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(54) Title: POWER CONNECTOR AND SYSTEM

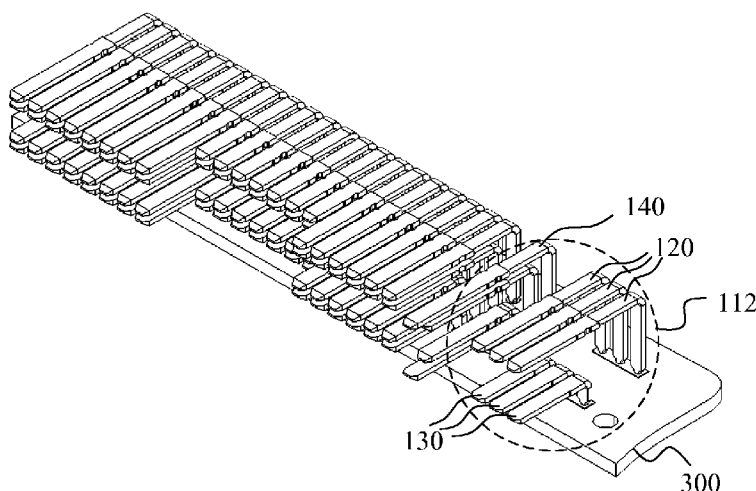


FIG. 2

(57) Abstract: The present invention relates to a power connector used in electronic systems. The power connector has an insulative housing into which conductive terminals are disposed. A first set of the conductive terminals are electrically connected together to a first pole, and aligned along a first row parallel to a lateral direction of the housing. A second set of the conductive terminals are electrically connected together to a second pole, and aligned along a second row parallel to the lateral direction of the housing. The break down voltage between the first and second sets of conductive terminals is increased by increasing the distance between first and the second row but without increasing the pitch of the conductive terminals. A power connector according to the present invention achieves higher power transmission capacity without increasing the lateral dimension of the connector.



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POWER CONNECTOR AND SYSTEM

Field of the Invention

5 The present invention relates to an electrical connector, and more particularly to a power connector. The present invention also relates to a connector system including such power connector.

Background of the Invention

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Power connectors are widely used in many electronic devices and systems for transmitting electrical power. With the increased functionality and complexity of the devices and systems, power connectors are required to provide higher and higher power transmission capacity, e.g. higher break down voltage or higher current, and more compact in size. To obtain higher power transmission capacity, conventional power connectors adopt the technique of increasing the physical dimension of the contact terminals, e.g. of blade-shaped terminals, in order to be able to carry higher electrical current. To further increase the capacity, terminals with greater physical dimension or cross-sectional area becomes necessary. Manufacturing contact terminals with different physical dimension or cross-sectional area requires different tooling and process, hence there is a higher cost to both the connector manufacturers and users.

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Summary of the Invention

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The present invention relates to a power connector used in electronic systems. The power connector has an insulative housing into which conductive terminals are disposed. A first set of the conductive terminals are electrically connected together to a first pole, and aligned along a first row parallel to a lateral direction of the housing. A second set of the conductive terminals are electrically connected together to a second pole, and aligned along a second row parallel to the lateral direction of the housing. According to one aspect, the present invention provides a power connector in which, the break down voltage between the first and second sets of conductive terminals can be increased by increasing

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the distance between first and the second row but without increasing the pitch of the conductive terminals. A power connector according to the present invention can provide higher power transmission capacity without increasing the lateral dimension of the connector. According to another aspect, the present invention provides a power connector which is easy customizable to achieve increased total current capacity without using contact terminals with greater physical dimensions. According to a further aspect, the present invention also provides a connector system using one or more connectors mounted on to a circuit board and configured based on the connector of the present invention.

For a better understanding of the present invention and its purpose and preferred embodiments, further description accompanied by figures is provided in detail below.

Brief description of the drawings

Fig. 1 is a perspective view showing a power connector according to one embodiment of the present invention;

Fig. 2 is a perspective view showing contact terminals of the power connector of Fig. 1 mounted on a circuit board;

Fig. 3 is a perspective bottom view of Fig. 2;

Fig. 4 is a perspective showing the power connector of Fig. 1 and a counterpart connector both mounted onto a respective circuit board;

Fig. 5 is an enlarged partial view of a power connector according to one embodiment of present invention;

Fig. 6 is an enlarged partial view of a power connector according to another embodiment of the present invention;

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Fig. 7 is an enlarged partial view of a power connector according to yet another embodiment of the present invention.

