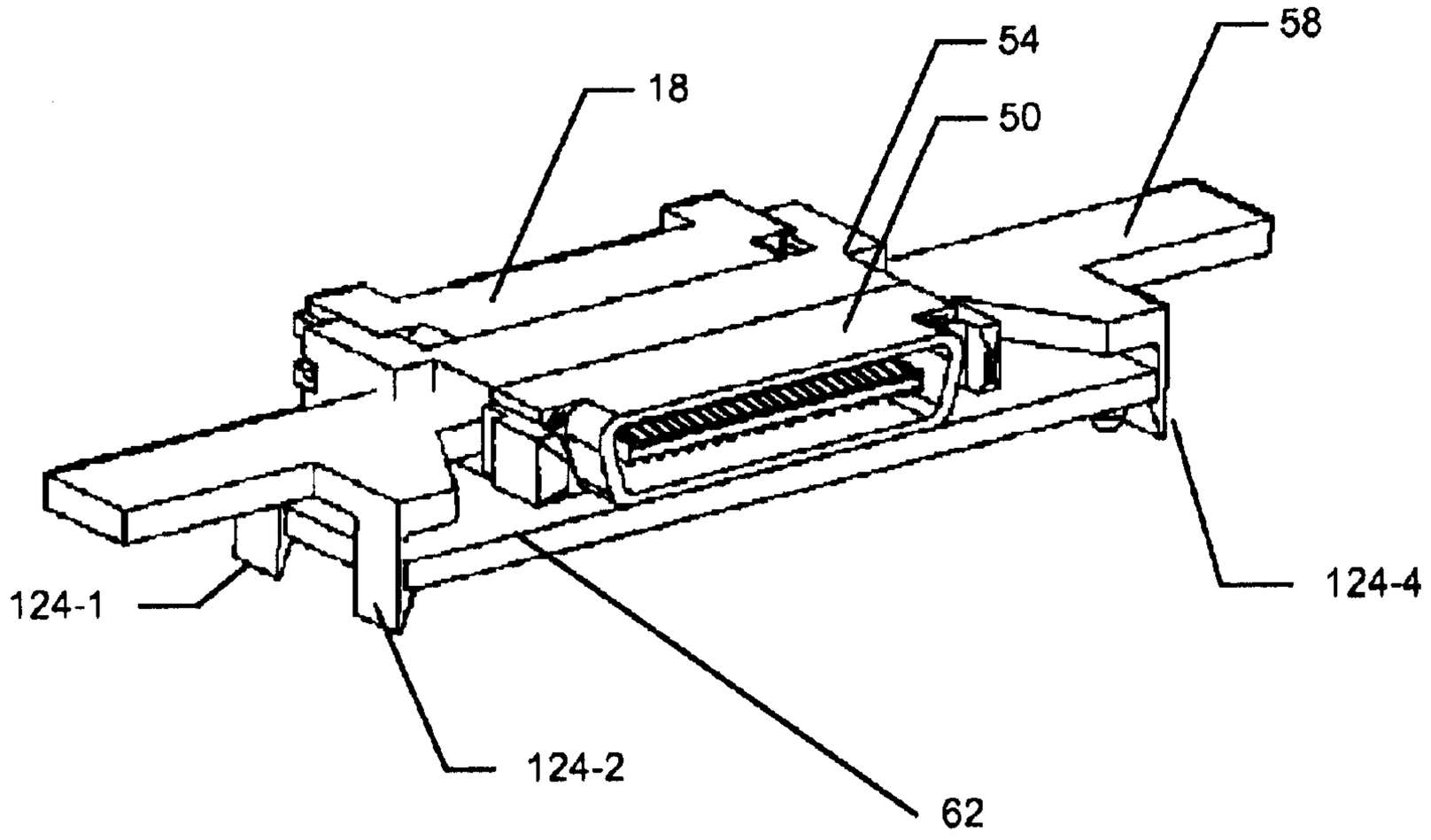

FIG. 11

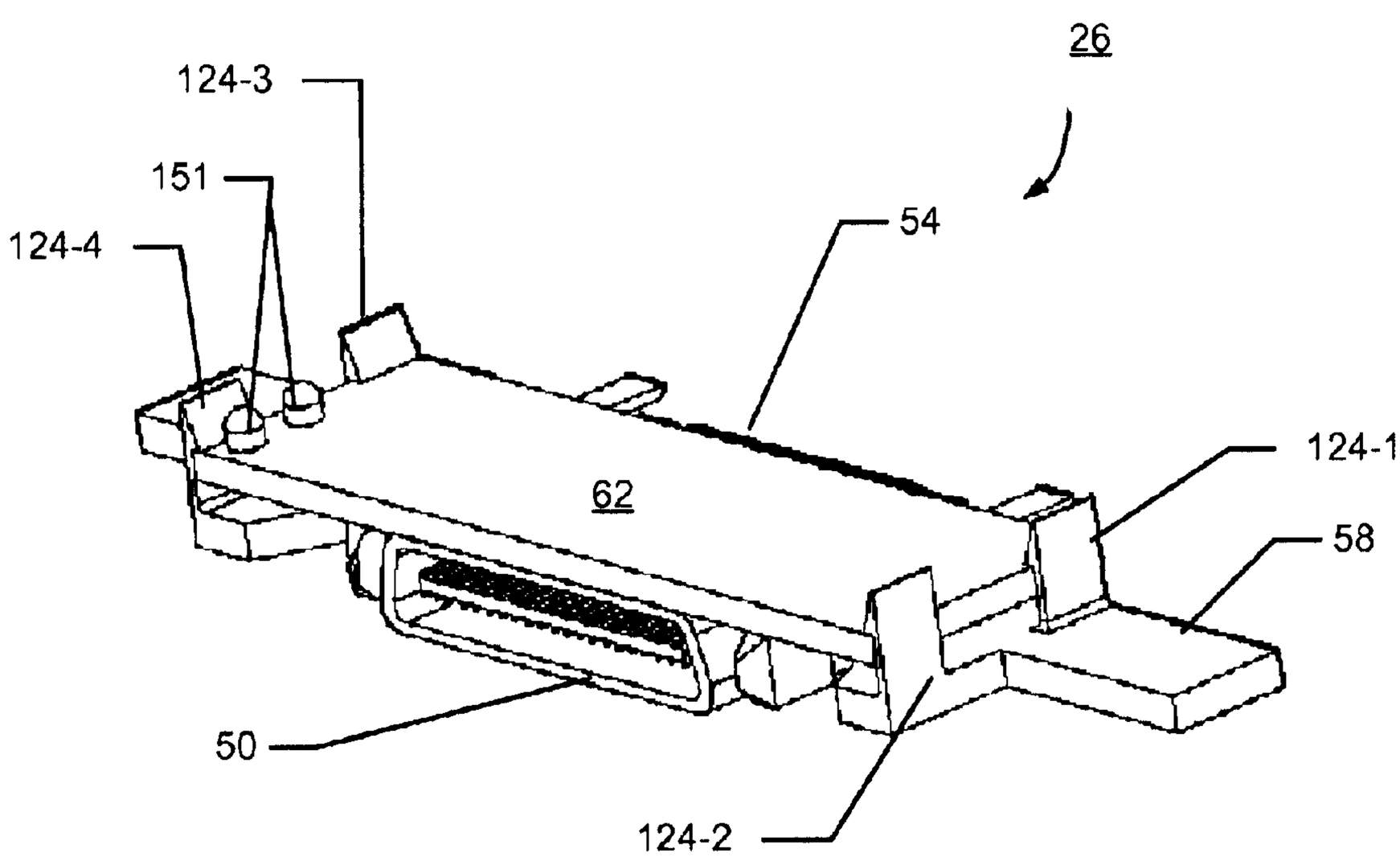

FIG. 12

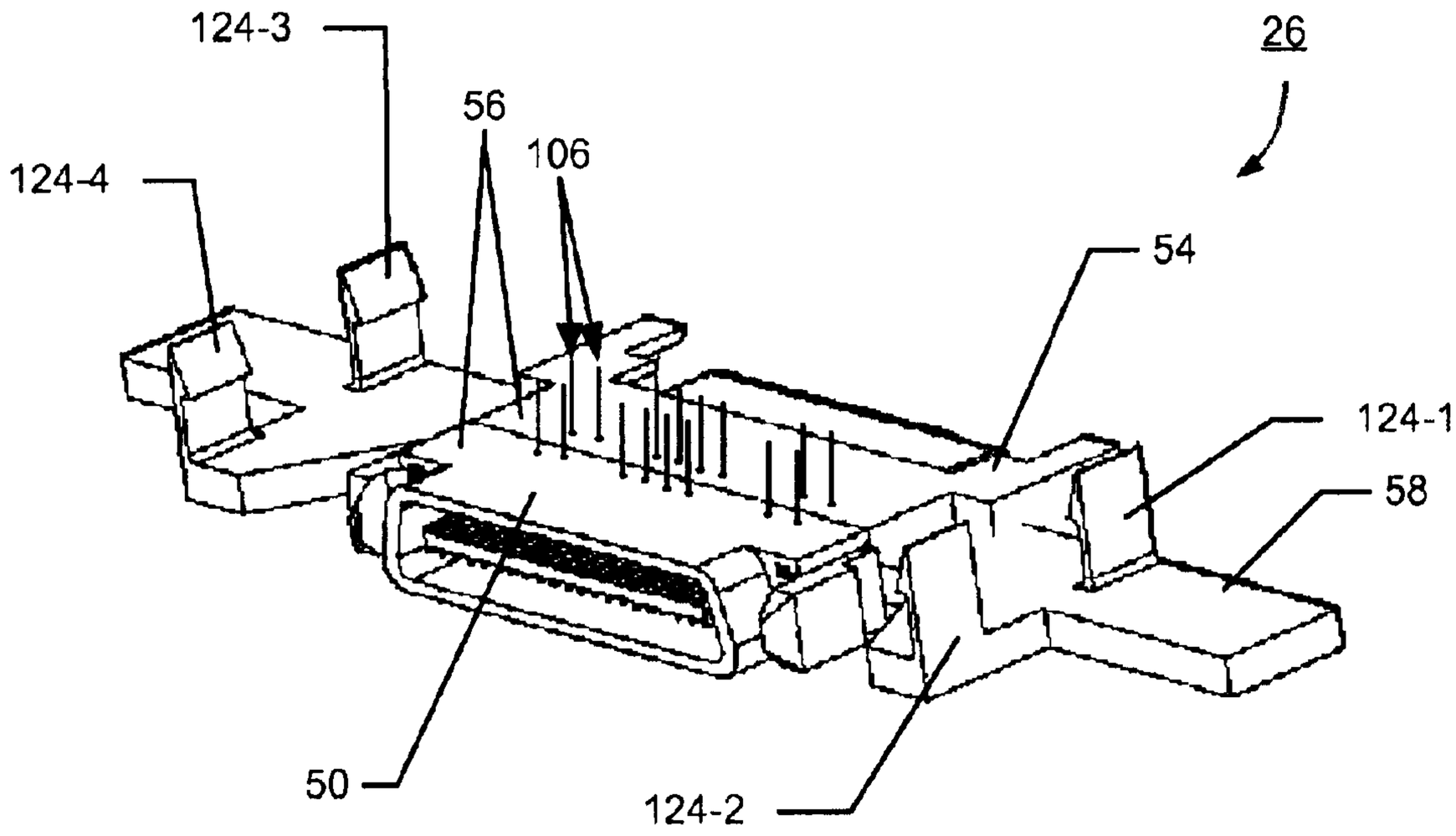

FIG. 13

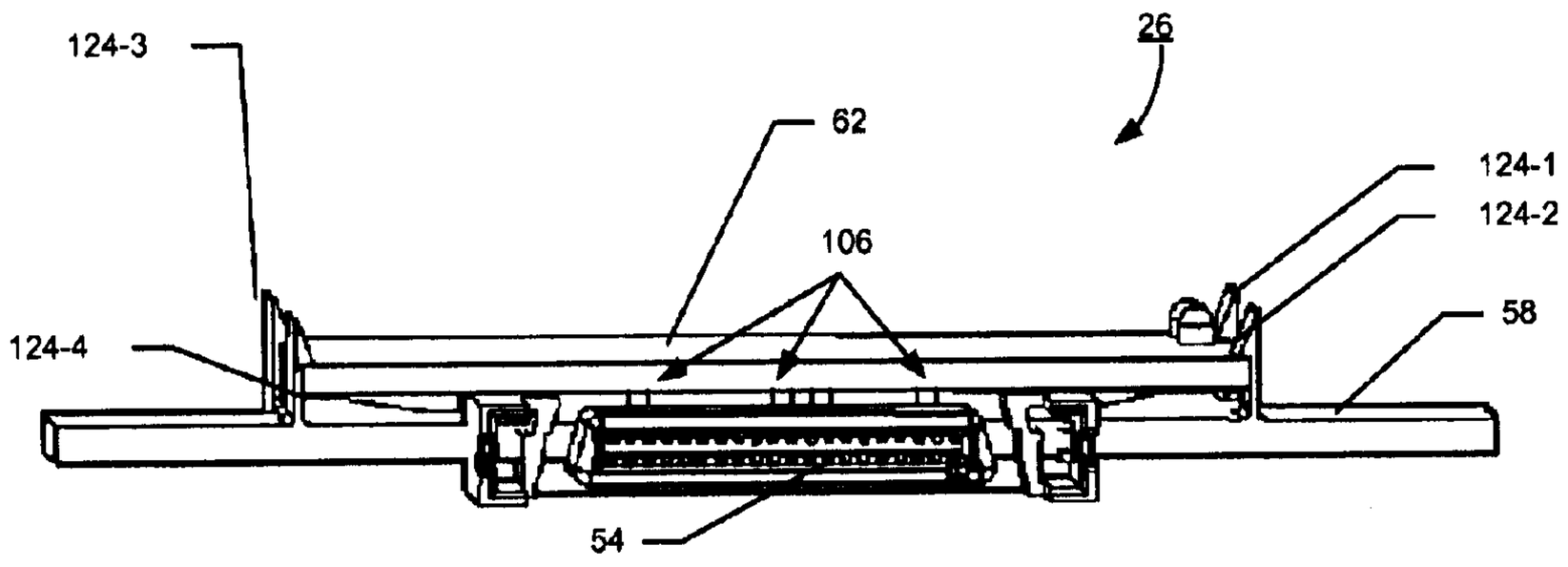

FIG. 14

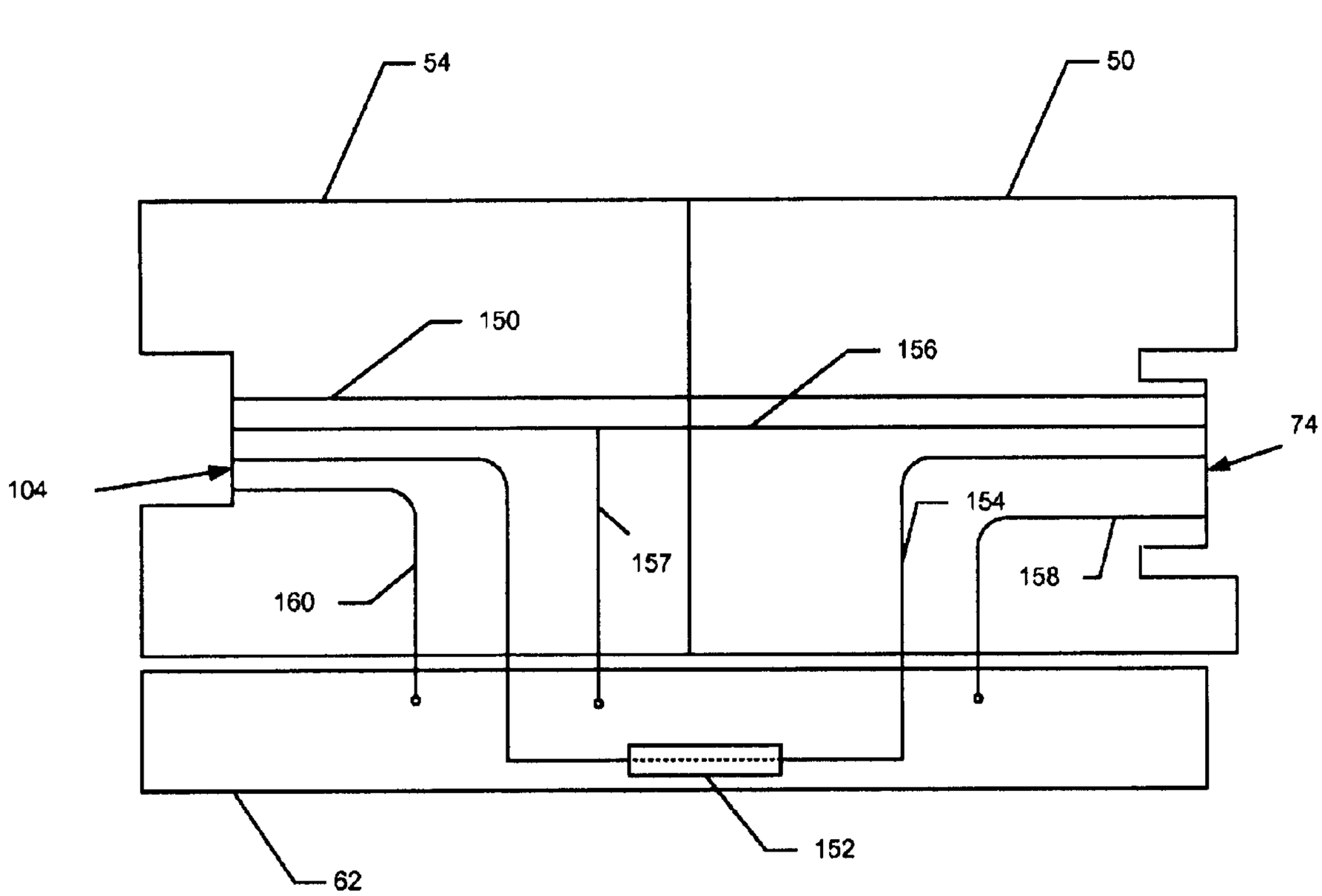

FIG. 15

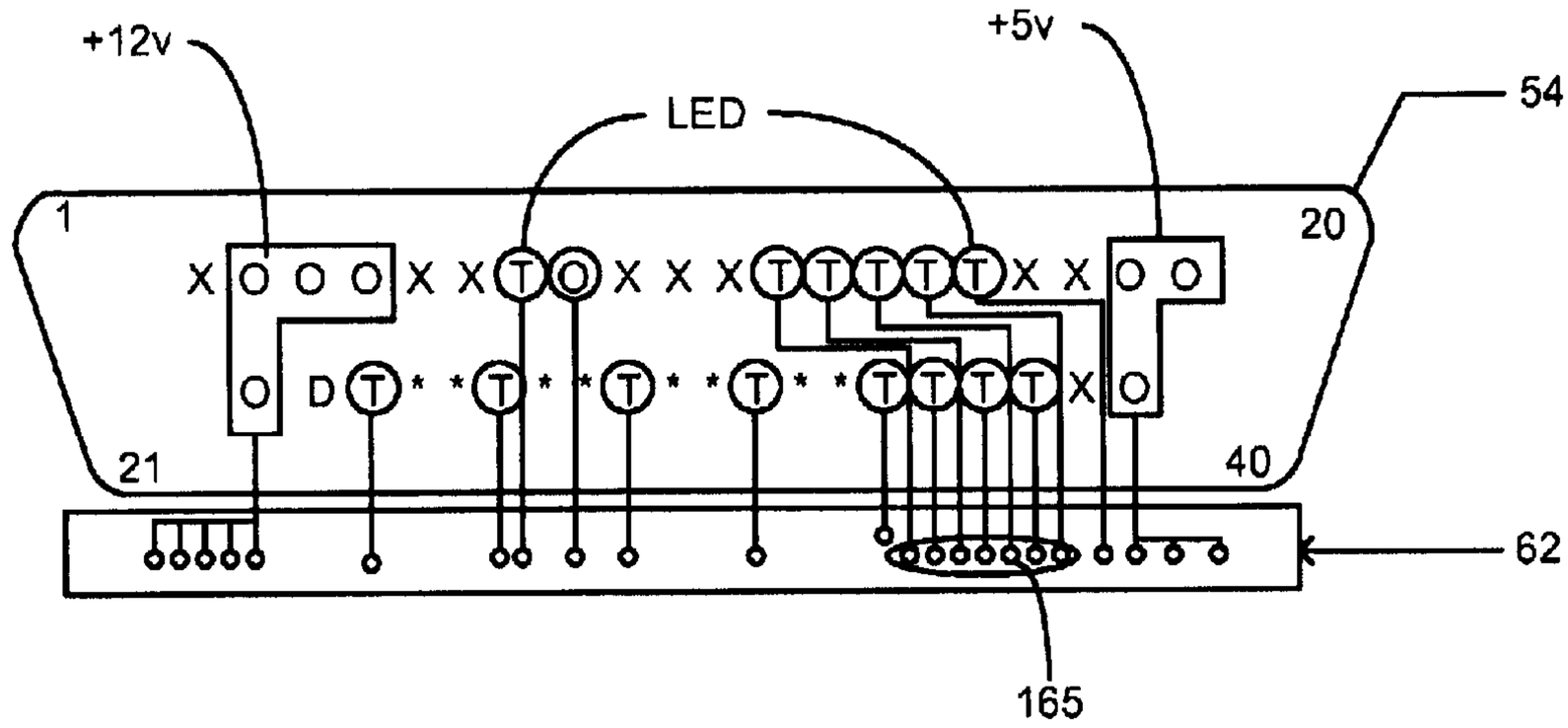

FIG. 16A

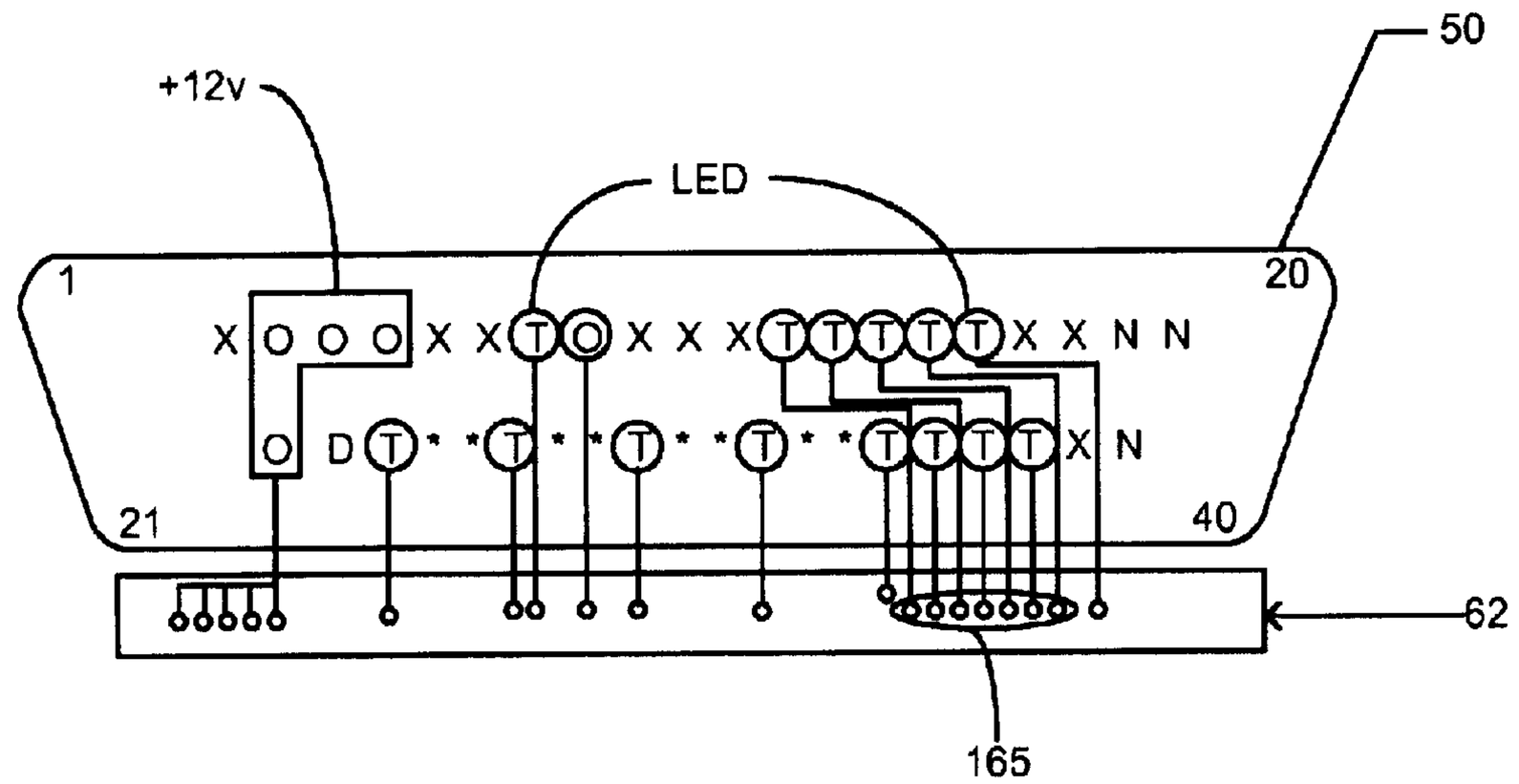

FIG. 16B

ELECTRICAL CONNECTOR AND CIRCUIT CARD 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.

RELATED APPLICATION

This utility application claims the benefit of U.S. Provisional Patent Application No. 60/863,905, filed on Nov. 1, 2006, the entirety of which is incorporated by reference herein.

FIELD OF THE INVENTION

