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(71) Applicant: **EATON CORPORATION** [US/US]; 1000 Eaton Boulevard, Cleveland, Ohio 44122 (US).

(72) Inventors: **MILLS, Patrick W.**; 4619 Shark Drive, Bradenton, Florida 34208 (US). **BENSHOFF, Richard G.**; 3764 Lena Lane, Sarasota, Florida 34240 (US). **McCORMICK, James M.**; 4604 Blue Marlin Drive, Bradenton, Florida 34208 (US).

(74) Agents: **HOUSER, Kirk D.** et al.; Eckert Seamans Cherin & Mellott, LLC, 600 Grant Street, 44th Floor, Pittsburgh, Pennsylvania 15219 (US).

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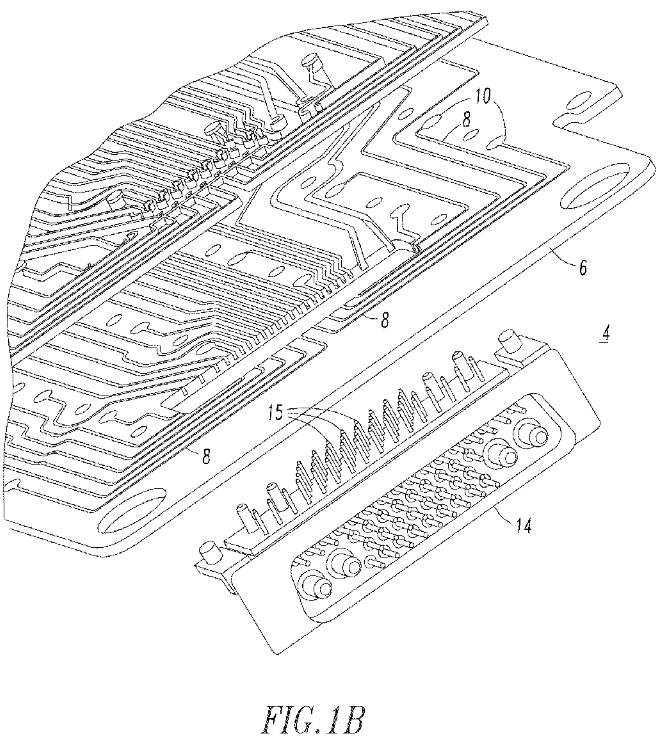

FIG.1B

(57) Abstract: A method of manufacturing a load buss array assembly (4) includes: placing a plurality of load conductors (2) within a thermally conductive substrate (6); placing a portion of a load connector (14) within the thermally conductive substrate; and electrically connecting the load conductors to the portion of the load connector within the thermally conductive substrate.

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LOAD BUSS ASSEMBLY AND METHOD OF MANUFACTURING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/670,741, filed July 12, 2012, which is incorporated by reference herein.

BACKGROUND

Field

The disclosed concept pertains generally to load modules and, more particularly, to load buss assemblies for such load modules. The disclosed concept further pertains to methods of manufacturing load buss assemblies.

Background Information

U.S. Patent No. 8,094,436 discloses a plug-in circuit breaker panel including a housing, an electrical bus structure coupled to the housing, and a number of first plug-in members coupled to the electrical bus structure. A number of circuit breakers include a first surface and a second plug-in member disposed opposite the first surface. The second plug-in member of each of the number of circuit breakers is mated with a corresponding one of the number of first plug-in members. A plate member is removably coupled to the housing. The plate member includes a first surface and an opposite second surface. The first surface of the number of circuit breakers engages the opposite second surface of the plate member in order to maintain mating of each of the number of circuit breakers with the corresponding one of the number of first plug-in members.

The rear of the plug-in circuit breaker panel includes first and second feeders for a three-phase alternating current (AC) system. Typically, for each of the feeders, there can be a single three-pole AC circuit breaker and a plurality of single pole AC circuit breakers for each of the three phases. For example, each of the feeders is a three-terminal terminal block having three power terminals for the three phases of the corresponding feeder. A first surface of the electrical bus structure is proximate the number of first plug-in members, and the feeders and power terminals thereof are coupled to the opposite second surface along with a number of load connectors. The load connectors include load outputs (e.g., loads) from the corresponding circuit breakers associated with the respective feeders. In a similar manner, the power inputs (e.g., lines) to the corresponding circuit breakers are associated with the respective feeders. The electrical bus structure (e.g., a number of inner power layers thereof) suitably routes the load outputs from and the power inputs to the various circuit breakers.

While the feeders are directly coupled to the electrical bus structure at corresponding terminal blocks and power terminals thereof, the load outputs from the circuit breakers are electrically connected between the electrical bus structure and corresponding load connectors by a number of discrete conductors or ribbon cable. As a result, a manual operation is needed to electrically connect the load outputs between the electrical bus structure and the corresponding load connectors. Also, the load connectors and the discrete conductors or ribbon cable significantly increase the size of the plug-in circuit breaker panel.

Therefore, there is room for improvement in circuit breaker panels.

There is also room for improvement in load buss assemblies of circuit breaker panels.

There is further room for improvement in methods of manufacturing load buss assemblies of circuit breaker panels.

SUMMARY

These needs and others are met by aspects of the disclosed concept which place a plurality of load conductors within a thermally conductive substrate; place a portion of a load connector within the thermally conductive substrate; and electrically connect the load conductors to the portion of the load connector within the thermally conductive substrate.

In accordance with one aspect of the disclosed concept, a load buss array assembly comprises: a thermally conductive substrate; a plurality of load conductors placed within the thermally conductive substrate; and a portion of a load connector placed within the thermally conductive substrate, wherein the load conductors are electrically connected the portion of the load connector within the thermally conductive substrate.

In accordance with another aspect of the disclosed concept, a method of manufacturing a load buss array assembly comprises: placing a plurality of load conductors within a thermally conductive substrate; placing a portion of a load connector within the thermally conductive substrate; and electrically connecting the load conductors to the portion of the load connector within the thermally conductive substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

A full understanding of the disclosed concept can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

Figure 1A is an isometric view of a plurality of miniature conductive traces for a load buss array assembly in accordance with embodiments of the disclosed concept.

Figure 1B is an exploded isometric view of the miniature conductive traces of Figure 1A, a thermally conductive substrate and a load connector for a load buss array assembly in accordance with another embodiment of the disclosed concept.

