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(54) Title: WAFER ASSEMBLY CABLE CONNECTOR

(57) Abstract: A wafer assembly cable connector is described. The wafer assembly cable connector can be modular and vertically fixed to a circuit board. The wafer has a thickness that is substantially less than its length or width. A plurality of wafers can be stacked onto each other and vertically connected and secured to a circuit board.

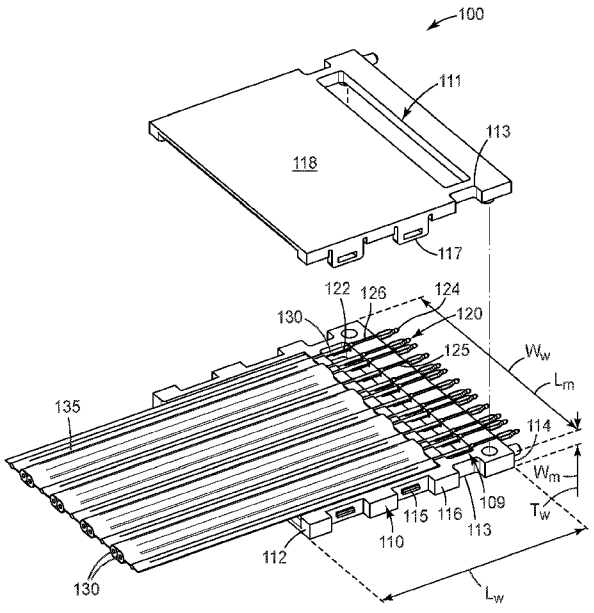


FIG. 1

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WAFER ASSEMBLY CABLE CONNECTOR

BACKGROUND

Flexible circuits and assemblies are often used as connectors in various applications of electronics equipment, such as printers, computers, servers, monitors and the like. Such circuits offer a benefit over previously used rigid circuit boards in both flexibility and space savings.

Cable assemblies have been mounted to a circuit board by direct solder or by a separable connector. The cable assembly design uses compliant pins which are used in backplane and other similar non-cabled connectors; these connectors are usually pressed onto a circuit board using a mechanical pressing system.

SUMMARY

The present disclosure relates to a wafer assembly cable connector. The wafer assembly cable connector can be modular and vertically fixed to a circuit board. The wafer has a thickness that is substantially less than its length or width. A plurality of wafers can be stacked onto each other and vertically connected and secured to a circuit board.

In one aspect, the present description relates to a wafer assembly for electrically connecting a plurality of wires to a circuit board. The wafer assembly includes an electrically insulative wafer and a plurality of wires received within the wafer. The electrically insulative wafer includes a wire receiving face for receiving a plurality of wires and an opposite mounting face for mounting the wafer assembly onto a circuit board. A plurality of terminals are partially disposed within the wafer and form a row of spaced apart substantially parallel terminals arranged along a length of the mounting face. Each terminal includes a contact portion disposed within the wafer for making contact with a wire, a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board, and a connecting portion connecting the contact portion to the press-fit portion. The plurality of wires is received within the wafer from the wire receiving face of the wafer. Each wire is terminated at the contact portion of a corresponding terminal. The wafer having a width along the length of the mounting face, a thickness along a width of the mounting face, and a length as a separation between the wire receiving and mounting faces. The thickness being substantially less than the length and the width.

In another aspect, the present description relates to a vertical connector for vertically mounting on a circuit board. The vertical connector includes a plurality of wafer assemblies, described herein, horizontally stacked.

In further embodiments, the present description relates to a vertical connector for vertically mounting on a circuit board further including a frame. The frame includes a body having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board. A pair of spaced apart opposing top arms extend from opposite top ends of the body proximate the wire receiving faces of the insulative wafers, and a pair of spaced apart opposing bottom arms extend from

opposite bottom ends of the body proximate the mounting faces of the insulative wafers. The pairs of top and bottom arms keep the plurality of wafer assemblies secure and in alignment.

In another aspect, the present description relates to a vertical connector for vertically mounting on a circuit board. The vertical connector includes a plurality of wafer assemblies, described herein, horizontally stacked and a frame keeping the plurality of wafer assemblies secure and in alignment such that mounting faces of the insulative wafers lie in a same plane. The frame having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board.