The present invention relates generally to electronics enclosures and electrical connector assemblies. More particularly, the present invention relates to an electrical connector assembly for electrically and physically coupling disk drives to a midplane within a disk array enclosure.

BACKGROUND

Some disk array enclosures use hard disk drives that require 12 volts DC only, and the midplane (or backplane) to which such disk drives are electrically connected provides the requisite voltage (i.e., 12 volts only). Additionally, some disk array enclosures use hard disk drives with customized features that enhance their suitability within a product. These features include, but are not limited to, on/off control, soft-start control, current-limit protection, and logic signal conditioning. To reduce the cost of disk array enclosures, one trend is to use commodity (i.e., off-the-shelf) disk drives. Commodity disk drives, however, can require more than a single voltage level, such as 12 volts DC and 5 volts DC. These disk drives may also lack the prerequisite enhanced features needed to make them suitable in a particular application or product. To use such commodity disk drives in these disk array enclosures therefore requires means, external to the disk drive, for converting the 12 volts supplied by the midplane into each required voltage level, for producing certain system functionality (e.g., the enhanced features), or both.

To perform this voltage conversion (and various system functionality, such as previously described), an external, small circuit card (also called a paddle card or an adapter board) is disposed between the midplane and the disk drive. This circuit card includes electrical signal paths and circuitry, e.g., for delivering a 5-volt and 12-volt supply to the disk drive based on the 12-volt supply provided by the midplane, for passing through the 12 volts from the midplane to meet the 12-volts requirements of the disk drive, and for providing the various enhanced functionality.