Figure 1C is an isometric view of the miniature conductive traces and the load connector of Figure 1B.

Figures 2A and 2B are an isometric view and a side vertical elevation view, respectively, showing the load conductive traces of a load buss array assembly of a load module assembly in accordance with another embodiment of the disclosed concept.

Figures 3A and 3B are an isometric view and a side vertical elevation view, respectively, of a circuit breaker panel including the load module assembly with embedded feeder layers and the load buss array assembly of Figure 2A.

Figure 4 is a plan view of the circuit breaker panel of Figure 3A with a cover removed to show a load connector.

Figures 5A and 5B are an isometric view and a side vertical elevation view, respectively, of a backplane module including the embedded feeder layers and the load buss array assembly of Figure 2A.

Figure 6 is a plan view of the embedded feeder layers of the backplane module of Figure 5A with the load buss array assembly removed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As employed herein, the term “number” shall mean one or an integer greater than one (*i.e.*, a plurality).

As employed herein, the statement that two or more parts are "connected" or "coupled" together shall mean that the parts are joined together either directly or joined through one or more intermediate parts. Further, as employed herein, the statement that two or more parts are "attached" shall mean that the parts are joined together directly.

The disclosed concept employs miniature conductive traces embedded in a thermally conductive substrate as part of a method of construction and automated electrical connection of a load connector to a plurality of load buss array miniature conductive traces. This method simplifies the construction of a load module, and provides considerable size, depth and weight benefits as compared to known methods of packaging a wiring interconnect.

The disclosed concept preferably provides: (1) a 100% thermally conductive backplane; and (2) a 100% embedded load conductor solution.

The materials of the miniature conductive traces can be, for example, copper or aluminum.

The materials of the thermally conductive substrate can be relatively highly heat-resistant resins like a liquid-crystal polymer (LCP) or polyetheretherketone (PEEK).

The disclosed concept is described in association with subminiature or aircraft circuit breakers, although the disclosed concept is applicable to a wide range of different circuit breakers for a wide range of different applications. Such circuit breakers can be employed, for example and without limitation, in aircraft alternating current (AC) systems having a typical frequency of about 400 Hz, but can also be used in direct current (DC) systems. It will also become evident that the disclosed concept is applicable to other types of circuit breaker panels including those used in AC systems operating at other frequencies; to larger circuit breakers, such as miniature residential or commercial circuit breakers; and to a wide range of circuit breaker applications, such as, for example, residential, commercial, industrial, aerospace, and automotive. As further non-limiting examples, both AC (e.g., without limitation, 120, 220, 480-600 VAC) operation at a wide range of frequencies (e.g., without limitation, 50, 60, 120, 400 Hz, and higher or lower frequencies) and DC operation (e.g., without limitation, 42 VDC) are possible. As still further non-limiting examples, single phase and plural phase (e.g., without limitation, three phase) operation are possible.

The miniature conductive traces 2 of a load buss array assembly 4 (Figures 1B and 1C) are suitably embedded in a thermally conductive substrate 6 (Figure 1B). For example and without limitation, the thermally conductive substrate 6 is suitably molded or machined to have grooves 8 and holes 10 to accept the miniature conductive traces 2 as shown in Figure 1B. The corresponding load module 12 (Figures 2A and 2B) replaces a known prior load module (not shown) having discrete wiring over-molded into urethane and attached to an embedded feed section via sockets. See, for example, U.S. Patent No. 8,094,436, which is incorporated by reference herein.

The disclosed method simplifies the construction of the load buss array assembly 4 and, thus, the load module 12. This permits, for example, the miniature conductive traces 2, which function as load conductors, to be embedded in the molded thermally conductive substrate 6 (e.g., without limitation, a liquid-crystal polymer (LCP), such as CoolPoly® E-series thermally conductive plastic marketed by Cool Polymers, Inc. of North Kingstown, Rhode Island; a suitable thermally conductive and electrically insulative epoxy), which seals and insulates the load conductors.

Alternatively, if the thermally conductive substrate 6 is machined, then the load conductors can be sealed and insulated (e.g., a conductor is placed in a channel and is sealed and insulated from other conductors and from the outside environment) by employing a suitable sealant (not shown) such as, for example and without limitation, tape, glue or epoxy. For example, the material is electrically insulative with adhesive on both sides, and is relatively very thin (e.g., without limitation, 0.005 in.) and conforms to the substrate 6 and traces 2.

The miniature conductive traces 2 can be automatically coupled to a load connector 14 and its load pins 15 (Figures 1B and 1C) by fixturing and by employing a conventional wave soldering process. For example, the load conductors are placed in the thermally conductive substrate 6 during molding, and the load connector 14 is fixtured to have a precise location and fit. Then, the load buss array assembly 4 is fed through a suitable wave soldering station (not shown) to electrically couple the connector load pins 15 and the load connector 14 to the load conductor traces 2. Alternatively, this could be a manual operation, but would not be cost favorable. This eliminates point-to-point wiring attachments (e.g., without limitation, crimps; hand soldering). The disclosed concept adds about another 0.25" of depth for the load thermally conductive substrate layers 16, which are directly coupled to feeder layers 18 of the load module 12 (Figures 2A, 2B, 3A and 3B). Also, a significant overall depth reduction to about 1" to about 2" from about 4" to about 5" of baseline depth is provided for the corresponding circuit breaker panel 20 (Figures 3A, 3B and 4).

Figure 4 shows the circuit breaker panel 20 with its cover 22 (shown in Figures 3A and 3B) removed to show the load connector 14.

Figures 5A and 5B show the backplane module 24 of the circuit breaker panel 20.

Various possible methods to place the load conductors within the thermally conductive substrate 6 include: (1) over-molding the miniature conductive traces 2 into the thermally conductive substrate 6; (2) hand placement of the miniature conductive traces 2 into the thermally conductive substrate 6; and (3) automated bobbin winding placement if the miniature conductive traces 6 have a suitable cross-section (e.g., without limitation, flat; round; square). For example, for the latter method, an uncoated load conductor (not shown) is placed with a CNC (x,y,z) controlled winder (not shown), such that a placed wire conductor (e.g., 2 of Figure 2A) is cut and placed without the use of manual touch-labor. The automated winding placement is suited to high-volume production, much like a wire feeder. This precisely feeds a wire cut length (not shown) to a nozzle (not shown), which is CNC-controlled to place the conductor (e.g., 2 of Figure 1A) into a groove 8 (Figure 1B) in the thermally conductive substrate 6 (Figure 1B).