These and various other features and advantages will be apparent from a reading of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a wafer assembly cable connector according to the present description;

FIG. 2 is a perspective view of two wafer assembly cable connectors stacked onto each other; and

FIG. 3 is a perspective view of four wafer assembly cable connectors secured to a frame;

FIG. 4 is a and schematic diagram side view of the frame assembly of **FIG. 3** secured to a circuit board; and

FIG. 5 is a perspective view of another wafer assembly cable connector.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration several specific embodiments. It is to be understood that other embodiments are contemplated and may be made without departing from the scope or spirit of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense.

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified. The definitions provided herein are to facilitate understanding of certain terms used frequently herein and are not meant to limit the scope of the present disclosure.

Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims are to be understood as being modified in all instances by the term “about.” Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the properties desired by those skilled in the art utilizing the teachings disclosed herein.

The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within that range.

As used in this specification and the appended claims, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

As used herein, "have", "having", "include", "including", "comprise", "comprising" or the like are used in their open ended sense, and generally mean "including, but not limited to". It will be understood that "consisting essentially of", "consisting of", and the like are subsumed in "comprising," and the like.

Spatially related terms, including but not limited to, "lower," "upper," "beneath," "below," "above," and "on top," if used herein, are utilized for ease of description to describe spatial relationships of an element(s) to another. Such spatially related terms encompass different orientations of the device in use or operation in addition to the particular orientations depicted in the figures and described herein. For example, if an object depicted in the figures is turned over or flipped over, portions previously described as below or beneath other elements would then be above those other elements.

As used herein, when an element, component or layer for example is described as forming a "coincident interface" with, or being "on" "connected to," "coupled with," "stacked on" or "in contact with" another element, component or layer, it can be directly on, directly connected to, directly coupled with, directly stacked on, in direct contact with, or intervening elements, components or layers may be on, connected, coupled or in contact with the particular element, component or layer, for example. When an element, component or layer for example is referred to as being "directly on," "directly connected to," "directly coupled with," or "directly in contact with" another element, there are no intervening elements, components or layers for example.

The present disclosure relates to a wafer assembly cable connector. The wafer assembly cable connector can be modular and vertically fixed to a circuit board. The wafer has a thickness that is substantially less than its length or width. The wafer assembly cable connector can include a window that exposes a termination region of each wire. A plurality of wafers can be stacked onto each other and vertically connected and secured to a circuit board. In many embodiments, the wafer assembly cable connector can include a frame keeping a plurality of wafer assemblies secure and in alignment such that mounting faces of the insulative wafers lie in a same plane. The frame having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board. The means for attaching can include a screw, for example, and the means for attaching can be used to engage and disengage the wafer assembly cable connector with and from the circuit board. While the present disclosure is not so limited, an appreciation of various aspects of the disclosure will be gained through a discussion of the examples provided below.

FIG. 1 is a perspective view of a wafer assembly cable connector **100** according to the present description. **FIG. 2** is a perspective view of two wafer assembly cable connectors **100** stacked onto each other. **FIG. 5** is a perspective view of another wafer assembly cable connector **100**.

The wafer assembly cable connector **100** includes an electrically insulative wafer **110** and a wire receiving face **112** for receiving a plurality of wires **130** (or cable **135**) and an opposite mounting face **114** for mounting the wafer assembly **100** onto a circuit board **300** (see **FIG. 4**). A plurality of terminals **120** are partially disposed within the wafer **110** and form a row of spaced apart substantially parallel terminals arranged along a length L_M of the mounting face **114**.

Each terminal **120** includes a contact portion **122** disposed within the wafer **100** for making contact with a wire **130**, a substantially straight press-fit portion **124** extending beyond and perpendicular to the mounting face **114** for being inserted into a conductive via of a circuit board **300**, and a connecting portion **126** connecting the contact portion **122** to the press-fit portion **124**.

A plurality of wires **130** is received within the wafer **110** from the wire receiving face **112** of the wafer **110**. Each wire **130** is terminated at the contact portion **122** of a corresponding terminal **120**. The wafer **110** has a width W_W along the length L_M of the mounting face **114**, a thickness T_W along a width W_M of the mounting face **114**, and a length L_W as a separation between the wire receiving **112** and mounting **114** faces. The thickness T_W is substantially less than the length L_W and the width W_W forming a wafer shape. In many embodiments the thickness T_W is at least 5 times the length L_W and the width W_W. In many embodiments the thickness T_W is at least 10 times the length L_W and the width W_W.

