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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 December 2010 (09.12.2010)

PCT

(10) International Publication Number
WO 2010/141307 A2

(51) International Patent Classification:
H01R 12/16 (2006.01) *H01R 13/08* (2006.01)
H01R 13/04 (2006.01) *H01R 12/08* (2006.01)

(21) International Application Number:
PCT/US2010/036340

(22) International Filing Date:
27 May 2010 (27.05.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
200903792-0 3 June 2009 (03.06.2009) SG

(71) Applicant *(for all designated States except US)*: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **QIAO, Yun Long** [CN/SG]; 1 Yishun Avenue 7, Singapore 768923 (SG).

(74) Agents: **HARTS, Dean M.** et al.; 3M Center Office of Intellectual, Property Counsel Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

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

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

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) Title: CONNECTOR

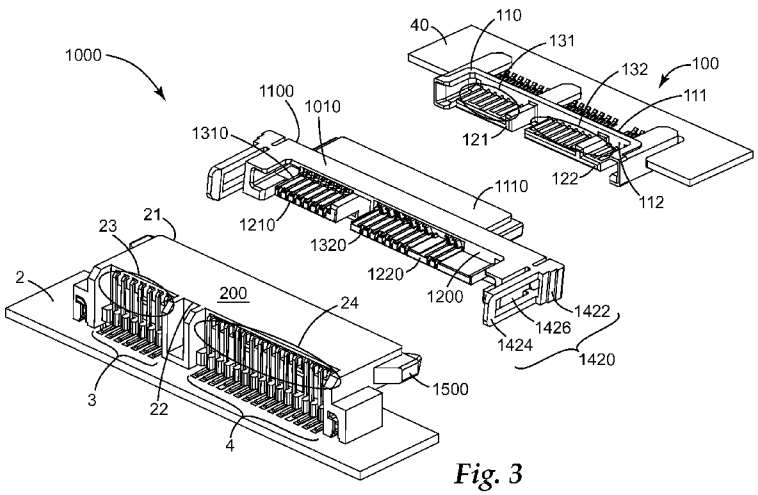

Fig. 3

(57) Abstract: An electrical connector includes a housing having a base portion with first and second mating ends. The first mating end can couple with a first complementary connector with a plurality of slots in an extension from the base, the second mating end can couple with a second complementary connector with a tongue portion extending from the base portion and having a first and a second tongue section. The connector has a plurality of contacts extending from the extension to the tongue portion, each contact having a first and a second contact section and a bridging section connecting these sections. The contacts are grouped forming a first and second contact set wherein the first and second contact section of each contact in the first contact set are aligned substantially along an axis while the first and second contact sections in the second contact set are aligned along different axes.

WO 2010/141307 A2

CONNECTOR

Technical Field

The present invention relates to a connector, in particular, an electrical connector for coupling devices with different hard disk drive interfaces.

Background

Hard disk drives (HDDs) are used to store digital data content for laptops, desktop computers, servers and other electronic devices in use today. Each of these electronic devices has its own requirements for the storage media to be used such as access time, capacity, form factor, reliability and data transmission rates.

An HDD interface is the communication channel over which the data flows as the data is read from or written to the HDD. Types of interfaces available today include Integrated Drive Electronics (IDE), Advanced Technology Attachment (ATA), Small Computer System Interface (SCSI), Serial ATA (SATA), Serial Attached SCSI (SAS), and micro SATA. It should be noted that the list of interfaces provided above is not exhaustive and is constantly increasing to keep pace with the ever changing demands of the electronic devices which dictate the specifications of the HDDs and their interfaces. In this document, the terms "interface" and "connector" are used interchangeably.

The SATA connector and the SAS connector are the two most commonly used connectors in the HDD industry today. According to the specifications set by the Small Form Factor (SFF) Committee, a SATA connector has 22 contacts (also referred to as "terminals" or "pins" in this document) of which 15 contacts are used for power transmission and 7 contacts are used for data signal transmission. In addition to the 22 contacts available in the SATA connector, an SAS connector has an additional 7 contacts (i.e. 29 contacts in total) for data signal transmission.

Along with the desire to have smaller electronic devices comes the need to have smaller physical size HDDs. Thus, there is an industry need to have a HDD connector with a smaller form factor (i.e. physical size) such as the micro SATA HDD connector. Similar to the SATA and SAS connector, the micro SATA connector has 7 data signal contacts.

However, as a micro SATA HDD is physically smaller and a micro SATA HDD consumes less power, the micro SATA connector only requires 9 power contacts.

Available in the market today are specialized test equipments used for testing HDDs before they are released for sale. However, most of these test equipments are designed specifically for HDDs with a particular type of connector such as the SATA HDD connector or the SAS HDD connector. With the introduction of the micro SATA HDDs, the existing test equipments will either require modifications or replacement before the micro SATA HDDs may be tested. Both options will require the HDD testing companies to incur substantial new capital spending. Moreover, it may not be cost effective for the HDD testing companies to install and house multiple types of test equipments solely for the testing of HDDs of different HDD connectors such as SATA, SAS and micro SATA HDD connectors.

It would be desirable to provide an electrical connector that can be used to couple devices with different HDD connectors. It would be desirable if the electrical connector can further be used with existing test equipment for testing HDDs with different HDD connectors from that of the test equipment. It would also be desirable if the electrical connector may be attached to a backplane or a printed circuit board (PCB) of an existing test equipment so that the existing test equipment may be reconfigured to be used for testing HDDs with a different type of HDD connector.

Summary

In accordance with one embodiment of the present invention, there is provided an electrical connector comprising:

an elongated insulative housing having a longitudinal base portion with a first mating end and a second mating end;

wherein the first mating end is configured to couple with a first complementary electrical connector by means of a plurality of slots defined within an extension extending from the base portion;

wherein the second mating end is configured to couple with a second complementary electrical connector by means of a tongue portion extending from the base

portion, the tongue portion comprising a first tongue section and a second tongue section; and

a plurality of contacts extending from the extension to the tongue portion, each contact comprising a first contact section, a second contact section and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

In accordance with another embodiment of the present invention, there is provided an interconnect system comprising at least one electrical connector, a first complementary electrical connector and a second complementary electrical connector wherein the electrical connector is configured to couple the first complementary electrical connector and the second complementary electrical connector; and wherein

the first complementary electrical connector is attached to a printed circuit board which is attached to a hard disk drive;

the second complementary electrical connector is attached to a backplane which is attached to test equipment; and wherein

said electrical connector comprises:

an elongated insulative housing having a longitudinal base portion with a first mating end and a second mating end; wherein the first mating end is configured to couple with the first complementary electrical connector by means of a plurality of slots defined within an extension extending from the base portion and the second mating end is configured to couple with the second complementary electrical connector by means of a tongue portion extending from the base portion, the tongue portion comprising a first tongue section and a second tongue section; and

a plurality of contacts extending from the extension to the tongue portion, each contact comprising a first contact section, a second contact section and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned

substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

In accordance with one embodiment of the present invention, there is provided an electrical connector on a backplane comprising:

an elongated insulative housing having a first mating end and a second mating end;

wherein the first mating end is configured to couple with a first complementary electrical connector by means of a plurality of slots defined within an extension extending from the first mating end of the housing; and

a plurality of contacts extending from the extension to the second mating end, each contact comprising a first contact section, a second contact section attached to the backplane and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

The invention further includes any alternative combination of parts or features mentioned herein or shown in the accompanying drawings. Known equivalents of these parts or features which are not expressly set out are nevertheless deemed to be included.

Brief Description of the Drawings

An exemplary form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1A is a perspective view of an existing interconnect system comprising a SATA socket attached to a backplane of a test equipment (not shown) and a SATA header attached to a printed circuit board (PCB) of a hard disk drive (HDD) (not shown);

Figure 1B is a front view of an extension of the socket of Figure 1A taken from a side facing a first mating surface of the socket;

Figure 2 is a perspective view of an existing interconnect system comprising a SAS socket attached to a backplane of a test equipment (not shown) and a SATA header attached to a PCB of a HDD (not shown);

Figure 3 is a perspective view of one embodiment of an interconnect system in accordance to an aspect of the present invention comprising a first complementary electrical connector attached to a PCB which is to be attached to a HDD (not shown), a second complementary electrical connector attached to a backplane which is to be attached to a test equipment (not shown) and one embodiment of an exemplary electrical connector according to an aspect of the present invention positioned between and ready to couple the first complementary electrical connector and the second complementary electrical connector;

Figure 4 is an exploded perspective view of the exemplary electrical connector of Figure 3;

Figure 5 is a front view of an extension of the exemplary electrical connector of Figure 3 taken from a first mating end;

Figure 6A is a perspective view of one embodiment of a contact from a first contact set in accordance to an aspect of the present invention;

Figure 6B is a perspective view of one embodiment of a contact from a second contact set in accordance to an aspect of the present invention;

Figure 7A is a perspective section view of the contact of Figure 6A being assembled into the exemplary electrical connector of Figure 3;

Figure 7B is a perspective section view of the contact of Figure 6B being assembled into the exemplary electrical connector of Figure 3;

Figure 8 is a perspective view of one embodiment of an interconnect system in accordance to an aspect of the present invention comprising one embodiment of an exemplary electrical connector in accordance to an aspect of the present invention attached to a backplane which is to be attached to a test equipment (not shown) and a first complementary electrical connector attached to a PCB which is to be attached to a HDD (not shown);

Figure 9A is a perspective view of one embodiment of a contact from a first contact set taken from the exemplary electrical connector of Figure 8;

Figure 9B is a perspective view of one embodiment of a contact from a second contact set taken from the exemplary electrical connector of Figure 8; and

Figure 10 is a perspective view of the exemplary electrical connector of Figure 8 attached to another backplane.