Fig. 8 is a cross sectional perspective view of A-A of Fig. 1 showing a further embodiment of the present invention

Detailed Description Of Preferred Embodiments

As shown in Figs. 1, 2, 3 and 4, a power connector 100 according to one embodiment of the present invention has a housing 110 and first and second sets of contact terminals 120, 130 disposed in housing 110. Housing 110 has a mating face 102 and a mounting face 104. In use, connector 100 is mounted to a first circuit board 300, and with mating face 102 facing a counterpart connector 200 which may be mounted on a second circuit board 400. Housing 110 defines a width direction X, a depth direction Y and a height direction Z. X, Y and Z directions are orthogonal to each other. Terminals 120 and 130 form a power connection module 112 in connector 100.

As shown in Fig. 5, in a connector system which includes connector 100 and circuit board 300, each of the first set of terminals 120 has a mating end 122 and a mounting end 124. Mating ends 122 are positioned adjacent to mating face 102, for connecting to the counterpart connector (not shown in Fig. 5). Mounting ends 124 are positioned adjacent to mounting face 104, for mounting to and electrically connecting to circuits or conductive pads formed on circuit board 300. Mating ends 122 are aligned along width direction X at a first row 122a. Mounting ends 124 are electrically connected together when connector 100 is mounted to circuit board 300, e.g. by first circuit 324, and for connecting to, directly or indirectly, a first electrode 520 of a power source 500. Likewise, each of the second set of terminals 130 has a mating end 132 and a mounting end 134. Mating ends 132 are positioned adjacent to mating face 102, for connecting to the counterpart connector (not shown in Fig. 5). Mounting ends 134 are positioned adjacent to mounting face 104, for mounting to circuit board 300. Mating ends 132 are aligned along direction X at a second row 132a which is parallel to, and offset along height direction Z from, first row 122a. Mounting ends 134 are electrically connected

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together when connector 100 is mounted to circuit board 300, e.g. by circuit 334, and for connecting to, directly or indirectly, a second electrode 530 of power source 500. As such, first and second set of terminals 120 and 130 are connected to power source 500 in parallel.

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Because the breakdown voltage capacity of power connection module 112 is determined by the distance H1 in height direction Z between mating ends of terminals 120 and 130, in applications where higher breakdown voltage is required, connector 100 may be configured by positioning mating ends of terminals 120 and 130 further away from each other, i.e. by increasing the distance H1. As such, there no need to increase the pitch P1 of terminals 120 and 130 as is the case of conventional power connectors. Accordingly, a power connector with higher anti-breakdown voltage capability may be provided, without increasing the width dimension of the connector.

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First terminals 120 may be formed with same physical dimensions and shapes and be made of same material, i.e. each terminal 120 has a fixed current capacity, for instance 5.5A. In applications where higher current capacity is required, instead of replacing the terminals with larger physical dimension, as is the case of conventional power connectors, the present invention provides a solution by using the same type of 5.5A terminals but to increase the total number of terminals. For example, a power connector shown in Fig. 5 has a total of three pairs of terminals 120, 130, and is capable of providing a maximum total current capacity of $5.5 \times 3 = 16.5\text{A}$. When a 20A current capacity is required, a fourth terminal can be added to achieve a total maximum current capacity of $5.5 \times 4 = 22\text{A}$. Accordingly, the present invention can provide a power connector with increased current capacity without the need of replacing the contact terminals with larger physical dimensions. This provides a cost-effective solution to manufacture power connector to meet different power transmission requirements by using contact terminals in substantially the same physical dimensions.