SUMMARY

In one aspect, the invention features an electrical connector assembly an electrical connector having a connector body with a receptacle connector portion at a first end and a plug connector portion at a second end opposite the first end. The receptacle connector portion has electrical contacts within an opening for mating with a plug electrical connector at the first end of the connector body. The plug connector portion has electrical contacts within an opening for mating with a receptacle electrical connector at the second end of the connector body. The connector body has an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from one side of the connector body. A circuit card is disposed adjacent to that one side of the connector body and is in electrical communication with the at least one electrical contact through the electrical conductor extending from the side of the connector body.

In another aspect, the invention features an electronics enclosure comprising a disk drive assembly having a disk drive and a disk drive connector extending from one end of the disk drive. A midplane has a midplane connector extending from one side thereof. An electrical connector assembly electrically couples the disk drive assembly to the midplane. The electrical connector assembly includes an electrical connector having a connector body with a receptacle connector portion at a first end and a plug connector portion at a second end opposite the first end. The receptacle connector portion has electrical contacts within an opening for mating with a plug electrical connector at the first end of the connector body. The plug connector portion has electrical contacts within an opening for mating with a receptacle electrical connector at the second end of the connector body.

The connector body has an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from one side of the connector body. A circuit card is disposed adjacent to that one side of the connector body and is in electrical communication with the at least one electrical contact through the electrical conductor extending from the side of the connector body.

In another aspect, the invention features an electrical connector assembly having an electrical connector body with a first electrical connector at a first end and with a second electrical connector at a second end opposite the first end. Each electrical connector has a plurality of electrical contacts. The electrical connector body has an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from one side of the connector body. A circuit card is disposed adjacent to that one side of the connector body and is in electrical communication with the at least one electrical contact through the electrical conductor extending from the side of the connector body. The electrical connector assembly has means for holding the circuit card adjacent to the connector body.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and further advantages of this invention may be better understood by referring to the following description in conjunction with the accompanying drawings, in which like numerals indicate like structural elements and features in the various figures. The drawings are not meant to limit the scope of the invention. For clarity, not every element may be labeled in every figure. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. **1** is a diagram of an embodiment of a disk drive assembly including an embodiment of an electrical connector assembly constructed in accordance with the invention.

FIG. **2** is a block diagram of an embodiment of an electronics enclosure having a midplane coupled to a plurality of disk drives through electrical connector assemblies of the present invention.

FIG. **3** is a diagram of an embodiment of the electrical connector assembly of FIG. **1** used to couple a midplane to a disk drive, the electrical connector including a circuit card.

FIG. **4** is a diagram of an embodiment of a plug connector portion of the electrical connector assembly of FIG. **3**, having a connector body with electrical contacts and an arm on each side thereof.

FIG. **5**A is a back view of an embodiment of a receptacle connector portion of the electrical connector assembly of FIG. **3**.

FIG. **5**B is a disk-side view of the receptacle connector portion of FIG. **5**A.

FIG. **6** is a diagram of a plug connector portion together with the receptacle connector portion of FIG. **3**.

FIG. **7** is a diagram of an embodiment of a cardholder portion of the electrical connector assembly of FIG. **3**.

FIG. **8** is a diagram of another embodiment of a cardholder portion of the electrical connector assembly of FIG. **3**.

FIG. **9** is a diagram of an embodiment of the cardholder body having electrical traces that extend between a receptacle member of the receptacle connector portion and a plug member of the plug connector portion.

FIG. **10** is a diagram of an embodiment of the electrical connector assembly with an empty cardholder.

FIG. **11** is a diagram of the electrical connector assembly with a circuit card held by the holding means of the cardholder.

FIG. **12** is a bottom view diagram of the electrical connector assembly.

FIG. **13** is a bottom view of the electrical connector assembly without the circuit card to show electrically conductive pins projecting through the side of the connector body.

FIG. **14** is a disk-drive-side view of the electrical connector assembly, with the circuit card.

FIG. **15** is a diagram of examples of various types of electrical signal paths in an embodiment of the electrical connector assembly of the invention.

FIGS. **16**A and **16**B are, respectively, exemplary pin descriptions (i.e., "pin outs") of the plug and receptacle connector portions of an embodiment of the electrical connector assembly of the invention.

DETAILED DESCRIPTION

Electrical connector assemblies of the present invention have a connector body with back-to-back first and second electrical connector portions. Extending from one side of the connector body are electrically conductive pins. A circuit board disposed adjacent to this side of the connector body couples to these electrical conductors and is thereby in electrical communication with the first and second electrical connector portions. In some embodiments, the electrical connector assembly includes a cardholder for holding the circuit card adjacent to the one side of the connector body.

Various types of electrical signal paths pass through the connector body. Some electrical signal paths pass directly through from the first electrical connector portion to the second electrical connector portion. Other electrical signal paths pass from the connector body to the circuit card, where such signal paths may terminate or propagate and return to connector body. For those signal paths passing through the circuit card, the circuit card has circuitry for responding to or operating upon the signals carried by the paths, e.g., to provide enhanced functionality or to perform signal conversions, such as converting a 12-volt power supply signal into a 5-volt power supply signal.

One exemplary use for the electrical connector assembly is to connect a disk drive to a midplane or backplane of a disk array enclosure. The first connector portion of the electrical connector assembly connects to an electrical connector of the disk drive and the second connector portion of the electrical connector assembly connects to an electrical connector on the midplane.

FIG. **1** shows an embodiment of a disk drive assembly **10** constructed in accordance with the invention. The disk drive assembly **10** includes a disk drive **14** with a disk drive connector **18** that physically and electrically connects to an embodiment of an electrical connector assembly **26** constructed in accordance with the invention. Opposite sides of the disk drive **14** are coupled to opposing carrier rails **22-1**, **22-2** (generally, **22**). Types of disk drives with which the electrical connector assembly **26** may be used include, but are not limited to, Fibre Channel and Advanced Technology Attachment (ATA) drives. In one embodiment, the disk drive **14** is of a type that requires 5 volts and 12 volts for proper operation. In another embodiment, the disk drive **14** is of a type needing only 12 volts.

FIG. **2** shows a block diagram of an embodiment of an electronics enclosure **30** (here, e.g., a disk array enclosure) within which the electrical connector assembly **26** of the present invention may be embodied. The electronics enclosure **30** includes disk drive assemblies **10-1**, **10**-n (generally, **10**), a midplane **32**, redundant (e.g., link) control cards **34-1**, **34-2** (generally, **34**), and redundant power supplies **36-1**, **36-2** (generally **36**). The midplane **32** includes disk-drive-side connectors **38** and supply-side connectors **40**. Each control card **34** and each power supply **36** has a connector **42** for mating with a corresponding supply-side connector **40**. Each disk drive assembly **10-1**, **10**-n includes a respective disk drive **14-1**, **14**-n with a disk drive connector **18**. An electrical connector assembly **26** of the invention electrically and physically couples the disk drive connector **18** with a disk-drive-side connector **38** of the midplane **32**.