While specific embodiments of the disclosed concept have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the disclosed concept which is to be given the full breadth of the claims appended and any and all equivalents thereof.

What is Claimed is:

1. A load buss array assembly (4) comprising:

a thermally conductive substrate (6);

a plurality of load conductors (2) placed within the thermally conductive substrate; and

a portion of a load connector (14) placed within the thermally conductive substrate,

wherein the load conductors are electrically connected the portion of said load connector within the thermally conductive substrate.

2. The load buss array assembly (4) of Claim 1 wherein said load conductors are a plurality of miniature conductive traces (2).

3. The load buss array assembly (4) of Claim 2 wherein said miniature conductive traces are over-molded into the thermally conductive substrate.

4. The load buss array assembly (4) of Claim 2 wherein said miniature conductive traces have a flat cross-section.

5. The load buss array assembly (4) of Claim 2 wherein said miniature conductive traces have a round cross-section.

6. The load buss array assembly (4) of Claim 2 wherein said miniature conductive traces have a square cross-section.

7. A load module (12) comprising the load buss array assembly (4) of Claim 1.

8. A circuit breaker panel (20) comprising:

a cover (22); and

a backplane module (24) comprising the load buss array assembly of Claim 1.

9. A method of manufacturing a load buss array assembly (4) comprising:

placing a plurality of load conductors (2) within a thermally conductive substrate (6);

placing a portion of a load connector (14) within the thermally conductive substrate; and electrically connecting the load conductors to the portion of the load connector within the thermally conductive substrate.

10. The method of Claim 9 further comprising:

employing a plurality of miniature conductive traces (2) as said plurality of load conductors.

11. The method of Claim 10 further comprising:

over-molding the miniature conductive traces into the thermally conductive substrate.

12. The method of Claim 10 further comprising:

manually placing the miniature conductive traces into the thermally conductive substrate.

13. The method of Claim 10 further comprising:

automatically placing the miniature conductive traces into the thermally conductive substrate.

14. The method of Claim 13 further comprising:

employing the miniature conductive traces having a flat, round or square cross-section; and

employing automated bobbin winding placement as said automatically placing.

15. The method of Claim 10 further comprising:

automatically coupling the miniature conductive traces to the portion of the load connector by fixturing and by wave soldering.