While the above-identified drawing figures set forth several embodiments of the invention, other embodiments are also contemplated, as noted in the discussion. In all cases, this disclosure presents the invention by way of representation and not limitation. It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art, which fall within the scope and spirit of the principles of the invention. The figures may not be drawn to scale. Like reference numbers have been used throughout the figures to denote like parts.

Detailed Description

Hard disk drives (HDDs) are used to store digital data content for many types of electronic devices today, including but not limited to, laptops, desktop computers, servers, etc. The requirements and specifications such as access time, capacity, form factor, reliability, data transmission rates, etc., of the HDDs will depend on the type of electronic devices in which the HDDs are to be installed.

An HDD interface is the communication channel over which the data flows as the data is read from or written to the HDD. The Serial Advanced Technology Attachment (SATA) and the Serial Attached Small Computer System Interface (SAS) are two most commonly used interfaces (connectors) for HDDs today. In this document, the terms "interface" and "connector" are used interchangeably.

According to specifications set by the Small Form Factor (SFF) Committee, a SATA connector has 22 contacts (also referred to as "terminals" or "pins" in this document) of which a first section of 7 contacts are used for data signal transmission and a second section of 15 contacts are used for power transmission. In the case of a SAS connector, there is an additional third section of 7 contacts dedicated for data signal transmission.

As the electronic devices get smaller in size, it is necessary to reduce the size of the HDDs and their connectors so that these HDDs may be fitted into the electronic devices. A HDD connector commonly used with smaller form factor HDDs is the micro SATA connector. Since a micro SATA HDD consumes less power than a standard SATA HDD

or SAS HDD, the micro SATA connector requires only 9 power contacts. Thus, a micro SATA connector has a total of 16 contacts of which a first section of 7 contacts are used for data signal transmission and a second section of 9 contacts are used for power transmission.

The HDDs have to be tested using specialized test equipments before they are released for sale or for use with the electronic devices. Each test equipment often have a specific type of HDD connector attached to the backplane (also referred to as "printed circuit board") and therefore, the test equipment can only be used to test HDDs with that particular HDD connector or connectors that are compatible to that particular HDD connector attached to the backplane.

To facilitate the explanation and illustration of the invention, references are made herein to specific electrical connectors such as SATA, SAS and micro SATA HDD connectors. It is important to note that such references are not intended to and should not be used to limit the invention to just the forms or the types of electrical connectors referenced.

Figure 1A is a perspective view of an existing interconnect system comprising a backplane connector **20** such as a SATA socket attached via soldering means to a backplane **2** which is attached to a test equipment (not shown) used for testing HDDs before the HDDs are put on sale or are installed in electronic devices and a first complementary electrical connector **10** such as a SATA header attached to a printed circuit board (PCB) 1 which is attached to a HDD (not shown) to be tested. It is important to note that a connector may be attached to a PCB using a variety of ways and devices in addition to soldering including press-fitting, through-hole, etc.

The backplane connector **20** comprises a first surface **21,** a second surface **22**, a first pin slot **25** and a second pin slot **26** located at the first surface **21** (see Figure 1B) adapted to cooperate with a first tongue extension **13** and a second tongue extension **14** of the first complementary electrical connector **10**, a plurality of pin grooves **27** (see Figure 1B) within each pin slot extending from the first surface **21** to the second surface **22,** and a plurality of pins assembled within the pin grooves **27**.

Provided on the backplane **2** are a plurality of circuit traces which are grouped to form a first trace set **3** and a second trace set **4**. The pins in the backplane connector **20** are

further grouped to form a first pin set **23** and a second pin set **24** wherein one end of the pins in the first pin set **23** are attached to the circuit traces in the first trace set **3** and one end of the pins in the second pin set **24** are attached to the circuit traces in the second trace set **4**.

Assembled on the first tongue extension **13** of the first complementary electrical connector **10** is a first terminal set **11** wherein each terminal in the first terminal set **11** is configured to connect electrically with a pin in the first pin set **23** of the backplane connector **20** when the two connectors mate. Similarly, assembled on the second tongue extension **14** of the first complementary electrical connector **10** is a second terminal set **12** wherein each terminal in the second terminal set **12** is configured to connect electrically with a pin in the second pin set **24** of the backplane connector **20** when the two connectors mate.

The circuit traces in the first trace set **3** provide a means by which the data signals may be exchanged between the test equipment and the HDD to be tested and the circuit traces in the second trace set **4** provide a means by which power may be provided from the test equipment to the HDD to be tested. The number, the arrangement and the pitch of the circuit traces that are provided on the backplane **2** may correspond to the number, the arrangement and the pitch of the pins on the backplane connector **20**. The number, the arrangement and the pitch of the pins on the backplane connector **20** will have an impact on the types of HDD connectors that can be used to establish the electrical connection between the test equipment and the HDD to be tested. For example, if the backplane connector **20** is a SATA socket (as shown in Figure lA) with 7 data signal pins in the first pin set and 15 power pins in the second pin set, then only HDDs with a SATA header having 7 data signal terminals in the first terminal set and 15 power terminals in the second terminal set may be tested.

It is clear to one skilled in the art that the number of circuit traces on the backplane **2** may be more than or equal to the number of pins in the backplane connector **20**. Also, the number of terminals in the first complementary electrical connector **10** may be less than the number of pins in the backplane connector **20**. In both situations, the backplane connector **20** and the first complementary electrical connector **10,** when mated, may be able to provide an electrical interface between the test equipment attached to the backplane

2 and the HDD attached to the PCB 1 if the pins in the backplane connector **20** may be aligned to the corresponding circuit traces on the backplane **2** as specified in accordance to the SFF specifications for that HDD interface and/or the terminals in the first complementary electrical connector **10** may be aligned to the corresponding pins in the backplane connector **20** as specified according to the SFF specifications for that HDD interface.

In Figure 2, a backplane connector **30** such as a SAS socket further comprises in addition to backplane connector **20** a third pin set **28** wherein each pin in the third pin set **28** is attached to a circuit trace belonging to a third trace set **5** on a backplane **6**. Test equipment (not shown) attached to the backplane **6** whereby the backplane connector **30** is attached may thus be used to test a HDD (not shown) attached to a PCB 1 with another first complementary electrical connector such as a SAS header (not shown) having a third terminal set wherein each terminal in the third terminal set is configured to connect electrically with a pin in the third pin set **28** of the backplane connector **30** when the two connectors mate.

It is clear to one skilled in the art that although the first complementary electrical connector **10** such as a SATA header as shown in Figure 2 does not have a third terminal set configured to connect electrically with the third pin set **28** of the backplane connector **30** such as a SAS socket as shown in Figure 2, the test equipment attached to the backplane 6 wherein the backplane connector **30** is attached, may still be used to test a HDD attached to the PCB 1 where the first complementary electrical connector **10** is attached if the third pin set **28** of the backplane connector **30** has no corresponding function or use in the first complementary electrical connector **10** and if each terminal in the first terminal set 11 and the second terminal set **12** of the first complementary electrical connector **10** are aligned to a pin in the first pin set **23** and the second pin set **24** of the backplane connector **30**. Accordingly, if terminals of a first complementary electrical connector are not aligned to pins of a backplane connector, test equipment attached to a backplane wherein the backplane connector is attached may not be used to test a HDD attached to a PCB wherein the first complementary electrical connector is attached.

It would be desirable to provide an electrical connector that can be used to couple and electrically connect a first complementary electrical connector of an HDD to a

backplane connector of test equipment even when terminals of the first complementary electrical connector are not aligned to pins of the backplane connector.

Figure 3 is a perspective view of one embodiment of an interconnect system in accordance to an aspect of the present invention comprising a first complementary electrical connector **100** such as a micro SATA header attached to a PCB **40** which is attached to a HDD (not shown), a second complementary electrical connector **200** such as a SATA socket attached to a backplane **2** which is attached to a test equipment (not shown) and one embodiment of an exemplary electrical connector **1000** according to an aspect of the present invention positioned between and ready to mate with the second complementary electrical connector **200** and the first complementary electrical connector **100**.

In this embodiment, the second complementary electrical connector **200** is similarly configured and similarly attached to the backplane **2** as the backplane connector **20** described earlier. The first complementary electrical connector **100** comprises an elongated body **110** having a first side **111** and a second side **112**; a first tongue extension **121** and a second tongue extension **122**, both tongue extensions extending from the second side **112** of the body **110**; and a plurality of terminals grouped to form a first terminal set **131** and a second terminal set **132** wherein terminals in the first terminal set **131** are assembled in the first tongue extension **121** and terminals in the second terminal set **132** are assembled in the second tongue extension **122**. While each terminal in the first terminal set **131** of the first complementary electrical connector **100** is aligned to a pin in the first pin set **23** of the second complementary electrical connector **200**, the terminals in the second terminal set **132** of the first complementary electrical connector **100** are not in alignment with the pins in the second pin set **24** of the second complementary electrical connector **200**. As explained earlier, the first complementary electrical connector **100** will not be able to couple directly with and connect electrically with the second complementary electrical connector **200** and as a result, test equipment attached to the backplane **2** on which the second complementary electrical connector **200** is also attached cannot be used to test the HDD attached to the PCB **40** on which the first complementary electrical connector **100** is also attached.