FIG. **3** shows an embodiment of the electrical connector assembly **26** in detail. The electrical connector assembly **26** includes a plug connector portion **50**, a receptacle connector portion **54**, and a cardholder portion **58** extending approximately midway from each side of the receptacle connector portion **54**. The plug connector portion **50** and receptacle connector portion **54** make up a unitary connector body **56** (e.g., injection-molded plastic). The connector body **56** may also be integrally formed as a single unit with the cardholder portion **58**. In addition, the width of the electrical connector assembly **26**, determined by the span of the cardholder portion **58**, may be designed to fit into a 2.5" or a 3.5" disk drive slot.

In one embodiment, the plug and receptacle connector portions **50**, **54** conform to SCA-2 industry standards for SCA connectors. In general, SCA-2 standards, e.g., SFF (Small Form Factor) Committee standard SFF-8045 for 40-pin SCA-2 Connector w/ Parallel Selection, SFF-8451 for 40- and 80-pin SCA connectors, and draft standard SFF-8053i for 20-pin SCA connectors, specify the size, length, width, height, board mounting, pin location, and specific mating features. Other embodiments of the plug and receptacle connector portions **50**, **54** include, but are not limited to, Serial Attached SCSI (SAS) connectors and Serial Advanced Technology Attachment (SATA) connectors. The housing of the plug and receptacle connector portions **50**, **54** can be made of plastic.

In one embodiment, the cardholder portion **58** holds a circuit card **62** adjacent to one side of the connector body **56**. Electrically conductive pins (not shown) emerge from the side of the connector body **56** and enter through-holes in the circuit card **62**, to couple the circuit card **62** electrically to the plug and receptacle connector portions **50**, **54**. Soldering

may be used to join the electrically conductive pins to the circuit card **62**. Although only one circuit card is shown in FIG. **3**, it is to be understood that multiple electrically interconnected circuit cards may be stacked together and coupled to the connector body.

Exemplary implementations of the circuit card **62** include, but are not limited to, a printed circuit board (PCB) and a flex circuit. In general, the circuit card **62** includes circuitry for achieving special-purpose functionality. To achieve this functionality, the circuitry can include a variety of components, e.g., active and passive devices, integrated circuit chips or devices, and light-emitting diodes. These components can be disposed on either or both sides of the circuit card **62**. On the side of the circuit board **62** facing the connector body **56**, the circuit card **62** can have mechanical standoffs that come against and may couple to the connector body **56**. In addition to providing structural support, such standoffs ensure a certain amount of spacing between components on that side of the circuit card **62** and the connector body **56**. The spacing may be useful in allowing cooling air to flow over the devices on the circuit card **62**.

In one embodiment, the circuitry of the circuit card **62** converts a 12-volts supply signal into a 5-volts supply. In other embodiments, the circuitry of the circuit card **62** provides certain disk drive functionality, e.g., on/off control, soft-start control, current-limit protection, logic signal conditioning, or combinations thereof. The circuitry can achieve other types of functionality without departing from the principles of the invention.

FIG. **4** shows an embodiment of the plug connector portion **50** of the electrical connector assembly **26**. The plug connector portion **50** has a connector body portion **70** with a plug opening **72** and an arm **78-1**, **78-2** on each side thereof. Within the plug opening **72** is a plug member **74** comprised of electrical contacts **76**.

FIG. **5**A and FIG. **5**B show an embodiment of the receptacle connector portion **54** having a connector body portion **100** with a receptacle member **104** comprised of electrical contacts (not visible). The connector body **100** portion has electrically conductive pins **106** passing therethrough and lateral grooves **108-1**, **108-2** (generally, **108**) on opposite sides thereof, from which the cardholder portion **58** laterally extends. These grooves **108** are representative of the general location of where the cardholder portion **58** meets the connector portion **54**. Such grooves need not exist for an integrally formed electrical connector assembly **26**, as mentioned previously. Near each groove **108** is electrical ground contact (only contact **112-2** is visible), which electrically communicates with electrical ground in the plug connector portion **50** and electrical ground on the circuit card **62**. The ground contacts **112** extend into opposing connector arms **114-1**, **114-2**. As shown in FIG. **5**B, the receptacle member **104** has a cavity with upper and lower rows of electrical contacts **110** for receiving therebetween an edge of a plug electrical connector.

FIG. **6** shows the connector body **56** with the plug connector portion **50** and the receptacle connector portion **54** together, as an embodiment of the connector body **56** if constructed separately from the cardholder portion **58**. The dashed line **57** represents an approximate delineation between the connector portions **50**, **54**, there being no actual delineation in an integrally formed connector body **56**. Electrically conductive pins **106**, **106'** (generally **106**) within the connector body **56** extend between the plug connector portion **50** and the receptacle connector portion **54**. Some of the pins **106** pass straight through (i.e. continuously) and other pins **106'** bend generally perpendicular from the plane of the connector body **56** and emerge from the side **59** of the connector body **56**. Those pins shown are merely illustrative. The connector body **56** can have more or fewer of each type of pin, and in different locations, than those shown.

FIG. **7** shows an embodiment of the cardholder portion **58** having a cardholder body **120** with four cardholding posts **124-1**, **124-2**, **124-3**, **124-4** (generally, **124**) extending perpendicularly from the same side of the cardholder portion **58**. Each post **124** has a notch **128** for receiving an edge of the circuit card **62** (here, two posts for each opposite edge of the circuit card **62**). The posts **124** hold the circuit card **62** parallel to the cardholder body **120**. To insert a circuit card **62** into the notches **128** of the cardholder portion **58**, the circuit card **62** is urged against the sloped surfaces of the four posts **124**, with the appropriate through-holes of the circuit card **62** in alignment with the pins extending from the side of the connector body **56**. The posts **124** are flexible and bend outwardly to allow the circuit card **62** to snap into place within the notches **128**, the posts **124** then returning to their original position.

Another embodiment of a cardholder **58'** includes sidewalls (**140-1**, **140-2**) with cardholding grooves (**144-1**, **144-2**) formed therein, as shown in FIG. **8**. Still other embodiments of electrical connector assemblies lack such cardholders: that is, the circuit card **62** can be held against and secured to the side of the connector body **56** by other types of holding means (e.g., screws, bolts, adhesives, soldering), without departing from the principles of the invention.

FIG. **9** shows an embodiment of a cardholder body **120'** (here shown without any posts **124**). A central portion **147** of the cardholder body **120'** may be implemented as a multilayer printed circuit board. Conductive electrical traces **148**, **149** run along a surface of the central portion **147** of the cardholder body **120'** between the plug member **74** and the receptacle member **104** (the connector body **56** that encapsulates the electrical traces being absent in order to facilitate the illustration). Some of the electrical traces **148** extend continuously from an electrical contact **76** at the plug member **74** to an electrical contact **110** at the receptacle member **104**. Such electrical traces are examples of "pass through" electrical signal paths.