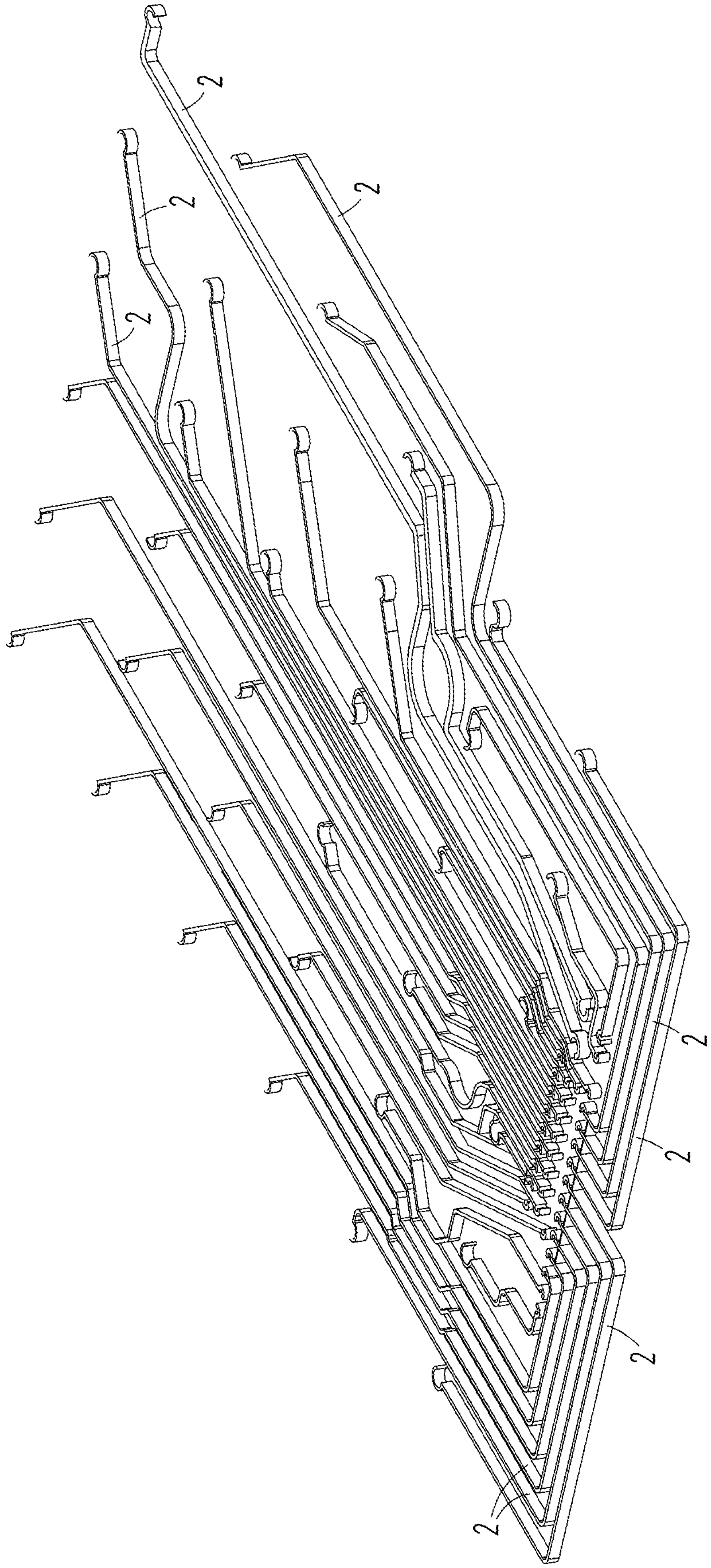

FIG. 1A

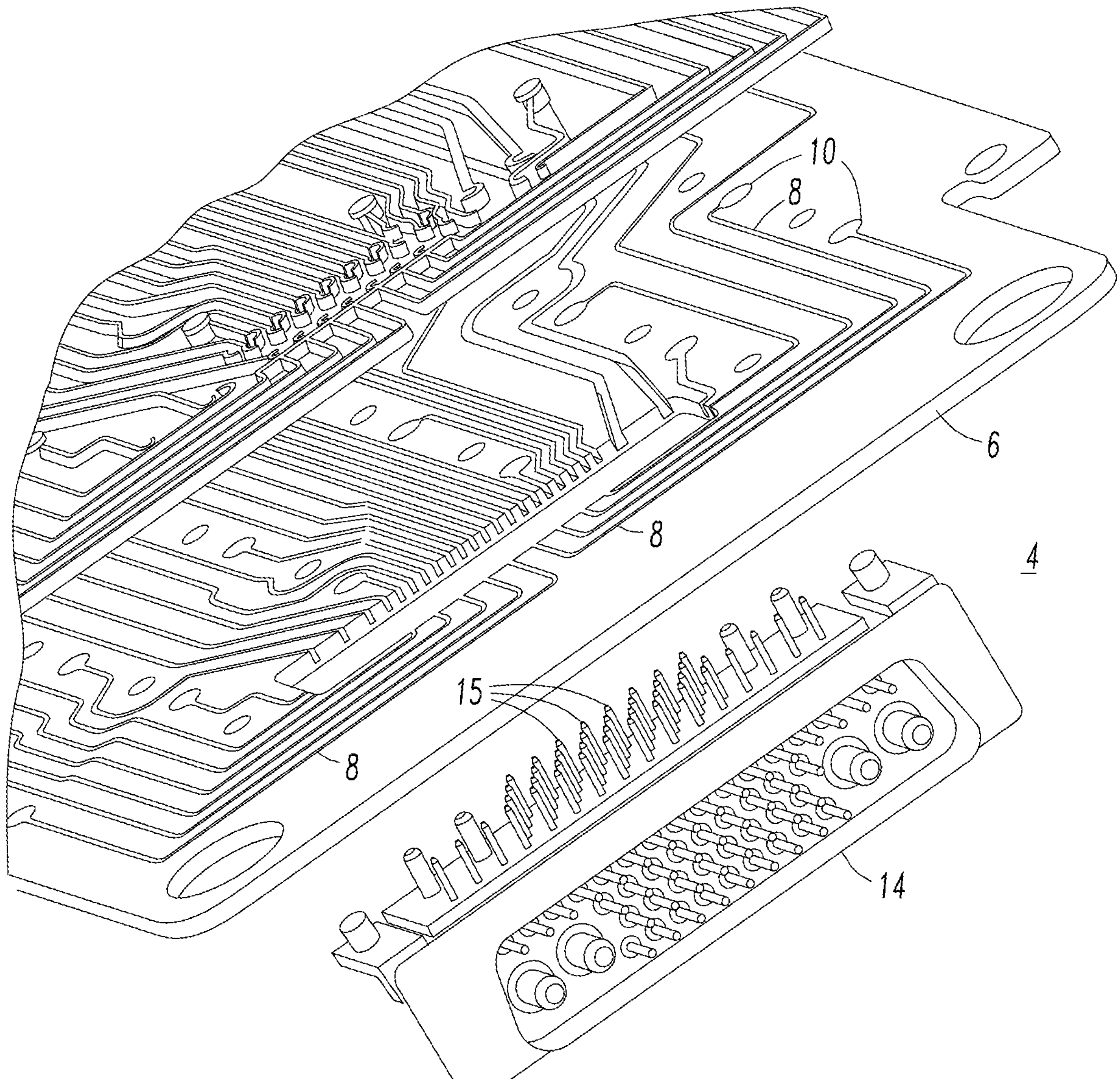

FIG.1B

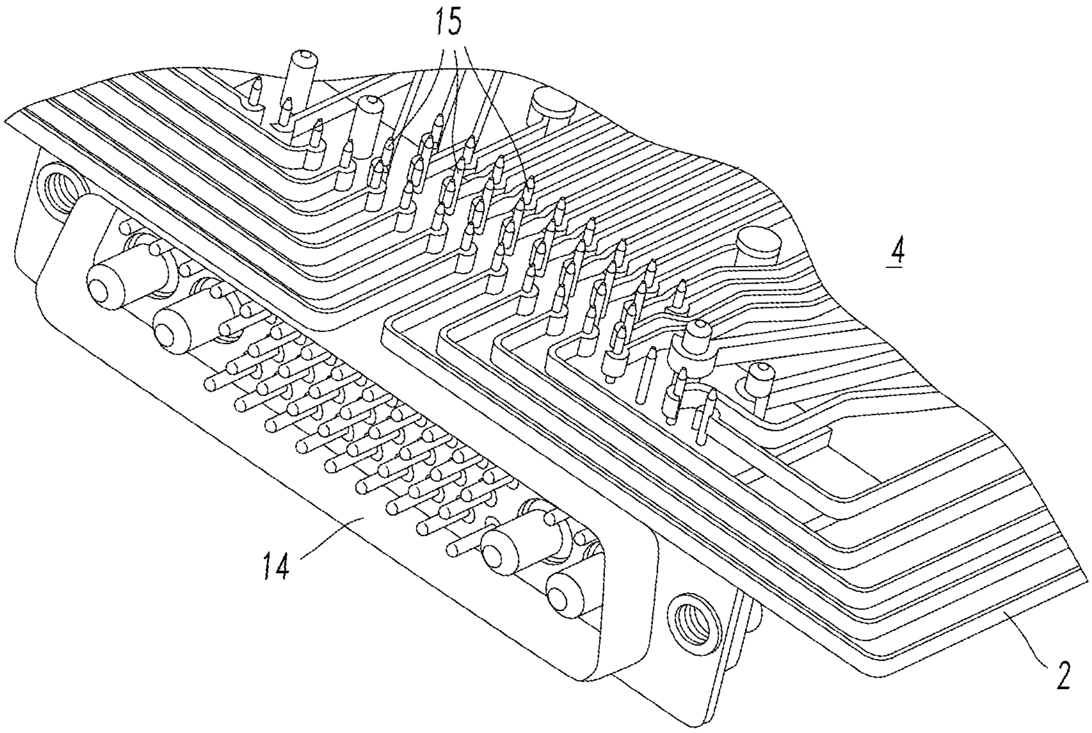

FIG. 1C

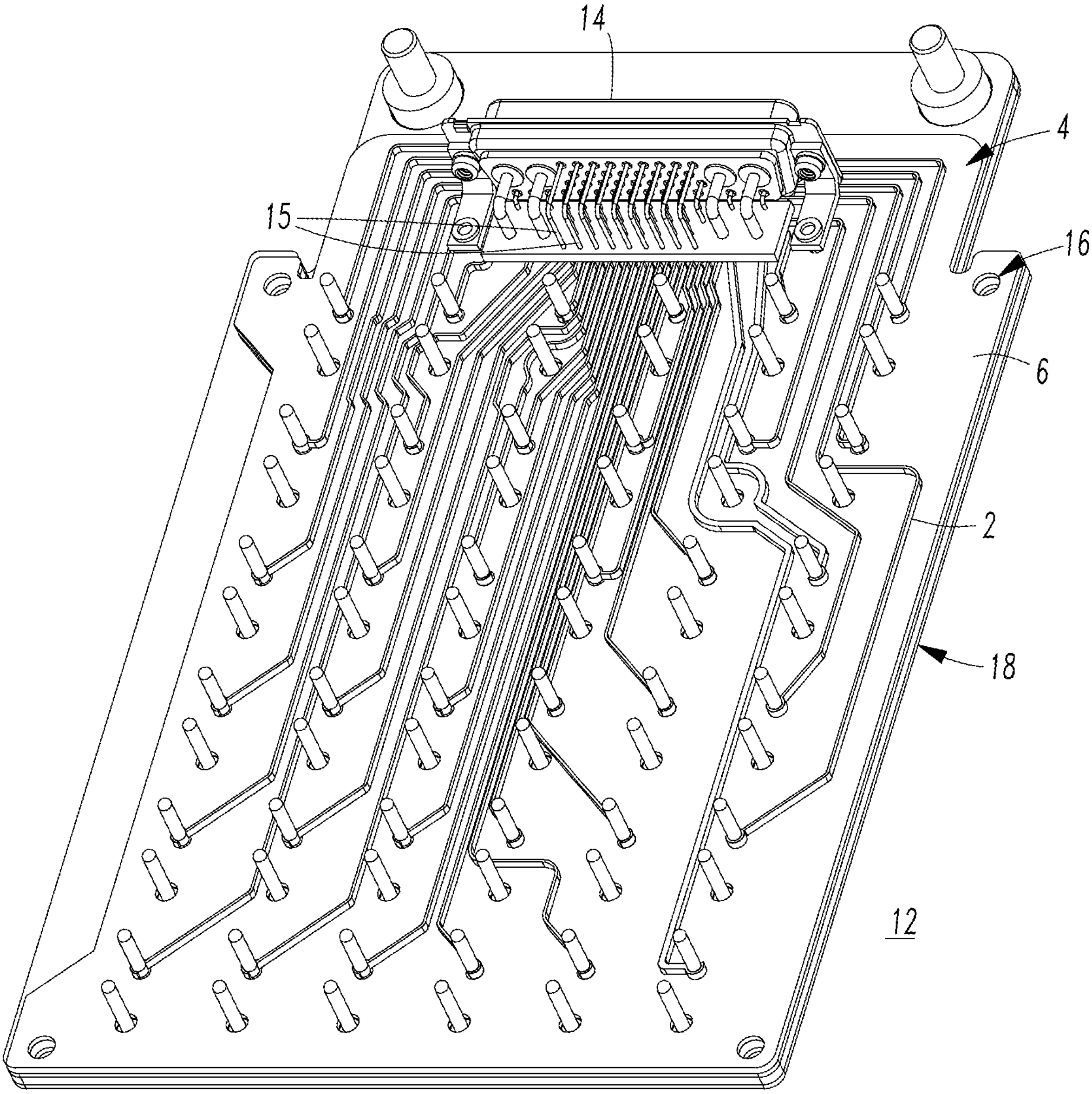