Figure 4 is an exploded perspective view of the exemplary electrical connector **1000**. The electrical connector **1000** comprises an elongated insulative housing having a longitudinal base portion **1010** with a first mating end **1100**, a second mating end **1200**, an extension **1110** extending from the first mating end **1100** of the base portion **1010**, a tongue portion comprising a first tongue section **1210** and a second tongue section **1220** extending from the second mating end **1200** of the base portion **1010**, and a plurality of contacts **1300** grouped to form a first contact set **1310** and a second contact set **1320** extending from the extension **1110** to the tongue portion. In one embodiment, the contacts in the first contact set **1310** are positioned within the first tongue section **1210** while the contacts in the second contact set **1320** are positioned within the second tongue section 1220.

As shown in Figure 5, provided at one end of the extension **1110** of the electrical connector **1000** is a plurality of slots **1120** having a plurality of grooves **1130** extending from the extension **1110** to the tongue portion and in which the contacts **1300** are placed. In one embodiment, the slot comprises a first slot **1121** and a second slot **1122** wherein the first slot **1121** houses the first contact set **1310** and the second slot **1122** houses the second contact set **1320**.

Figure 6A is a perspective view of one embodiment of a contact from the first contact set **1310** in accordance to an aspect of the present invention while Figure 6B is a perspective view of one embodiment of a contact from the second contact set **1320** in accordance to an aspect of the present invention. In one embodiment, the contact in the first contact set **1310** comprises a first contact section **1311**, a second contact section **1312** and a bridging section **1313** connecting the first contact section **1311** to the second contact section **1312** and the contact in the second contact set **1320** comprises a first contact section **1321**, a second contact section **1322** and a bridging section **1323** connecting the first contact section **1321** to the second contact section **1322**. In one embodiment, provided near one end of the first contact section **1311**, **1321** of the contact in the first contact set **1310** and/or second contact set **1320** is a plurality of securing devices such as barbs **1400** which are used to secure the contacts **1300** to the housing of the electrical connector **1000**.

In one embodiment, the first contact sections **1311**, **1321** of the contacts in the first contact set **1310** and/or the second contact set **1320** are of cantilever beam structures and

provided at one end of the second contact sections **1321**, **1322** of the contacts in the first contact set **1310** and/or the second contact set **1320** are securing devices such as U-shaped structures **1410**. The U-shaped structures **1410** secure the second contact sections **1312**, **1322** of the contacts **1300** to the tongue portion so as to prevent the contacts from lifting off the tongue portion during the mating and the un-mating of the electrical connector **1000** and the second complementary electrical connector **200**.

In one embodiment, the first contact sections **1311** and the second contact sections **1312** of the contacts in the first contact set **1310** are aligned substantially along a same axis **A1-A1** whereas the first contact sections **1321** and the second contact sections **1322** of the contacts in the second contact set **1320** are aligned along different axes **A11-A11**, **A2-A2**. The axis **A11-A11** may be parallel to or may be at an angle to the axis **A2-A2**.

Accordingly, as illustrated by Figures 5, 7A and 7B, both a first section **1131** and a second section **1132** of the grooves **1130** in the first slot **1121** in which the contacts belonging to the first contact set **1310** are fitted extend along the axis **A1-A1** from the first tongue section **1210** to the extension **1110** while a first section **1131** of the grooves **1130** in the second slot **1122** extend along the axis **A11-A11** at the extension **1110** and a second section **1132** of the grooves **1130** in the second slot **1122** extend along the axis **A2-A2** at the second tongue section **1220** so that the contacts from the second contact set **1320** may be fitted in the grooves.

During mating, the terminals in the first terminal set **131** of the first complementary electrical connector **100** and the pins in the first pin set **23** of the second complementary electrical connector **200** are aligned to the first contact sections **1311** and second contact sections **1312** of the contacts in the first contact set **1310** which are aligned to the axis **A1-A1**; the terminals in the second terminal set **132** of the first complementary electrical connector **100** are aligned to the first contact sections **1321** of the contacts in the second contact set **1320** which are aligned to the axis **A11-A11** and the pins in the second pin set **24** of the second complementary electrical connector **200** are aligned to the second contact sections **1322** of the contacts in the second contact set **1320** which are aligned to the axis **A2-A2**.

By configuring the first contact sections **1321** of the contacts in the second contact set **1320** to align along a different axis from the second contact sections **1322** of the

contacts in the second contact set **1320**, the electrical connector **1000** is now able to couple two electrical connectors such as the first complementary electrical connector **100** and the second complementary electrical connector **200** wherein the terminals in one electrical connector may not be aligned to the pins in the other electrical connector.

One benefit of using such a method and the exemplary electrical connector **1000** is the ability to use test equipment which has one type of HDD interface to test a HDD which has another type of HDD interface. In doing so, it is possible to reduce operating costs and maximize resources by using existing test equipment to test new HDDs as they are developed and introduced in the industry to meet the HDD demands of new electronic devices. Other benefits of using an intermediate electrical connector (sometimes referred to as "sacrificial connector") to couple a plurality of complementary electrical connectors with high mating cycles requirement are discussed in a Singapore Patent Application No. 200701728-8.

In one embodiment, the electrical connector **1000** further comprises a bonding device such as a latching device **1420** (see Figure 3) with a latch release **1422**, a latch member **1424** extending away from the second mating end **1200** and a hole **1426** in the latch member **1424**. As the electrical connector **1000** mates with the second complementary electrical connector **200** at the second mating end **1200**, a protrusion **1500** coupled to an end wall on the second complementary electrical connector **200** adapted to cooperate with the latching device **1420** pushes the latch member **1424** outwards away from the end wall of the second complementary electrical connector **200** as the latch member **1424** rides over the slope of protrusion **1500**. As the latch member **1424** passes the ridge of the protrusion **1500**, the hole **1426** in the latch member **1424** engages with the protrusion **1500** of the second complementary electrical connector **200** causing the latch member **1424** to fall back to its original horizontal position. This is the locked position of the latching device **1420** and the electrical connector **1000** is firmly coupled to the second complementary electrical connector **200**. To de-couple the electrical connector **1000** from the second complementary electrical connector **200**, the latch release **1422** is depressed inwards towards the base portion **1010** of the electrical connector **1000**. In doing so, the hole **1426** in the latch member **1424** disengages with the protrusion **1500** on the second complementary electrical connector **200**, and the two connectors **1000**, **200** can be easily

de-coupled by pulling the electrical connector 1000 in a direction away from the second complementary electrical connector **200**.

For a manufacturer of test equipment, the invention also presents a way in which the manufacturer may manufacture test equipment for testing HDD attached with a first electrical connector of a first HDD interface using existing backplane with circuit traces configured for a second electrical connector of a second HDD interface wherein the terminals in the first electrical connector may not be aligned with the circuit traces on the backplane configured for the second electrical connector. This allows the manufacturer of test equipment to save costs and reduce wastage by using the existing backplanes in stock.

Figure 8 is a perspective view of one embodiment of an interconnect system in accordance to an aspect of the present invention comprising one embodiment of an exemplary electrical connector in accordance to an aspect of the present invention attached to a backplane **2** which is to be attached to a test equipment (not shown) and a first complementary electrical connector **100** attached to a PCB **40** which is to be attached to a HDD (not shown).

The electrical connector **2000** comprises an elongated insulative housing **2010** having a first mating end **2100** and a second mating end **2200**, an extension **2110** extending from the first mating end **2100** of the housing, and a plurality of contacts **2300** grouped to form a first contact set **2310** and a second contact set **2320** extending from the extension to the second mating end **2200**.

In one embodiment, the first mating end **2100** is configured to couple with the first complementary electrical connector **100** by means of a plurality of slots (not shown) provided at one end of the extension **2110** having a plurality of grooves **2130** extending from the extension **2110** to the second mating end **2200**; wherein the slots are similarly grouped into a first slot and a second slot as the slots **1120** in Figure 5 and the grooves **2130** are similarly in structured and configured with a first section **2131** and a second section **2132** as shown in Figures 7A and 7B.

In one embodiment, the contacts in the first contact set **2310** comprises a first contact section **2311**, a second contact section **2312** and a bridging section **2313** connecting the first contact section **2311** to the second contact section **2312** as illustrated by the perspective view in Figure 9A and the contacts in the second contact set **2320**

comprises a first contact section **2321**, a second contact section **2322** and a bridging section **2323** connecting the first contact section **2321** to the second contact section **2322** as illustrated by the perspective view in Figure 9B.

In one embodiment, the first contact sections **2311** and the second contact sections **2312** of the contacts in the first contact set **2310** are aligned substantially along a same axis **A1-A1** whereas the first contact sections **2321** and the second contact sections **2322** of the contacts in the second contact set **2320** are aligned along different axes **A11-A11, A2-A2**.

Figure 10 is a perspective view of another embodiment of the invention wherein the electrical connector **2000** is attached to a backplane **6** having a first trace set **3**, a second trace set **4** and a third trace set **5** similar to a backplane configured with a SAS HDD interface. The first section **2131** and the second section **2132** of the grooves **2130** in the first slot in which the contacts belonging to the first contact set **2310** are fitted extend along the axis **A1-A1** from the extension **2110** to the second mating end **2200** while the first section **2131** of the grooves **2130** in the second slot extend along the axis **A11-A11** at the extension **1110** and the second section **2132** of the grooves **2130** in the second slot extend along the axis **A2-A2** at the second mating end **2200** so that the contacts from the second contact set **2320** may be fitted in the grooves.