Other electrical traces **149** are discontinuous, i.e., there is a gap in the electrical trace between an electrical contact **76** at the plug member **74** and an electrical contact **110** at the receptacle member **104**. Instead of being direct pass-through electrical signal paths, these electrical traces **149** provide electrical signal paths that pass to the circuit card **62** (not shown) by way of electrically conductive pins. Such electrical signal paths may terminate at the circuit card **62** or return to an electrical trace **149** (e.g., on the other side of the gap).

In another embodiment, the connector body **56** encapsulates electrically conductive pins that provide the electrical signal paths between the electrical contacts of the plug member **74** and receptacle member **104** (i.e., straight-through pins) and between the electrical contacts of either member **74**, **104** and the circuit card **62** (i.e., pins that bend approximately perpendicularly from the plane of the connector body and project from the side thereof).

FIG. **10** shows an embodiment of the electrical connector assembly **26** (without the circuit card **62**), constructed in accordance with the invention. The posts **124** of the cardholder portion **58** are merely illustrative of a means for holding the circuit card **62**. FIG. **11** shows the electrical connector assembly **26** with the circuit card **62** being held by the

posts **124** of the cardholder portion **58**. Also shown is the disk drive connector **18** physically and electrically coupled to the receptacle connector portion **54** of the electrical connector assembly **26**.

FIG. **12** shows a bottom view of the electrical connector assembly **26** with the circuit card **62**. The bottom view shows a pair of LEDs **151** that can be in communication with the circuitry on the circuit card **62**. FIG. **13** shows a bottom view of the electrical connector assembly **26** without the circuit card **62**. Electrically conductive pins **106** project from the side of the connector body **56** adjacent to the circuit card **62**. FIG. **14** shows a disk-drive-side view of the electrical connector assembly **26**, in which are visible the cardholder portion **58**, circuit card **62**, receptacle connector portion **54**, and pins **106** that electrically coupling the circuit card **62** to the connector body **56**.

FIG. **15** shows examples of various types of electrical signal paths in one embodiment of the electrical connector assembly **26**. Some electrical signal paths go straight through the connector body **56**, as exemplified by electrical signal path **150** (i.e., directly through the connector portions **50**, **54**, from the midplane connector **38** of FIG. **2** to the disk drive connector **18**).

Other electrical signal paths pass between an electrical contact **76** of the plug member **74** and an electrical contact **110** of the receptacle member **104** through the circuit card **62** (as typified by the electrical signal path **154**). Circuitry **152** on the circuit card **62** can receive and operate upon electrical signals traversing this signal path **154** (e.g., to convert a 12-volt voltage supply signal from the midplane **32** into a 5-volt supply signal for the disk drive **14**).

Some of the electrical paths can terminate at the circuit card **62** and provide "test" nodes at which a signal probe from external electronic equipment can analyze the signals passing therethrough. For example, an electrical signal path **156** passes through from the receptacle member **104** of the receptacle connector portion **54** and has a tap **157** (i.e., an electrical conductor) that extends perpendicularly therefrom and terminates at the circuit card **62**. As another example, an electrical signal path **158** includes an electrical conductor that extends from the plug member **74** of the plug connector portion **50**, bends approximately perpendicularly therefrom, and terminates at the circuit card **62**. Electrical signal path **160** exemplifies yet another type of signal path that terminates at the circuit card **62**, this path originating from an electrical contact of the receptacle member **104**.

FIGS. **16**A and **16**B show, respectively, exemplary pin descriptions (i.e., "pin outs") of the receptacle and plug connector portions **54**, **50** of the electrical connector assembly **26**. Numbers for representative pin locations appear in the corners of the connector portions. Table 1 associates each pin location with a number and a signal name.

TABLE 1

Pin Number	Signal Name	Comments
1	–EN Bypass Port 1	Output Driven High When Port 1 is Operating Correctly
2	+12 Vout/+12 vin	+12 v out on receptacle (drive end)/ +12 v on plug (midplane end)
3	+12 Vout/+12 vin	+12 v out on receptacle (drive end)/ +12 v on plug (midplane end)
4	+12 Vout/+12 vin	+12 v out on receptacle (drive end)/ +12 v on plug (midplane end)

TABLE 1-continued

Pin Number	Signal Name	Comments
5	–Parallel ESI	Input to allow ESI operation using the SELx pins
6	GND	
7	ACTLED	Output to drive the activity LED cathode
8	Reserved	
9	Start1	Input to control spin-up behavior
10	Start2	Input to control spin-up behavior
11	–EN	Bypass Port 2 Output driven high when port 2 is operating correctly
12	SEL6	Device ID bit 6/ESI write clock
13	SEL5	Device ID bit 5/ESI read clock
14	SEL4	Device ID bit 4/ESI acknowledge clock
15	SEL3	Device ID bit 3/ESI bit 3
16	FLTLED	Output to drive the fault LED cathode
17	DEVCTRL2	Input to control interface speed
18	DEVCTRL1	Input to control interface speed
19	+5 V	Drive side only
20	+5 V	Drive side only
21	+12 Vout/+12 vin	+12 v out on receptacle (drive end)/ +12 v on plug (midplane end)
22	GND	
23	GND	
24	+IN1	Fibre Channel Input
25	–IN1	Fibre Channel Input
26	GND	
27	+IN2	Fibre Channel Input
28	–IN2	Fibre Channel Input
29	GND	
30	+OUT1	Fibre Channel Output
31	–OUT1	Fibre Channel Output
32	GND	
33	+OUT2	Fibre Channel Output
34	–OUT2	Fibre Channel Output
35	GND	
36	SEL2	Device ID bit 2/ESI bit 2
37	SEL1	Device ID bit 1/ESI bit 1
38	SEL0	Device ID bit 0/ESI bit 0
39	DEVCTRL0	Input to control interface speed
40	+5 V	Drive side only

In this exemplary embodiment, the signal names are associated with Fibre Channel signals. At each numbered pin location is a symbol (O, X, T, *, or D) indicating the type of electrical signal path with which that pin (i.e., electrical contact) is coupled. Pin locations marked with an "X" or with an asterisk (*) are coupled to electrical paths that pass directly (i.e., straight) through the connector portions **50**, **54**, as exemplified by electrical signal path **150** in FIG. **15**. Those locations marked with an asterisk signify high-speed pass through paths.

Pin locations identified by an "O" are "interrupted" electrical paths that pass between the connector portions **50**, **54** through circuitry **152** of the circuit card **62**, as exemplified by electrical signal path **154** in FIG. **15**. Pin locations marked with a "T" pass to the circuit card **62** (and can "tap" at the circuit card **62**) for purposes of providing test nodes, as exemplified by electrical signal path **156** in FIG. **15**. Some of the pin locations designated with a "T" (reference numeral **165**) may instead be pulled up to an internal +5 v level (i.e., within the connector assembly) using a pull-up resistor (e.g., 10K). A pin location with a D designation indicates that the pin is open (i.e., disconnected); those with an N designation indicates that the pin is a "no connect".