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In another embodiment, as shown in Fig. 6 (the housing of the connector is omitted so as to show the terminals), a power unit 613 is provided for supplying AC power. Power unit 613 includes a power module 612 which is similar to power module 112 illustrated in

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the previous embodiment, and a grounding module 614. Power unit 613 may be configured by connecting terminals 620 to AC-Life (AC-L) of an Alternating Current (AC) power source, terminals 630 to AC-Neutral (AC-N) and terminals 640 to AC-Earth (AC-PE). In the present embodiment, grounding module 614 has two standard terminals 640, each having the same length as terminals 620 and 630, and two sacrificial terminals 641. Each sacrificial terminal 641 is longer than standard terminals 640. Another words, the mating end of each sacrificial terminal 641 is positioned closer to mating face 102 than mating ends of standard terminals 640. During a mating / un-mating process with a counterpart connector, the two sacrificial terminals 641 serve as “first-to-mate, last-to-break” terminals for the purpose of arresting arcs generated during the mating/un-mating process. Each of the two standard terminals 640 and sacrificial terminals 641 may be an individual contact terminal with the same current capacity, e.g. 5.5A. Based on the actual arc-arresting requirements, one or more terminals can be configured as sacrificial terminals, and at any one or respective designated locations.

In yet another embodiment shown in Fig. 7, a power connector includes one or more power modules 712 (the housing of the connector is omitted so as to show the terminals). Power module 712 has a first set of contact terminals 720, 721 and 722, and a second set of contact terminals 730. The first set of contact terminals are to be electrically connected together to a first electrode. The second set of contact terminals are to be electrically connected together to a second electrode. One or more of the first set of contact terminals, e.g. contact terminal(s) 720, is/are configured as standard terminals, having a length L720, for power transmission. A first sacrificial terminal 721 has a length L721 longer than the length L720 of standard contact terminals 720. A second sacrificial terminal 722 has a length L722 longer than the length L720 of standard contact terminals 720 but shorter than the length L721 of first sacrificial contact terminal. Accordingly, first sacrificial contact terminal 721 configured as the “first-to-mate / last-to-break” terminal, serving as the arc-arresting terminal, during the mating / un-mating process. Both the second sacrificial contact terminal 722 and standard contact terminal(s) 720 serve as normal power transmission terminals. In the event that first sacrificial contact terminal 721 fails to perform the arc-arresting function, for instance by loose-contact, oxidized contact surface or burnt-off, the second sacrificial contact terminal 722 will become the

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“first-to-mate / last-to-break” terminal, taking over the arc-arresting role from the first sacrificial contact terminal 721. A power connector including two or more sacrificial contact terminals structured in the above-illustrated manner will have a higher safety level and a more reliable operability with respect to the arc-arresting capability.

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Fig. 8 shows a further embodiment of the present invention. As shown in Fig. 8, a power connector 800 has a housing 810 and four sets of contact terminals 822, 832, 842 and 852 disposed in housing 810. First and second sets of contact terminals 822 and 832 are supported by a first tongue 812 of housing 810, and are configured to be electrically connected to a first electrode 520 of a power source. Third and fifth sets of contact terminals are supported by a second tongue 814 of housing 810, and are configured to be electrically connected to a second electrode 530 of a power source.

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Structured in the above-illustrated manner, contact terminals 822, 832 and 842, 852 form a power module in power connector 800. The distance H2 in height direction Z between second set of contact terminals 832 and third set of contact terminals 842 is used to determine the breakdown voltage capacity of this power module. In applications where higher breakdown voltage is required, first and second sets of contact terminals 822, 832 may be positioned further away from third and fourth sets of contact terminals 842, 852, i.e. by increasing the distance H2, without increasing the pitch P2 of each set of contact terminals 822, 832 and 842, 852. Accordingly, a connector with higher anti-breakdown capability may be provided, without increasing the width dimension of the connector. It follows that three or more tongue structure may be provided in the housing, stacked to each other along the height direction Z and each tongue supports two sets of contact terminals to provide a power connector with further increased power transmission capacity, without increase the width of the connector.