During mating, the terminals in the first terminal set **131** of the first complementary electrical connector **100** (see Figure 3) are aligned to the first contact sections **2311** of the contacts in the first contact set **2310** which are aligned to the axis **A1-A1** and the terminals in the second terminal set **132** of the first complementary electrical connector **100** are aligned to the first contact sections **2321** of the contacts in the second contact set **2320** which are aligned to the axis All-All. The second contact sections **2312, 2322** of the contacts in the first contact set **2310** and the second contact set **2320** may be attached to the backplane **2** in many ways including soldering the second contact sections **2312, 2322** to a plurality of circuit traces from the first trace set **3** and second trace set **4** respectively. By aligning the first contact sections **2321** and the second contact sections **2322** of the contacts in the second contact set **2320** along different axes **A11-A11** and **A2-A2**, it is possible to establish electrical connection between the circuit traces of the second trace set **4** with the terminals of the second terminal set **132** even though they are initially not in alignment.

The foregoing description of various preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, since many modifications or variations thereof are possible in light of the above teaching. All such modifications and variations are within the scope of the invention. The embodiments described herein were chosen and described to best explain the principles of the invention and its practical application, thereby to enable others skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated thereof. It is intended that the scope of the invention be defined by the claims appended hereto, when interpreted in accordance with the full breadth to which they are legally and equitably suited.

What is claimed is:

I. An electrical connector comprising:

an elongated insulative housing having a longitudinal base portion with a first mating end and a second mating end;

wherein the first mating end is configured to couple with a first complementary electrical connector by means of a plurality of slots defined within an extension extending from the base portion;

wherein the second mating end is configured to couple with a second complementary electrical connector by means of a tongue portion extending from the base portion, the tongue portion comprising a first tongue section and a second tongue section; and

a plurality of contacts extending from the extension to the tongue portion, each contact comprising a first contact section, a second contact section and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

2. The electrical connector of claim 1 wherein a first axis along which the first contact section of a contact in the second contact set is aligned to is substantially parallel to a second axis along which the second contact section of the contact in the second contact set is aligned to.

3. The electrical connector of claim 1 or 2 wherein the contacts grouped in the first contact set are positioned within the first tongue section and the contacts grouped in the second contact set are positioned within the second tongue section.

4. The electrical connector of any one of claims 1 to 3 wherein either the first contact section or the second contact section of each contact is of a cantilever beam structure.

5. The electrical connector of any one of claims 1 to 3 wherein either the first contact section or the second contact section of each contact has a U-shaped structure at one end.

6. The electrical connector of any one of claims 1 to 3 wherein the first contact section of each contact is of a cantilever beam structure and the second contact section of each contact has a U-shaped structure at one end of the second contact section.

7. An interconnect system comprising at least one electrical connector, a first complementary electrical connector and a second complementary electrical connector wherein the electrical connector is configured to couple the first complementary electrical connector and the second complementary electrical connector; and wherein

the first complementary electrical connector is attached to a printed circuit board which is attached to a hard disk drive;

the second complementary electrical connector is attached to a backplane which is attached to test equipment; and wherein

said electrical connector comprises:

an elongated insulative housing having a longitudinal base portion with a first mating end and a second mating end; wherein the first mating end is configured to couple with the first complementary electrical connector by means of a plurality of slots defined within an extension extending from the base portion and the second mating end is configured to couple with the second complementary electrical connector by means of a tongue portion extending from the base portion, the tongue portion comprising a first tongue section and a second tongue section; and

a plurality of contacts extending from the extension to the tongue portion, each contact comprising a first contact section, a second contact section and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

8. The interconnect system of claim 7 wherein a first axis along which the first contact section of a contact in the second contact set is aligned to is substantially parallel to a second axis along which the second contact section of the contact in the second contact set is aligned to.

9. The interconnect system of claim 7 or 8 wherein the contacts grouped in the first contact set are positioned within the first tongue section and the contacts grouped in the second contact set are positioned within the second tongue section.

10. The interconnect system of any one of claims 7 to 9 wherein either the first complementary electrical connector or the second complementary electrical connector is a micro SATA connector.

11. An electrical connector on a backplane comprising:

an elongated insulative housing having a first mating end and a second mating end; wherein the first mating end is configured to couple with a first complementary electrical connector by means of a plurality of slots defined within an extension extending from the first mating end of the housing; and

a plurality of contacts extending from the extension to the second mating end, each contact comprising a first contact section, a second contact section attached to the backplane and a bridging section connecting the first contact section to the second contact section, and the contacts are further grouped to form a first contact set and a second contact set wherein the first contact section and the second contact section of each contact in the first contact set are aligned substantially along a same axis whereas the first contact section and the second contact section of each contact in the second contact set are aligned along different axes.

12. The electrical connector of claim 11 wherein a first axis along which the first contact section of a contact in the second contact set is aligned to is substantially parallel to a second axis along which the second contact section of the contact in the second contact set is aligned to.

13. The electrical connector of claim 11 or 12 wherein the contacts grouped in the first contact set are positioned within the first tongue section and the contacts grouped in the second contact set are positioned within the second tongue section.

14. An interconnect system comprising the electrical connector of claim 11 and a hard disk drive attached to the first complementary electrical connector via a printed circuit board.