In many embodiments the electrically insulative wafer **110** includes opposing first **116** and second **118** wafer halves assembled to each other. In many of these embodiments the plurality of wires **130** is received onto the first wafer half **116**. The first **116** and second **118** wafer halves are assembled to each other by a latch **117** of the second wafer half **116** engaging a hook **115** of the first wafer half **116**. Thus the first **116** and second **118** wafer halves can snap together with any useful detent mechanism. In other embodiments the first **116** and second **118** wafer halves are assembled to each other by the first wafer half **116** adhering to the second wafer half **118** or the first wafer half **116** interference fitting or friction fitting to the second wafer half **118**.

Each wire **130** can terminated at the contact portion **122** of the corresponding terminal **120** at a termination region **109**. In many embodiments, the electrically insulative wafer **110** incldues a window **113** extending along the width of the wafer **110** and exposing the termination region **109** of each wire **130**. The window **113** can provide access to the termination region **109** of each wire **130** to allow for convenient termination of the wire **130** to the contact portion **122** of the corresponding terminal **120**. In many embodiments the window **113** provides clear access for laser welding of the wire **130** to the contact portion **122** of the corresponding terminal **120**. In other embodiments the window **113** provides clear access for soldering or other types of termination of the wire **130** to the contact portion **122** of the corresponding terminal **120**.

FIG. 5 illustrates a cap **108** covering and substantially matching the window **109** of an illustrative wafer assembly cable connector **100**, as described above. The cap **108** can include fixing elements **106**

that align with mating element **107** within or on the wafer **110.** In some embodiments the fixing elements are hooks **106** and the mating elements are ledges **107** that engage the hooks **106** and secure the cap **108** into the window **109** of an illustrative wafer assembly cable connector **100**. The cap **108** can thus "snap" into place over the window **109** of an illustrative wafer assembly cable connector **100**. In some embodiments the cap **108** is electrically conductive.

In some embodiments the window **109** of an illustrative wafer assembly cable connector **100** is overmolded with a polymer material, to form an overmold and substantially fill the window **109**. In many embodiments, the electrically insulative wafer **110** has one or more or a plurality of spaced apart substantially parallel grooves **125**. Each groove **125** receiving a corresponding wire **130** in the plurality of wires.

A plurality of wafer assembly cable connectors **100** can be stacked onto each other. Thus the wafer assembly cable connectors **100** can be modular. In these embodiments the wafer assembly **101** includes a plurality of electrically insulative wafers **100**. Each electrically insulative wafer has a wire receiving face **112** for receiving a plurality of wires **130** (or cable **135**) and an opposite mounting face **114** for mounting the wafer assembly **100**, **101** onto a circuit board **300**.

A plurality of terminals **120** are partially disposed within the wafer **110** and form a row of spaced apart substantially parallel terminals **120** arranged along a length L_M of the mounting face **114**. Each terminal includes a contact portion **122** disposed within the wafer **100** for making contact with a wire **130**, a substantially straight press-fit portion **124** extending beyond and perpendicular to the mounting face **114** for being inserted into a conductive via of a circuit board **300**, and a connecting portion **126** connecting the contact portion **122** to the press-fit portion **124**.

A plurality of wires **130** is received within the wafer **110** from the wire receiving face **112** of the wafer **110**. Each wire **130** is terminated at the contact portion **122** of a corresponding terminal **120**. The wafer **110** has a width W_W along the length L_M of the mounting face **114**, a thickness T_W along a width W_M of the mounting face **114**, and a length L_W as a separation between the wire receiving **112** and mounting **114** faces. The thickness T_W is substantially less than the length L_W and the width W_W forming a wafer shape. In many embodiments the thickness T_W is at least 5 times the length L_W and the width W_W. In many embodiments the thickness T_W is at least 10 times the length L_W and the width W_W.

FIG. 3 is a perspective view of four wafer assembly cable connector **102** secured to a frame **200**. **FIG. 3** illustrates a vertical connector **200** for vertically mounting on a circuit board **300** a plurality of wafer assemblies **100** horizontally stacked onto each other. The mounting faces **114** of the insulative wafers **110** lie in a same plane **214** (see **FIG. 4**). **FIG. 4** is a schematic diagram side view of the frame assembly **200** of **FIG. 3** secured to a circuit board **300**.

The plurality of wafer assembly cable connectors **100** can be stacked onto each other and secured with a frame **200**. The frame **200** can include a body **201** having means for attaching **250** the frame **200** to a circuit board **300** when the vertical connector **103** is mounted on the circuit board **300**. The means for attaching **250** the frame **200** to the circuit board **300** can also facilitate the mounting of the vertical connector **103** on the circuit board **300**.