CLAIMS

1. An electrical connector comprising:
 - a housing having a mating face and a mounting face, the housing defining a
 - width direction, a height direction and a depth direction;
 - first and second groups of terminals disposed in the housing, each terminal
 - having a contact end adjacent to the mating face and a mounting end
 - adjacent to the mounting face,
 - the contact ends of the first group of terminals are aligned in a first row along
 - the width direction,
 - the contact ends of the second group of contact terminals are aligned in a
 - second row along the width direction, wherein the second row is offset
 - from the first row along the height direction,
 - wherein the mounting ends of the first group of terminals are electrically
 - connectable to a first electrode, and
 - wherein the mounting ends of the second group of terminals are electrically
 - connectable to a second electrode.
2. The electrical connector of claim 1, further comprising a third group of terminals
- disposed in the housing, each one of the third group of terminals having a contact
- end adjacent to the mating face and a mounting end adjacent to the mounting face,
- wherein the mating ends of the third group of terminals are aligned in a column
- along the height direction, and the mounting ends of the third group of terminals
- are electrically connectable to a third electrode.
3. The electrical connector of claim 2, wherein the third group of terminals
- comprising a first ground terminal having a contact end disposed on the first row
- and a second ground terminal having a contact end disposed on the second row.
4. The electrical connector of claim 1, further comprising a first sacrificial terminal
- having a contact end located closer to the mating face than the contact ends of the
- first group of terminals.

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5. The electrical connector of claim 3, wherein the first sacrificial terminal having a mounting end electrically connectable to one of the first and the second electrodes.
- 5 6. The electrical connector of claim 3, further comprising a second sacrificial terminal having a contact end located closer to the mating face than the contact ends of the first group of terminals and farther than the contact ends of the first sacrificial terminal.
- 10 7. The electrical connector of claim 6, wherein the second sacrificial terminal having a mounting end electrically connectable to one of the first and the second electrodes.
8. A connector system comprising:
15 a circuit board having a first circuit and a second circuit supported thereon;
a connector mounted on the circuit board, the connector comprising:
a housing having a mating face and a mounting face, the housing defining a width direction, a height direction and a depth direction;
first and second groups of terminals disposed in the housing, each terminal
20 having a contact end adjacent to the mating face and a mounting end adjacent to the mounting face,
the contact ends of the first group of terminals are aligned in a first row along the width direction,
the contact ends of the second group of contact terminals are aligned in a
25 second row along the width direction, wherein the second row is offset from the first row along the height direction,
wherein the mounting ends of the first group of terminals are electrically connected to the first circuit, and
wherein the mounting ends of the second group of terminals are electrically
30 connected to the second circuit.
9. The connector system of claim 8, wherein the circuit board further comprising a third circuit and the connector further comprising a third group of terminals

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disposed in the housing, each one of the third group of terminals having a contact end adjacent to the mating face and a mounting end adjacent to the mounting face, wherein the mating ends of the third group of terminals are aligned in a column along the height direction, and the mounting ends of the third group of terminals are electrically connected to the third circuit.

10. The connector system of claim 9, wherein the third group of terminals comprising a first ground terminal having a contact end disposed on the first row and a second ground terminal having a contact end disposed on the second row.

11. The connector system of claim 8, further comprising a first sacrificial terminal having a contact end located closer to the mating face than the contact ends of the first group of terminals.

12. The connector system of claim 11, wherein the first sacrificial terminal having a mounting end electrically connected to one of the first and the second circuits.

13. The connector system of claim 11, further comprising a second sacrificial terminal having a contact end located closer to the mating face than the contact ends of the first group of terminals and farther than the contact ends of the first sacrificial terminal.

14. The connector system of claim 13, wherein the second sacrificial terminal having a mounting end electrically connected to one of the first and the second circuits.

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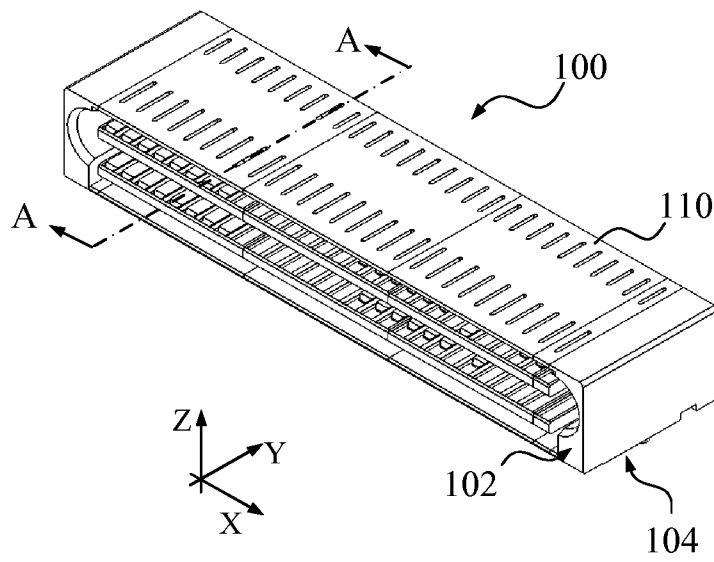