15. The interconnect system of claim 14 wherein the first complementary electrical connector is a micro SATA connector.

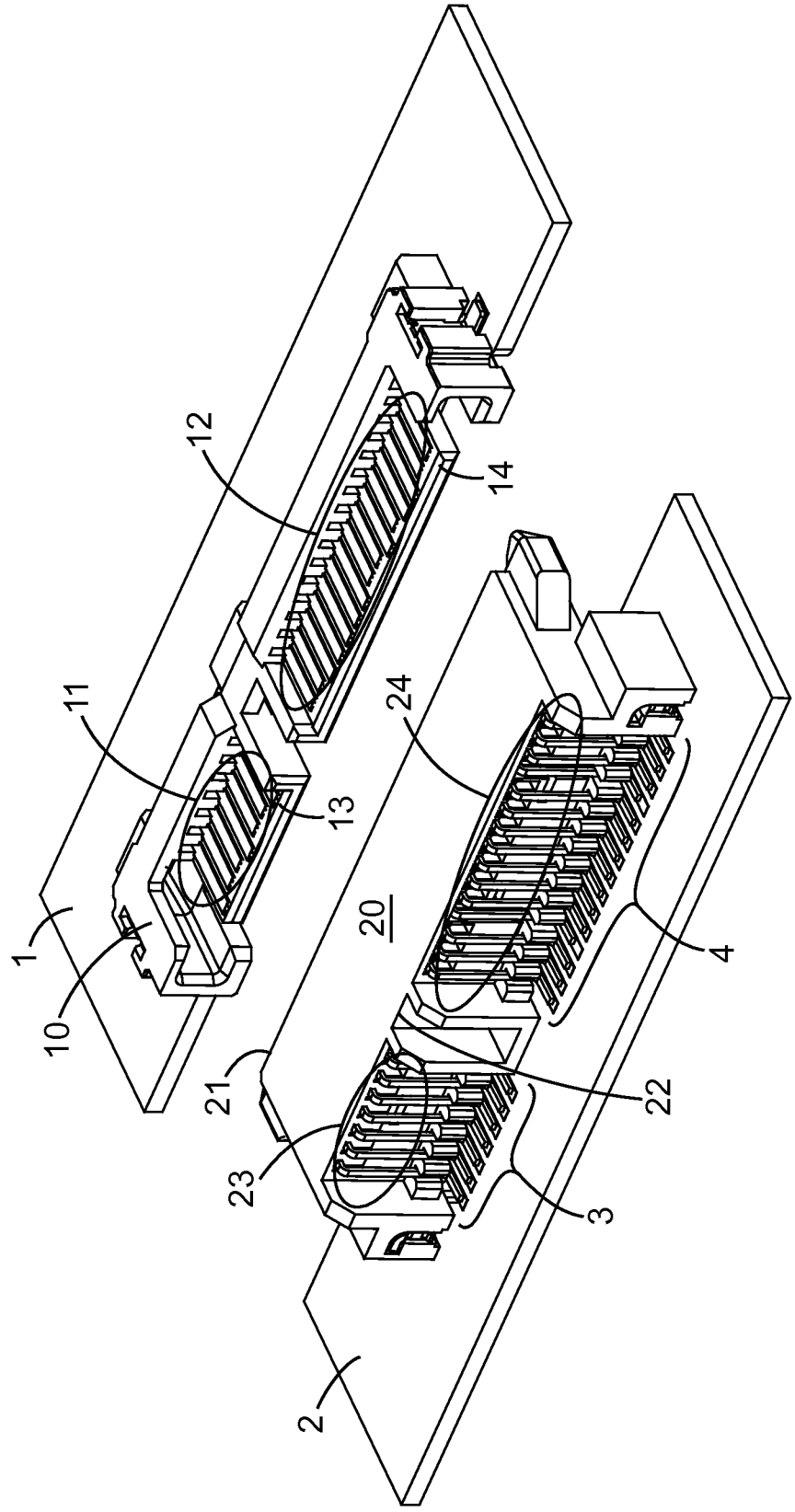

Fig. 1A

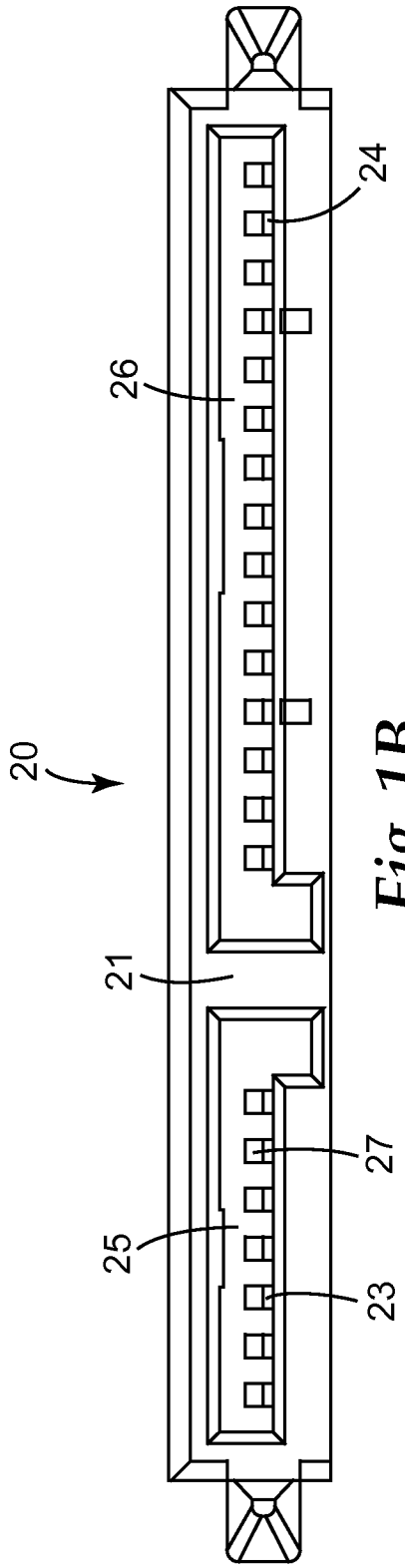
20
21
25
23
27
26
24

Fig. 1B

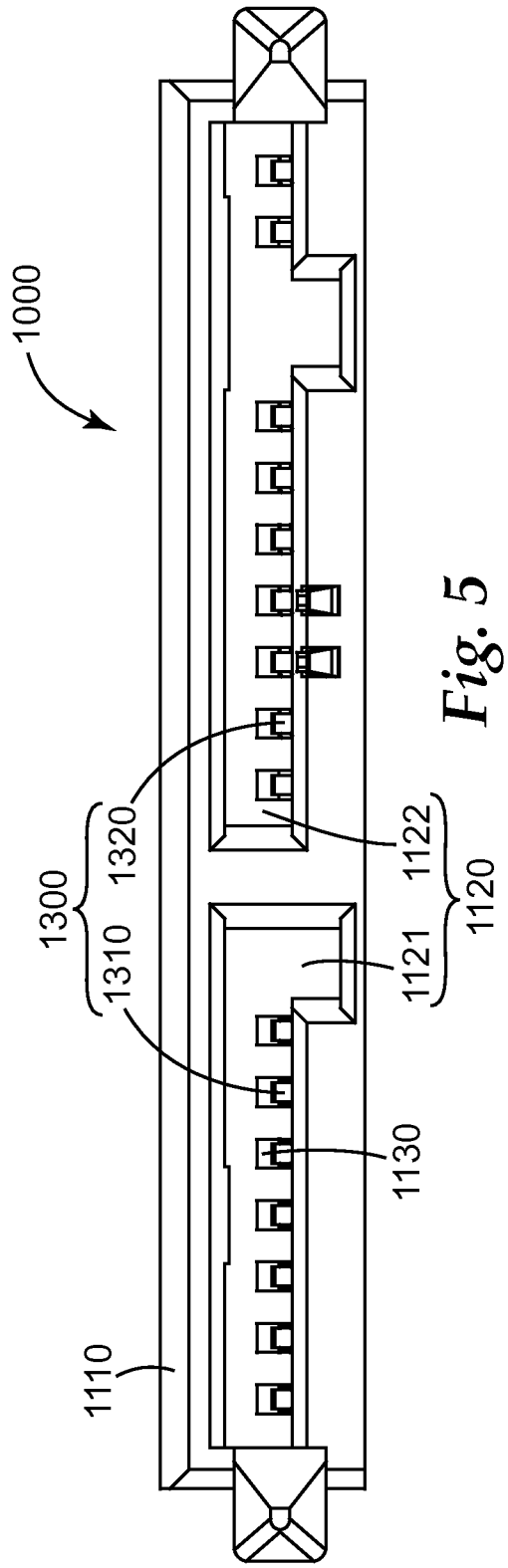
1000
1300
1310
1320
1110
1130
1121
1122
1120