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims. For example, other embodiments of electrical

connector assemblies constructed in accordance with the invention can have two plug connector portions at opposite ends of the connector body, instead of a plug connector portion and a receptacle connector portion. Alternatively, the connector body can be comprised of two receptacle connector portions. As other examples, the circuit card can be disposed adjacent to the other side of the connector body, or circuit cards can be disposed adjacent both sides of the connector body (which, in this embodiment, has electrically conductive pins emerging from both sides thereof).

Further, although described herein with reference to disk array enclosures, electrical connector assemblies of the invention can find application within other types of electronics enclosures, i.e., wherever an external adapter board or circuitry is employed to provide an interface to an electronics assembly, e.g., to enhance its functionality or to perform signal conversions.

What is claimed is:

1. An electrical connector assembly comprising:

an electrical connector body with a first electrical connector at a first end, with a second electrical connector at a second end opposite the first end, and a side surface extending from the **[**receptacle connector portion**]** *first electrical connector* at the first end to the **[**plug receptacle portion**]** *second electrical connector* at the second end, each electrical connector having a plurality of electrical contacts, the electrical connector body having an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from the side surface of the connector body;

a circuit card having a surface disposed adjacent to and facing the side surface of the connector body, the surface of the circuit card having an electrical conductor that is in electrical communication with the electrical conductor extending from the side surface of the connector body; and

means for holding the circuit card adjacent to the connector body.

2. The electrical connector assembly of claim **1**, wherein each of the electrical connectors of the connector body is a plug electrical connector.

3. The electrical connector assembly of claim **1**, wherein each of the electrical connectors of the connector body is a receptacle electrical connector.

4. An electrical connector assembly comprising:

an electrical connector having a connector body with a receptacle connector portion at a first end of the connector body, a plug connector portion at a second end of the connector body opposite the first end, and a side surface extending from the receptacle connector portion at the first end to the plug **[**receptacle**]** *connector* portion at the second end, the receptacle connector portion having electrical contacts within an opening for mating with a plug electrical connector at the first end of the connector body, and the plug connector portion having electrical contacts within an opening for mating with a receptacle electrical connector at the second end of the connector body, the connector body having an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from the side surface of the connector body; and

a circuit card physically coupled to the connector body, the circuit **[**board**]** *card* having a surface disposed adjacent to and facing the side surface of the connector body, the surface of the circuit card having an electrical conductor that is in electrical communication with the electrical conductor extending from the side surface of the connector body, to provide thereby an electrical path from the circuit card to the at least one electrical contact.

5. The electrical connector assembly of claim **4**, wherein one of the electrical contacts of the electrical connector is in electrical communication with the circuit card over an electrical signal path that includes the electrical conductor and terminates at the circuit card.

6. The electrical connector assembly of claim **4**, wherein the circuit card includes circuitry that provides logic signal conditioning.

7. The electrical connector assembly of claim **4**, wherein the circuit card is a flex circuit.

8. The electrical connector assembly of claim **4**, wherein the plug and receptacle connector portions of the electrical connector are SCA-2 standard compliant SCA (single connector attachment) connectors.

9. The electrical connector assembly of claim **4**, wherein one of the electrical contacts of the plug connector portion is in electrical communication with one of the electrical contacts of the receptacle connector portion over an electrical signal path that includes the electrical conductor and passes through the circuit card.

10. The electrical connector assembly of claim **9**, wherein the electrical signal path carries a 12-volt power supply signal and the circuit card includes circuitry for converting the 12-volt power supply signal into a 5-volt power supply signal.

11. The electrical connector assembly of claim **4**, wherein one of the connector portions of the electrical connector is configured to mate electrically and physically with an electrical connector of a disk drive.

12. The electrical connector assembly of claim **11**, wherein the circuit card includes circuitry that provides on-off control functionality for the disk drive.

13. The electrical connector assembly of claim **11**, wherein the circuit card includes circuitry that provides soft-start control for the disk drive.

14. The electrical connector assembly of claim **11**, wherein the circuit card includes circuitry that provides current-limit protection for the disk drive.

15. The electrical connector assembly of claim **4**, further comprising means for holding the circuit **[**board**]** *card* adjacent to the one side of the connector body.

16. The electrical connector assembly of claim **15**, wherein the means for holding includes a holder body extending from the connector body and posts extending perpendicularly from one side of the holder body, each post having a notch for holding an edge of the circuit card.

17. The electrical connector assembly of claim **16**, wherein the means for holding, the plug connector portion, and the receptacle connector portion are an integrally formed component.

18. An electronics enclosure comprising:

a disk drive assembly having a disk drive and a disk drive connector extending from one end of the disk drive;

a midplane having a midplane connector extending from one side thereof; and

an electrical connector assembly electrically coupling the disk drive assembly to the midplane, the electrical connector assembly comprising:

an electrical connector having a connector body with a receptacle connector portion at a first end of the connector body, a plug connector portion at a second end of the connector body opposite the first end, and a side surface extending from the receptacle connector

portion at the first end to the plug **[**receptacle**]** *connector* portion at the second end, the receptacle connector portion having electrical contacts within an opening for mating with a plug electrical connector at the first end of the connector body, and the plug connector portion having electrical contacts within an opening for mating with a receptacle electrical connector at the second end of the connector body, the connector body having an electrical conductor that is in electrical communication with at least one of the electrical contacts and extends from the side surface of the connector body; and

a circuit card physically coupled to the connector body, the circuit **[**board**]** *card* having a surface disposed adjacent to and facing the side surface of the connector body, the surface of the circuit card having an electrical conductor that is in electrical communication with the electrical conductor extending from the side surface of the connector body, to provide thereby an electrical path from the circuit card to the at least one electrical contact.

19. The electronics enclosure of claim **18**, wherein the circuit card includes circuitry that provides on-off control functionality for the disk drive.

20. The electronics enclosure of claim **18**, wherein the circuit card includes circuitry that provides soft-start control for the disk drive.

21. The electronics enclosure of claim **18**, wherein the circuit card includes circuitry that provides current-limit protection for the disk drive.

22. The electronics enclosure of claim **18**, wherein the circuit card includes circuitry that provides logic signal conditioning.

23. The electronics enclosure of claim **18**, wherein the circuit card is a flex circuit.

24. The **[**electrical connector assembly**]** *electronics enclosure* of claim **18**, wherein the plug and receptacle connector portions are SCA-2 standard compliant SCA (single connector attachment) connectors.

25. The electronics enclosure of claim **18**, wherein one of the electrical contacts of the plug connector portion is in electrical communication with one of the electrical contacts of the receptacle connector portion over an electrical signal path that includes the electrical conductor and passes through the circuit card.

26. The electronics enclosure of claim **25**, wherein the electrical signal path carries a 12-volt power supply signal and the circuit card includes circuitry for converting the 12-volt power supply signal into a 5-volt power supply signal used by the disk drive for operation.

27. The electronics enclosure of claim **18**, further comprising means for holding the circuit **[**board**]** *card* adjacent to the one side of the connector body.

28. The electronics enclosure of claim **27**, wherein the means for holding includes a holder body and posts extending perpendicularly from one side of the holder body, each post having a notch for holding an edge of the circuit card.

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