FIG. 1

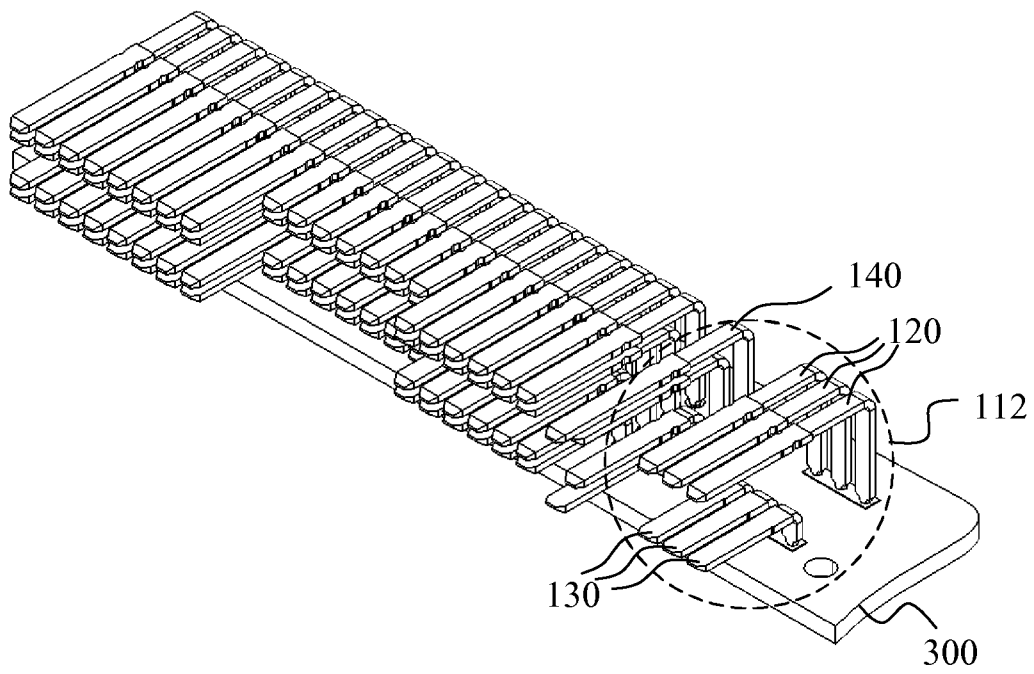


FIG. 2

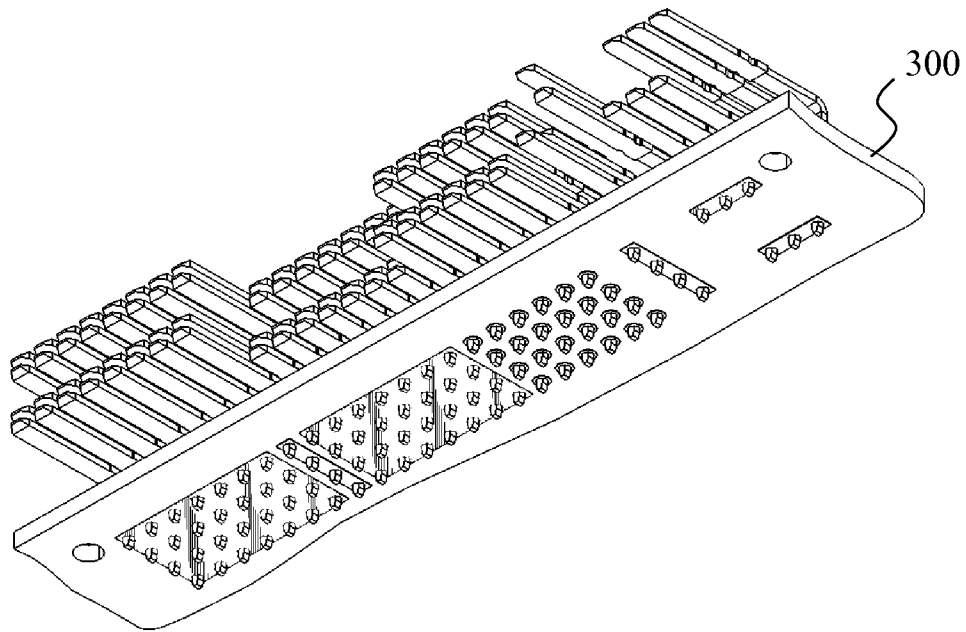