Fig. 5

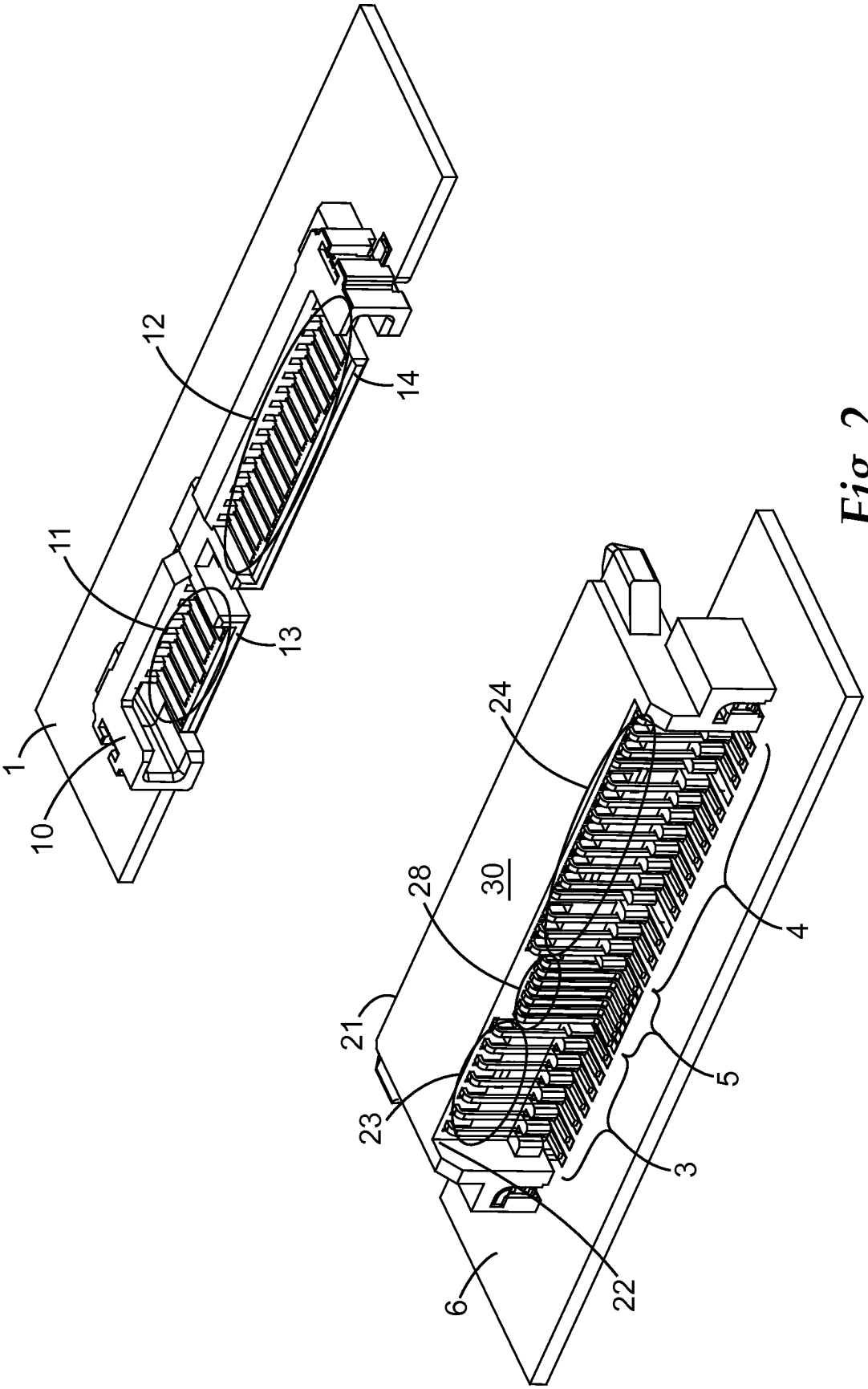

Fig. 2

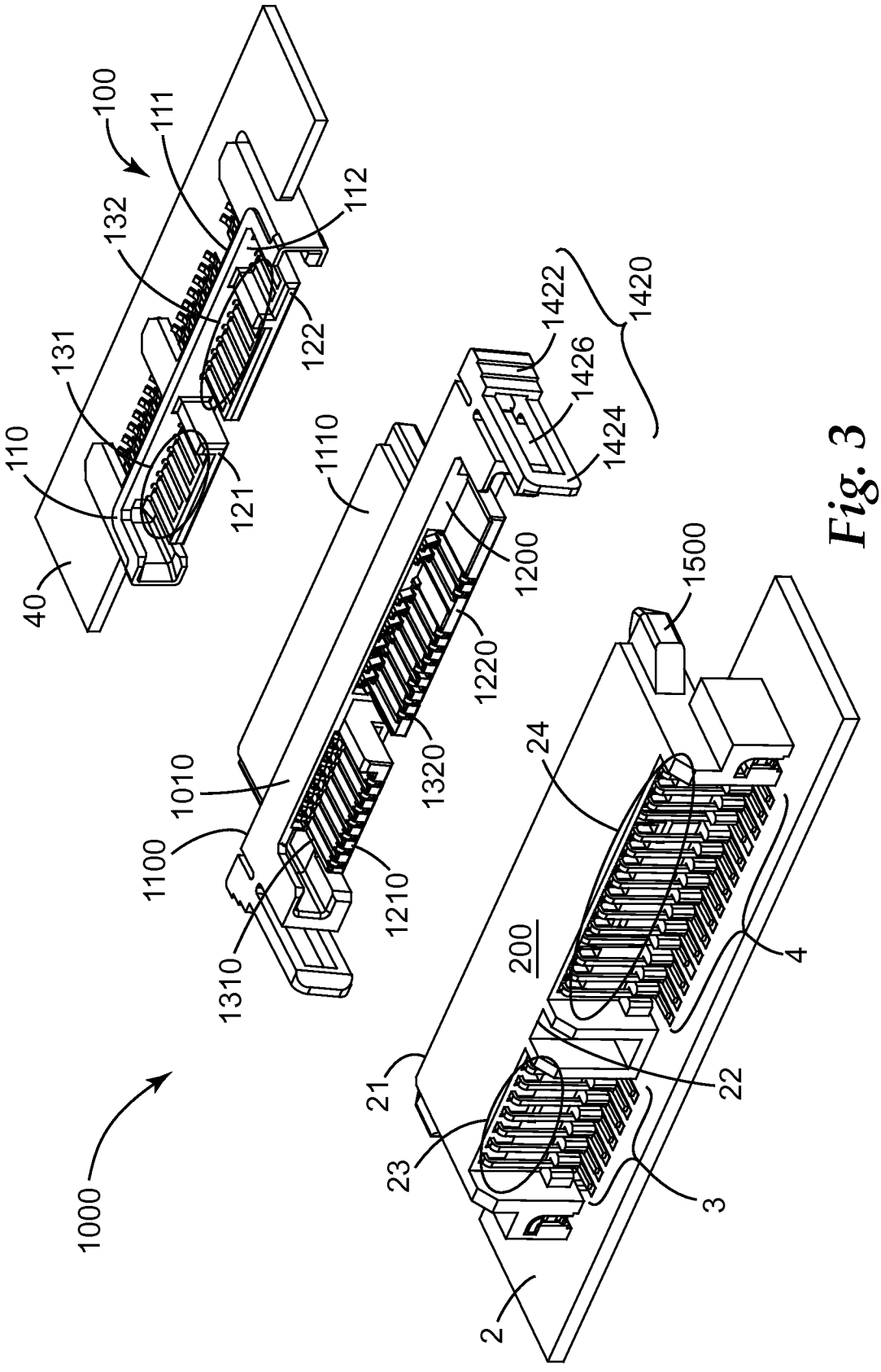
100
111
112
132
122
131
110
121
40
1110
1422
1420
1426
1424
1200
1500
1220
1320
1010
1100
1210
1310
24
200
4
21
22
23
3
2
1000

Fig. 3

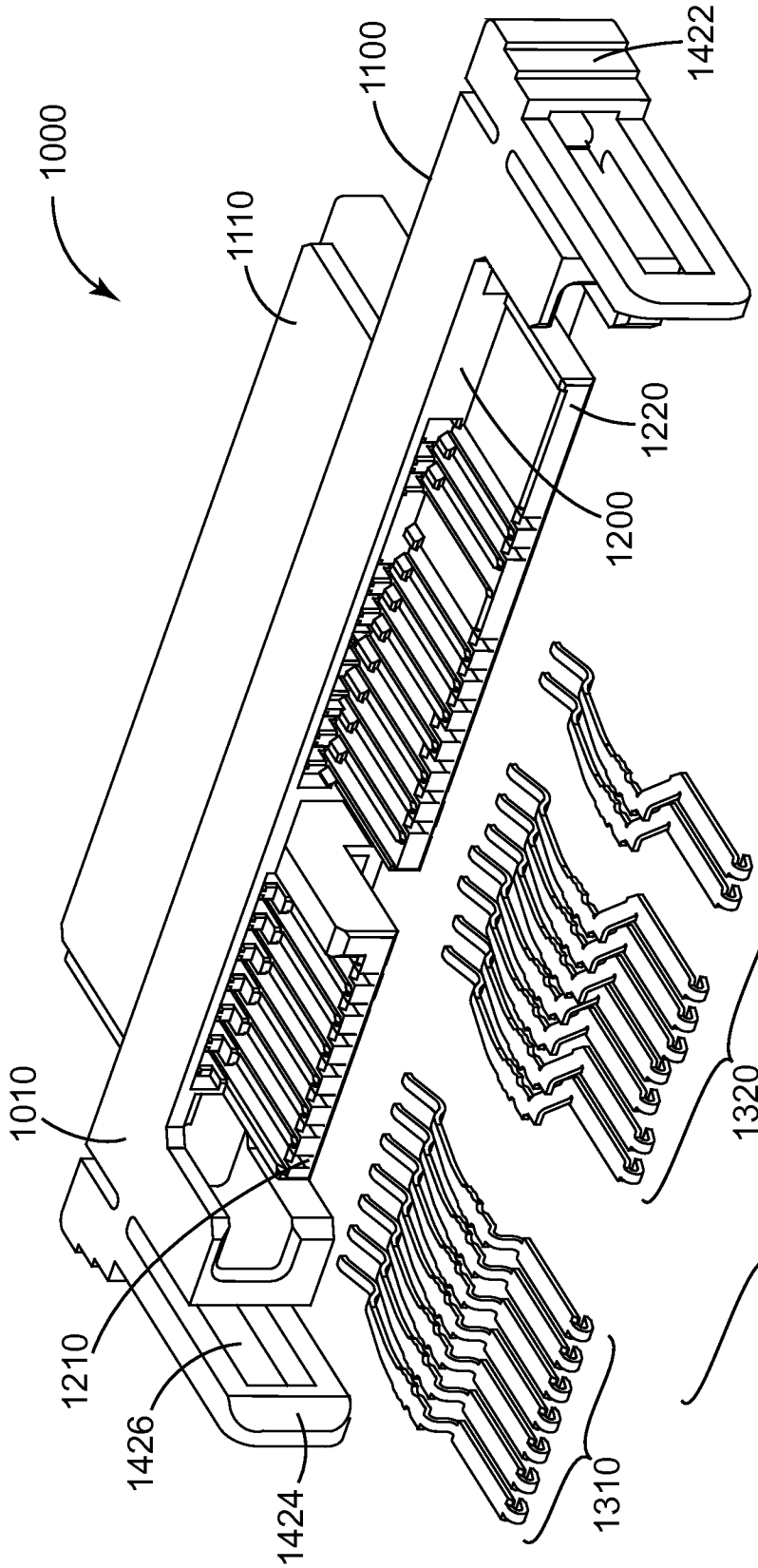
1000
1100
1422
1110
1220
1200
1010
1320
1210
1426
1300
1424
1310

Fig. 4

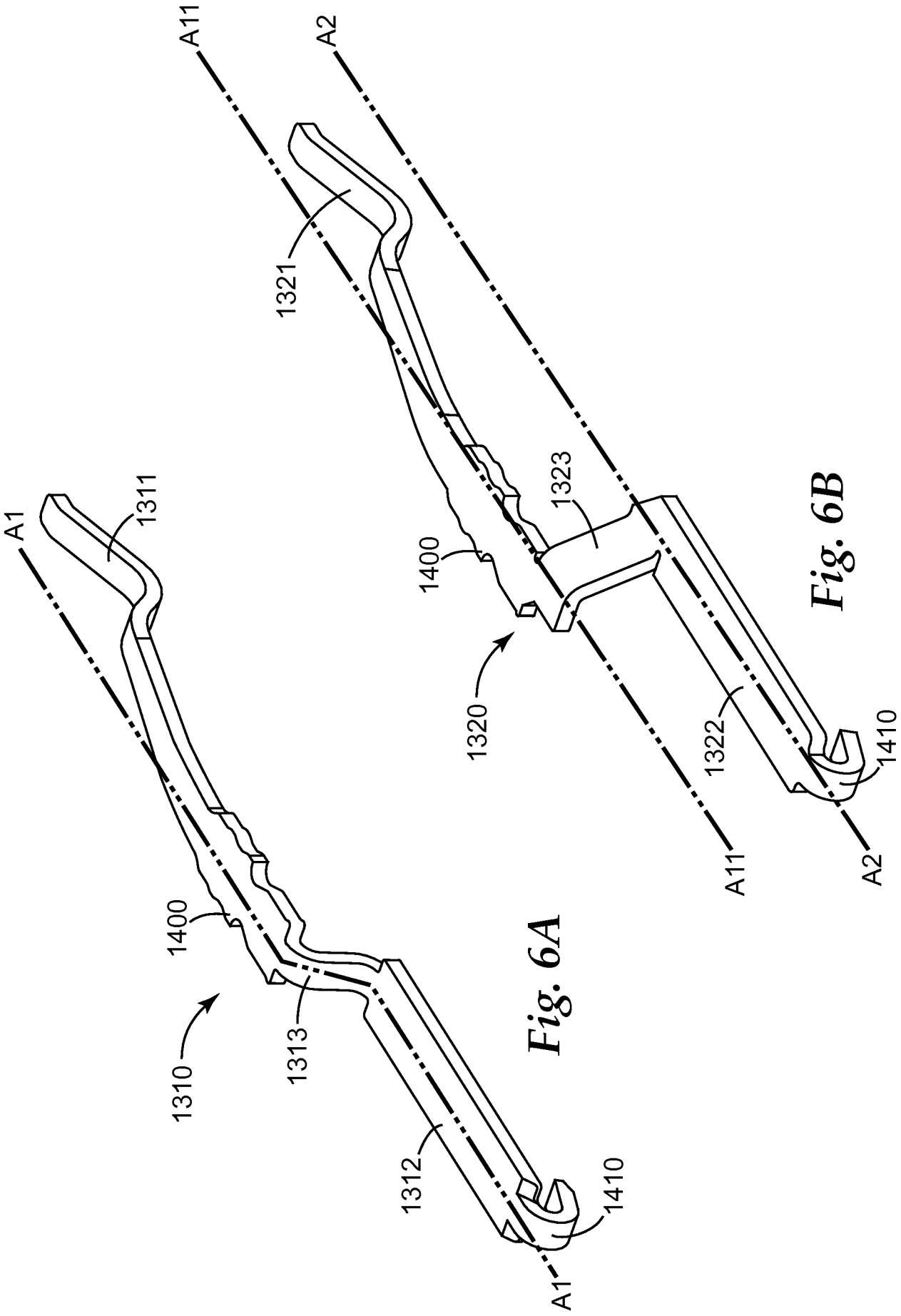
A1
1311
1400
1310
1313
1312
1410
A1
A11
A2
1321
1323
1400
1320
1322
1410
A11
A2