FIG.2A

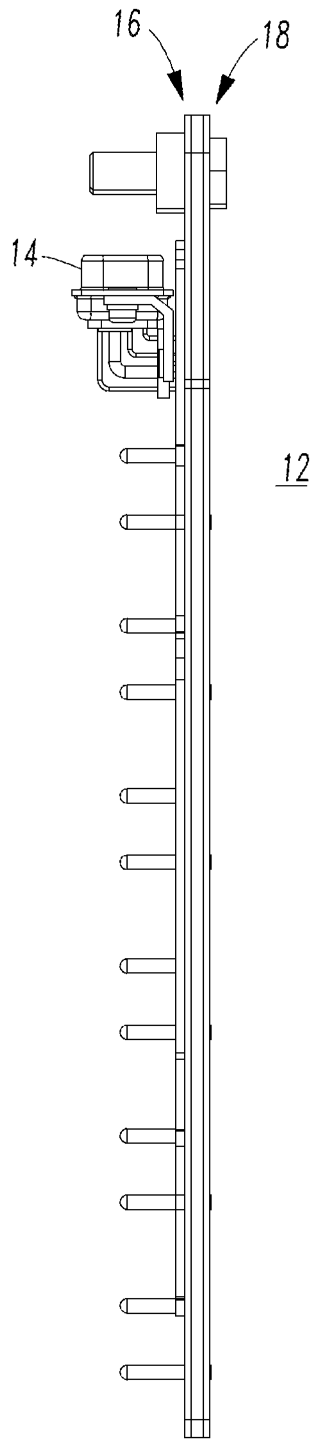

FIG.2B

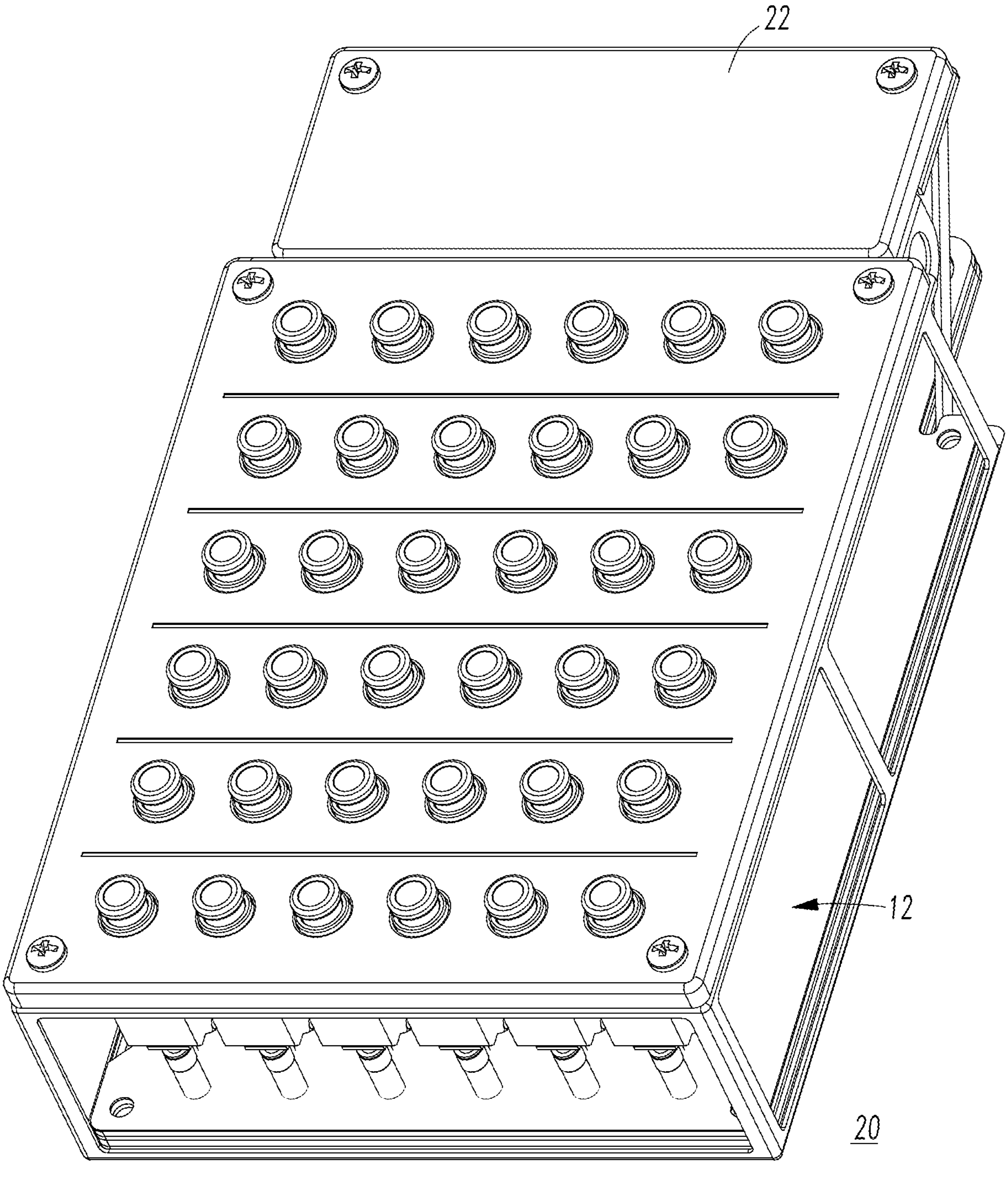

FIG.3A

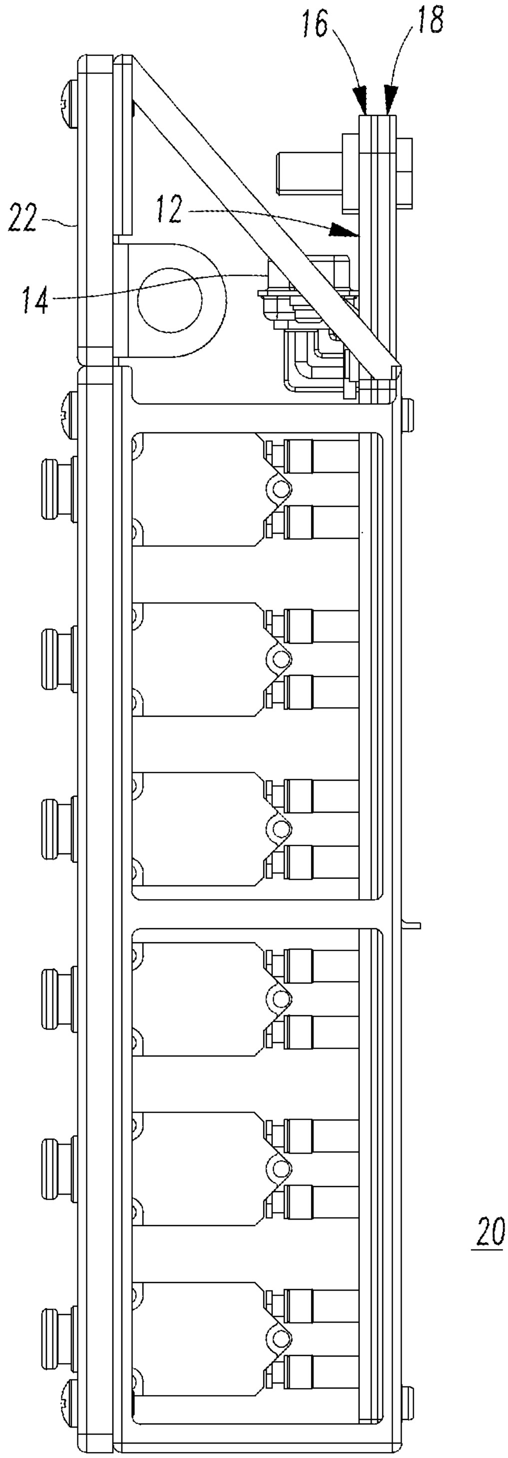

FIG.3B