FIG. 3

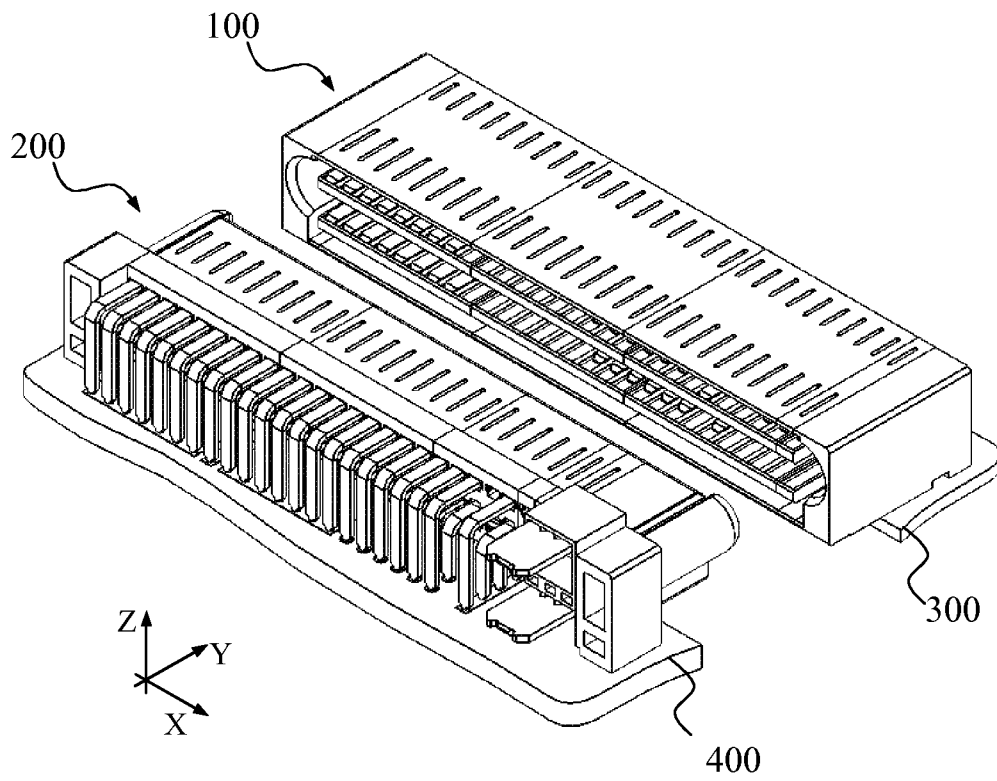


FIG. 4

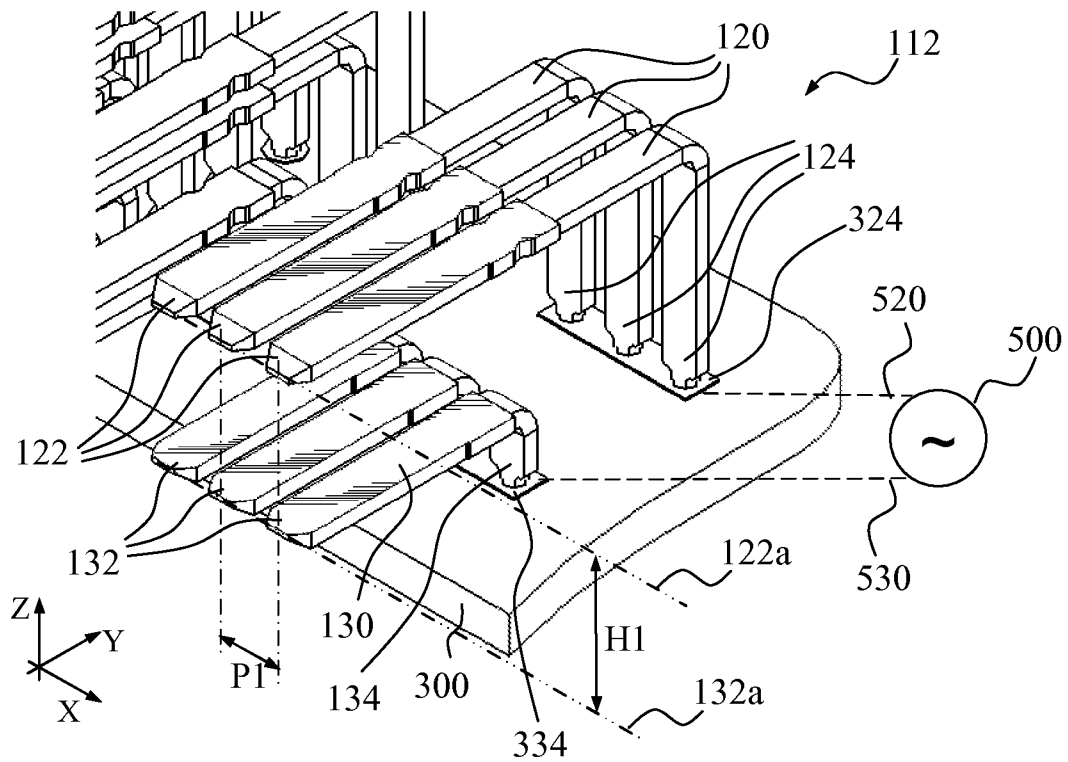