Fig. 6A

Fig. 6B

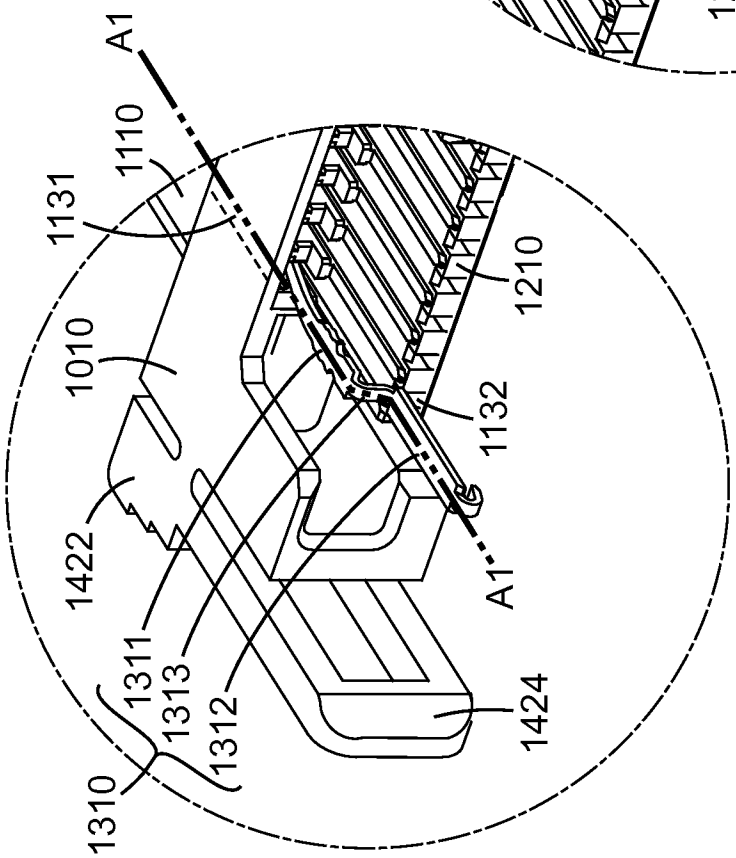
A1
1110
1131
1010
1422
1311
1313
1312
1310
1132
1210
1424

Fig. 7A

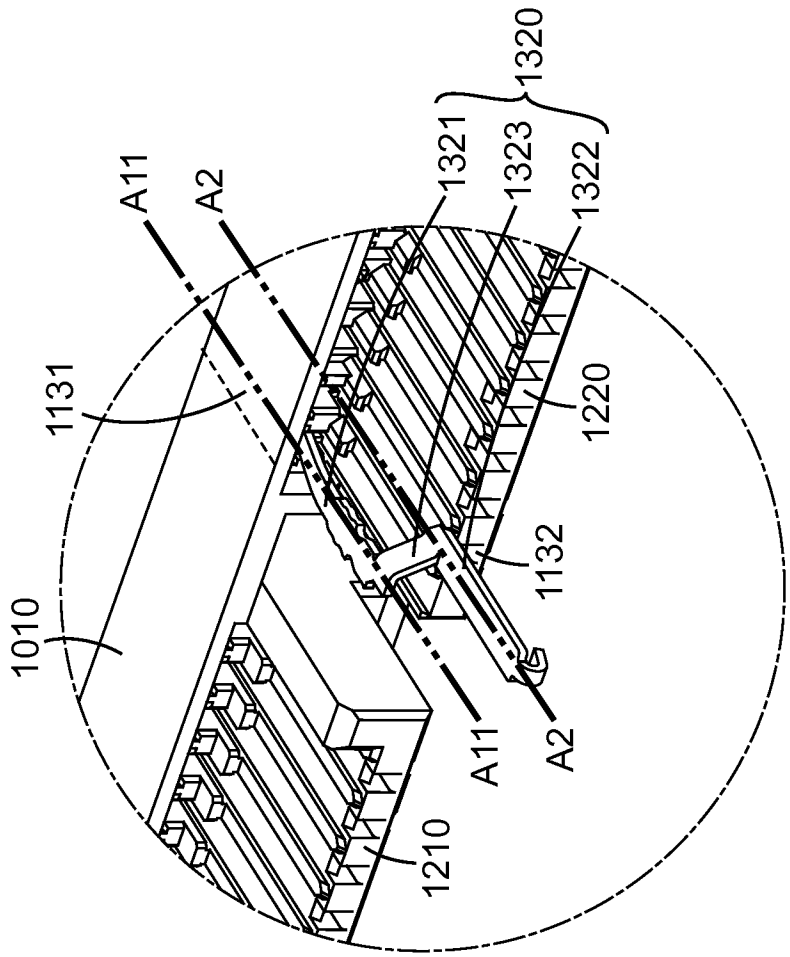
1320
1321
1323
1322
A11
A2
1131
1220
1132
1010
1210

Fig. 7B

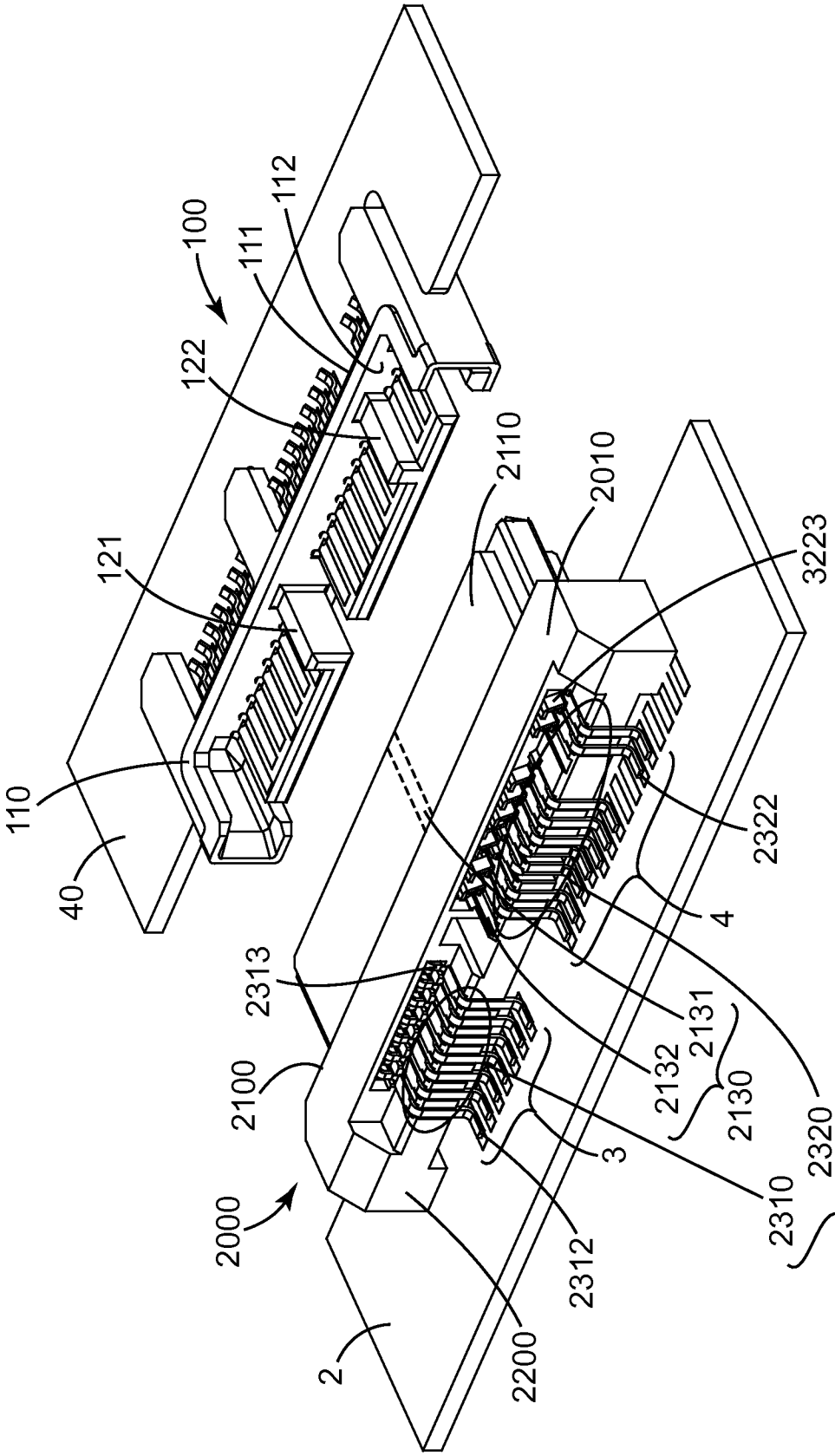
100
111
112
122
121
110
40
2110
2010
3223
2322
4
2313
2100
2131
2132
2130
2320
3
2310
2300
2000
2312
2200
2