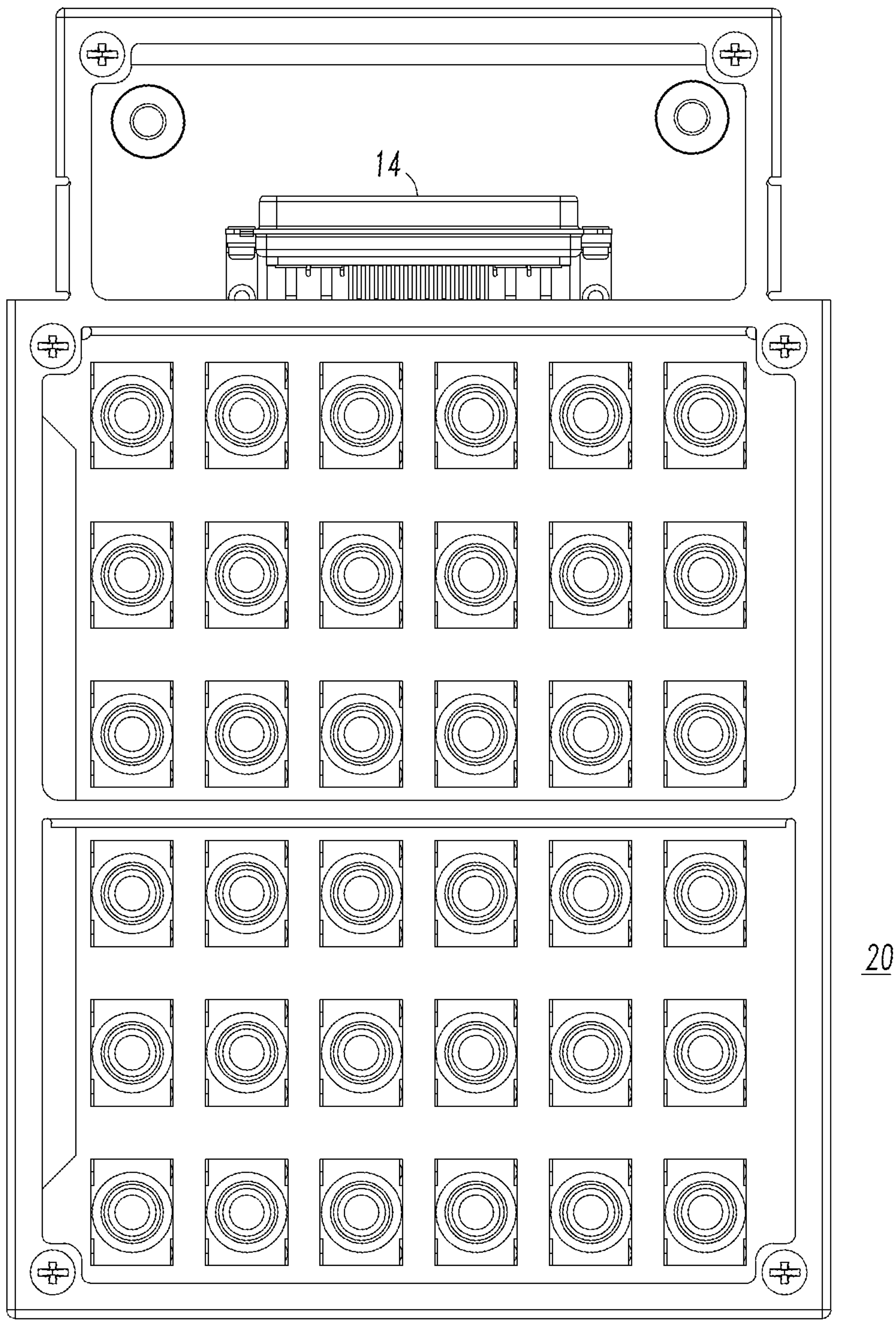

FIG. 4

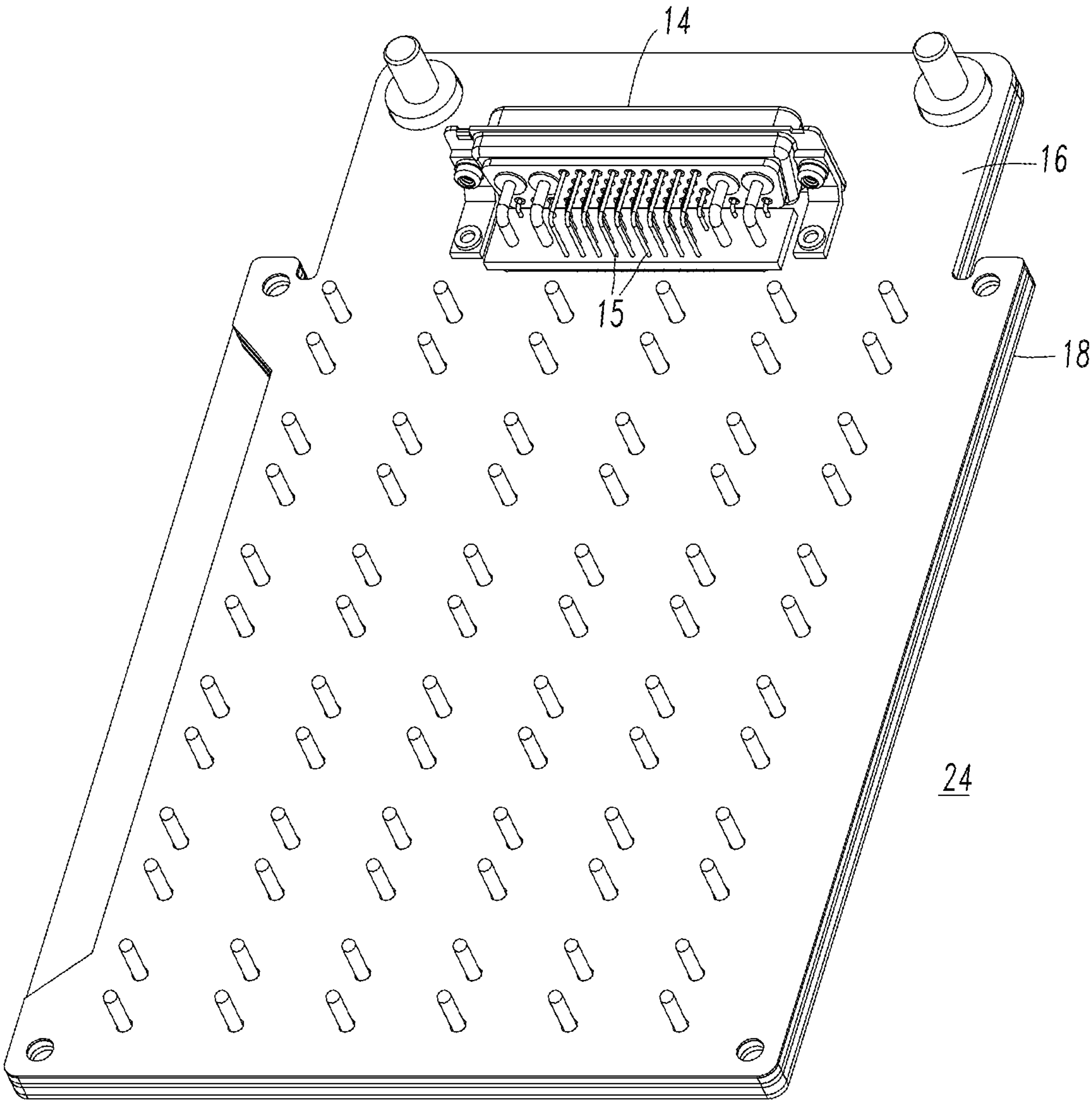

FIG.5A

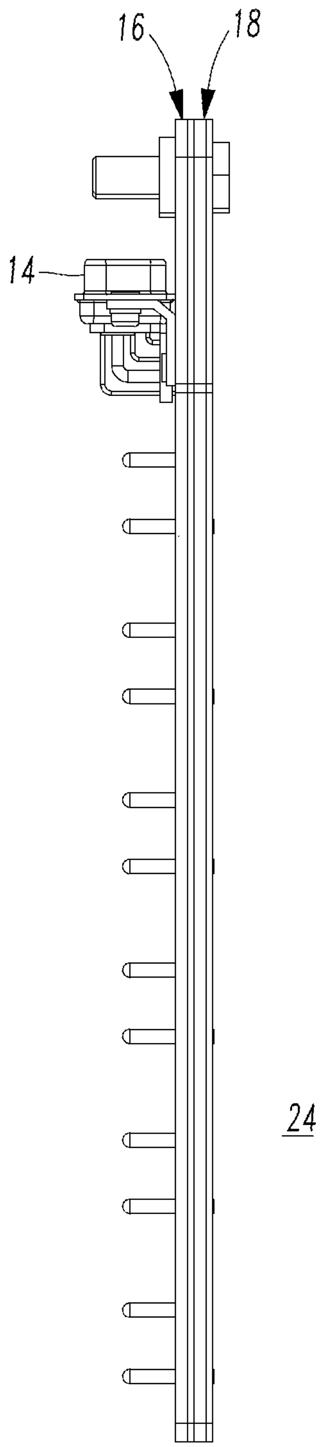

FIG.5B

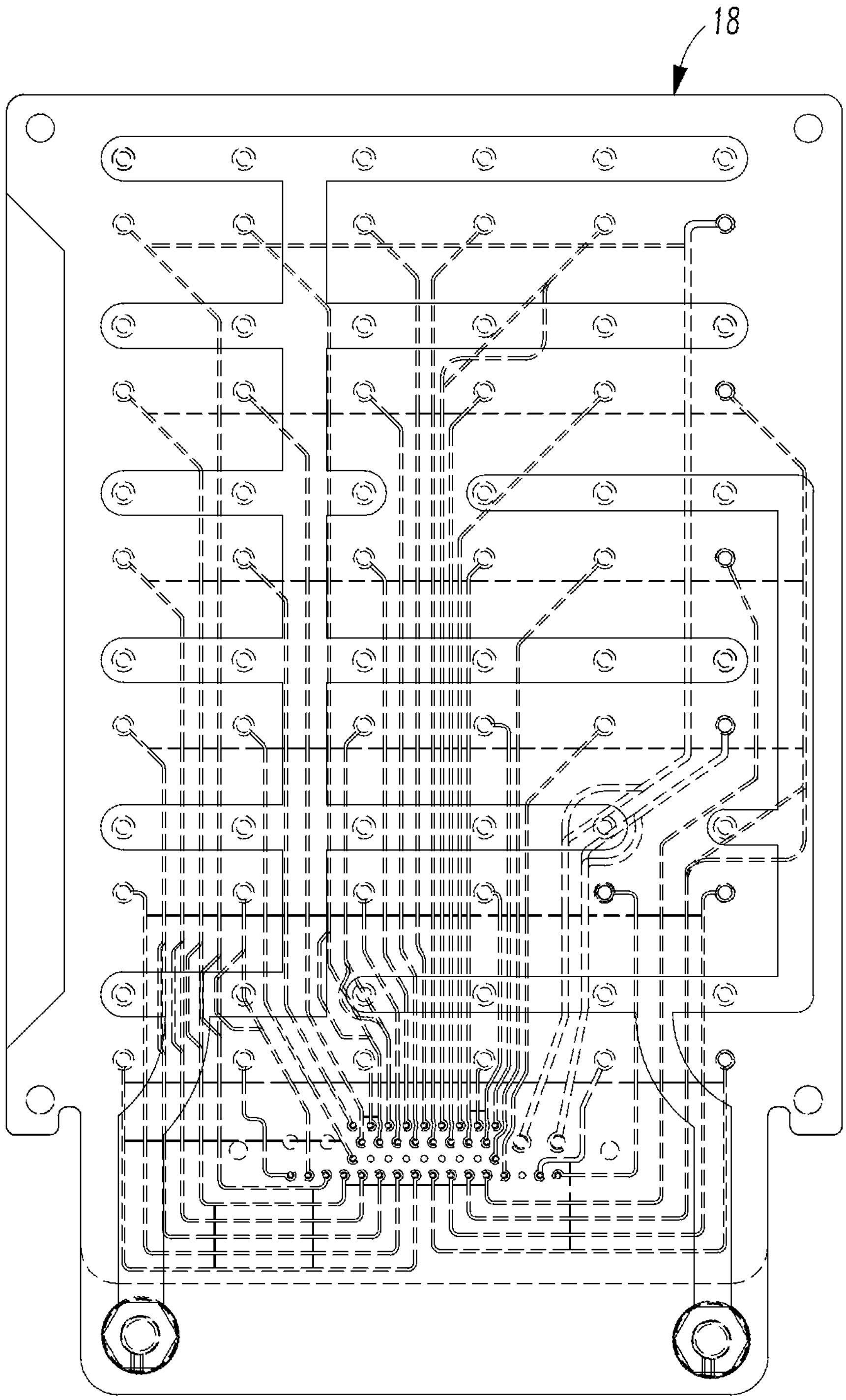

FIG.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/032927

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02B1/056
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02B H05K

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2013	28/06/2013

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

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