FIG. 5

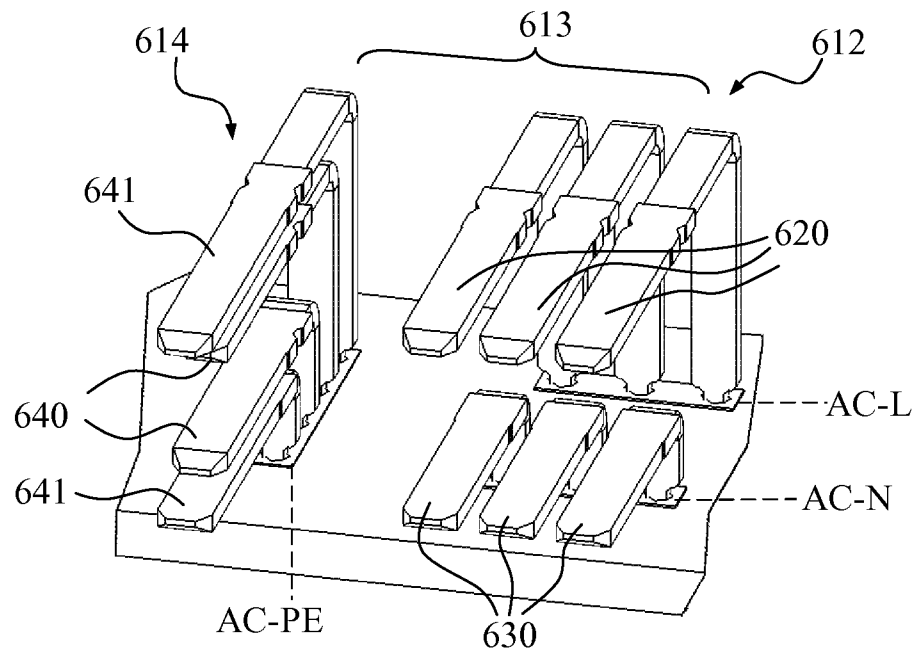


FIG. 6