Fig. 8

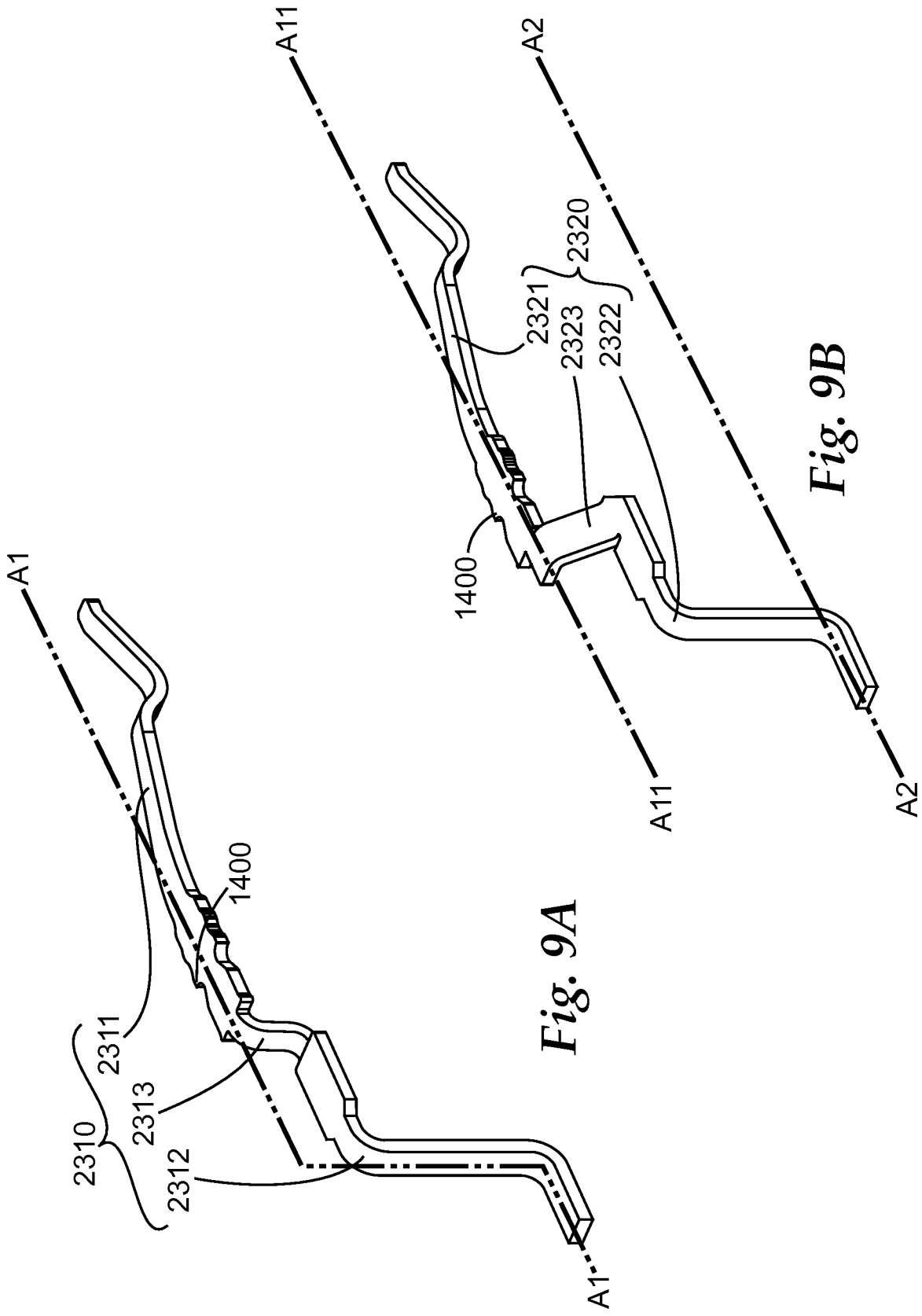
A1
2310
2311
2313
2312
1400
A1
A11
1400
2321
2323
2322
2320
A2
A11
A2

Fig. 9A

Fig. 9B

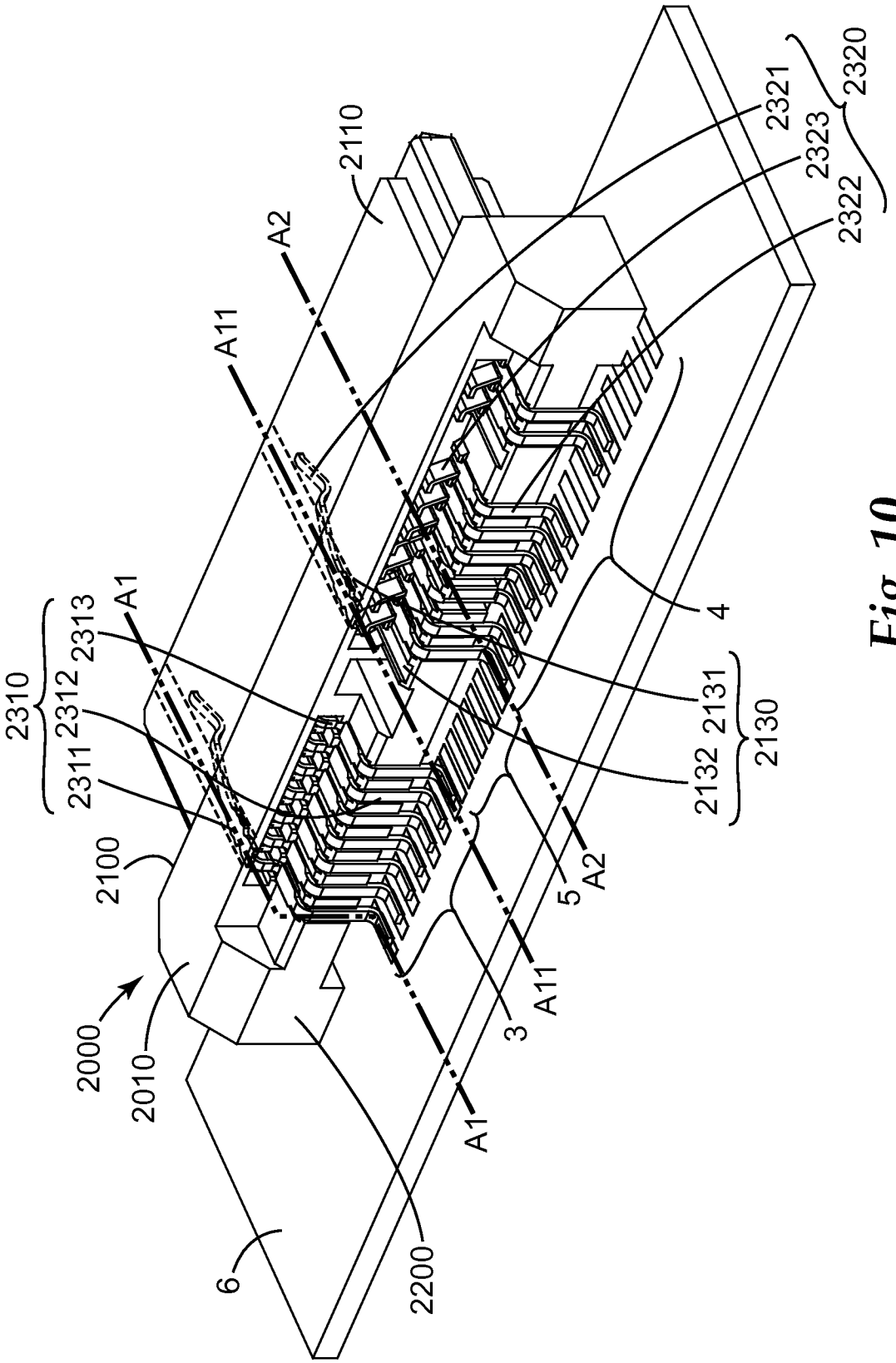
2110
A2
A11
A1
2313
2310
2312
2311
2100
2000
2010
6
2200
2321
2323
2322
2320
4
2131
2132
2130
5
A2
A11
3
A1

Fig. 10