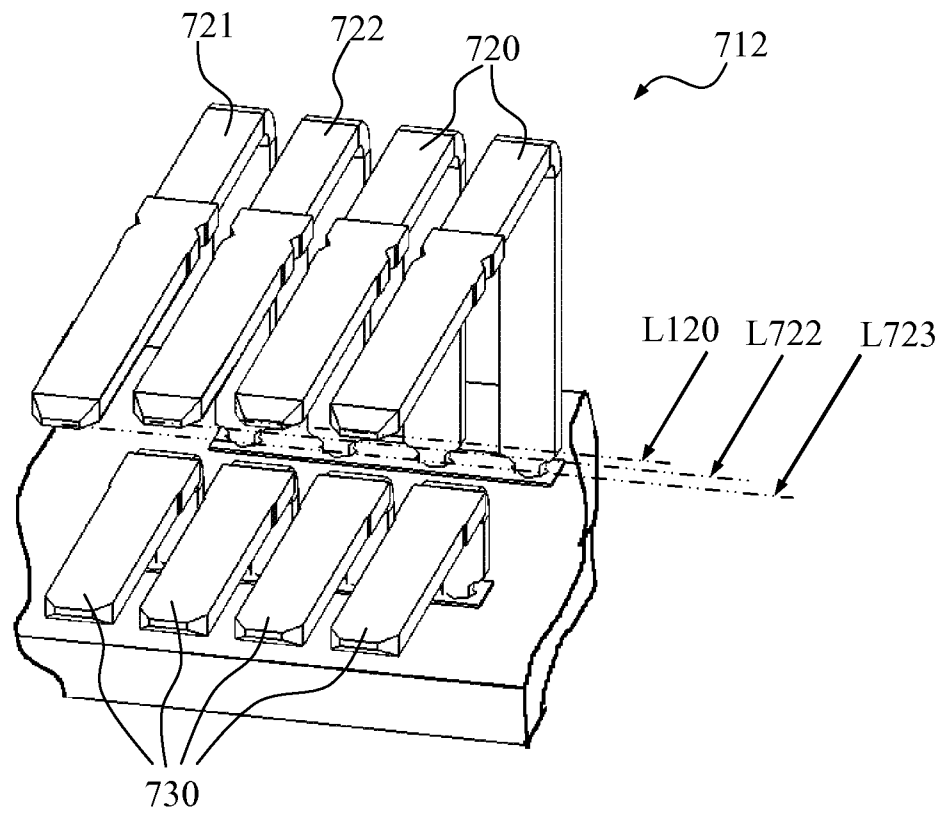


FIG. 7

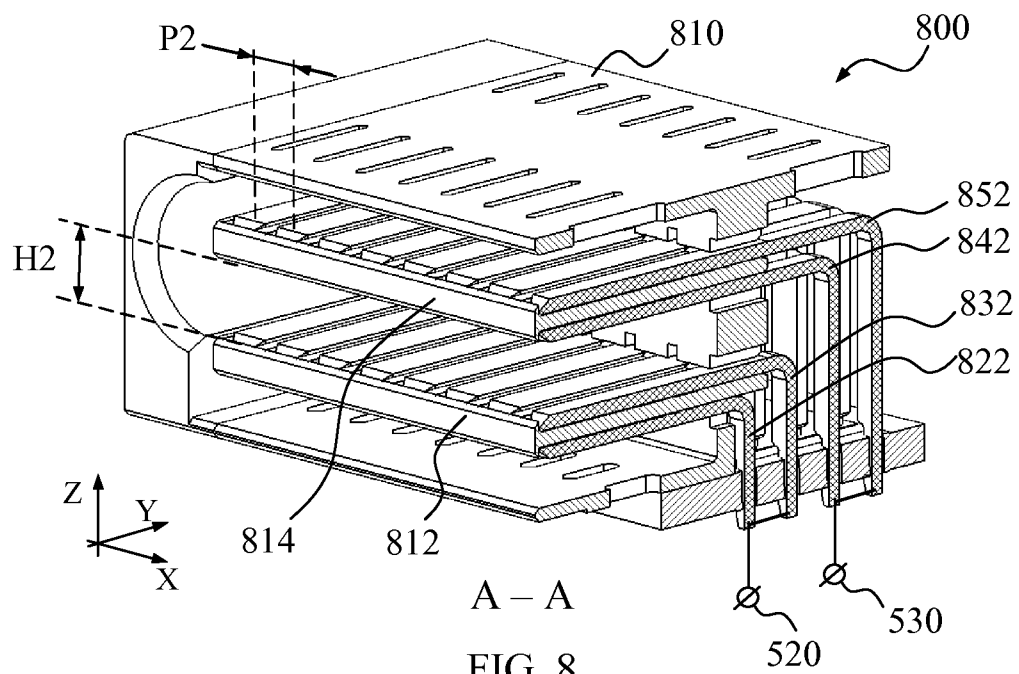


FIG. 8