The means for attaching **250** can be any useful fasteners such as a screw **252** that is inserted into a screw hole of the circuit board **300** from a top side of the circuit board **300** and secures the frame **200** to the circuit board **300** where the screw hole of the circuit board **300** is a threaded screw hole, such that when the vertical connector **103** is mounted on a circuit board **300**, the screw **252** is screwed into the threaded screw hole. In many embodiments, the means for attaching **250** can be a screw **252** and a nut **254** where the screw passes through the circuit board **300** and the screw **252** engages the nut **254** from a bottom side of the circuit board **300**.

The frame body **201** can include a plurality of arms extending away from the body **201**. In many embodiments, the frame body **201** includes a pair of spaced apart opposing top arms **202** extending from opposite top ends of the body **201** proximate the wire receiving faces **112** of the insulative wafers **100** and a pair of spaced apart opposing bottom arms **204** extending from opposite bottom ends of the body **201** proximate the mounting faces **114** of the insulative wafers **100**. The pairs of top and bottom arms **202, 204** keep the plurality of wafer assemblies **101** secure and in alignment.

In many embodiments, each wafer **100** includes a plurality of recesses **113** engaging at least some of the arms in the pairs of first and second arms **202, 204**. In further embodiments, the frame **200** includes a left pair of spaced apart opposing top arms **202** extending along a left direction from opposite top ends of the body **201** proximate the wire receiving faces **112** of the insulative wafers **100** and a right pair of spaced apart opposing top arms **202** extending along a right direction from the opposite top ends of the body **201** proximate the wire receiving faces **112** of the insulative wafers **100** for a total of four opposing top arms **202**. The frame **200** includes a left pair of spaced apart opposing bottom arms **204** extending along the left direction from opposite bottom ends of the body **201** proximate the mounting faces **114** of the insulative wafers **100** and a right pair of spaced apart opposing bottom arms **204** extending along the right direction from the opposite bottom ends of the body **201** proximate the mounting faces **114** of the insulative wafers **100** for a total of four opposing bottom arms **204**. The left pairs of top **202** and bottom **204** arms engaging at least one wafer **100** in the plurality of wafer assemblies, and the right pairs of top **202** and bottom **204** arms engaging at least one other wafer **100** in the plurality of wafer assemblies, the left and right pairs of top **202** and bottom **204** arms keeping the plurality wafer assemblies **100** secure and in alignment.

In many embodiments, the frame **200** includes a body **201** having means for attaching **250** the frame **200** to a circuit board **300** when the vertical connector **103** is mounted on the circuit board **300**. The frame body **201** includes a plurality of left arms **202, 204** extending from the body **201** along a left direction, and a plurality of right arms **202, 204** extending from the body **201** along a right direction, the plurality of left and right arms **202, 204** keeping the plurality of wafer assemblies **100** secure and in alignment.

A vertical connector **103** for vertically mounting on a circuit board **300** includes a plurality of wafer assemblies **100** horizontally stacked and a frame **200** keeping the plurality of wafer assemblies **100** secure and in alignment such that the mounting faces **114** of the insulative wafers **100** lie in a same plane **214**. The frame **200** having means for attaching **250** the frame **200** to a circuit board **300** when the vertical

connector **103** is mounted on the circuit board **300**. In many embodiments, the vertical connector **103** further includes an electrically conductive shield at least partially covering the plurality of wafer assemblies **100**.

Thus, embodiments of WAFER ASSEMBLY CABLE CONNECTOR are disclosed as follows:

Embodiment 1 is a wafer assembly for electrically connecting a plurality of wires to a circuit board, comprising:

an electrically insulative wafer comprising:

a wire receiving face for receiving a plurality of wires and an opposite mounting face for mounting the wafer assembly onto a circuit board;

a plurality of terminals partially disposed within the wafer and forming a row of spaced apart substantially parallel terminals arranged along a length of the mounting face, each terminal comprising:

a contact portion disposed within the wafer for making contact with a wire;

a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board; and

a connecting portion connecting the contact portion to the press-fit portion; and

a plurality of wires received within the wafer from the wire receiving face of the wafer, each wire terminated at the contact portion of a corresponding terminal, the wafer having a width along the length of the mounting face, a thickness along a width of the mounting face, and a length as a separation between the wire receiving and mounting faces, the thickness being substantially less than the length and the width.

Embodiment 2 is a wafer assembly of embodiment 1, wherein the electrically insulative wafer comprises opposing first and second wafer halves assembled to each other.

Embodiment 3 is a wafer assembly of embodiment 2, wherein the first and second wafer halves are assembled to each other by a latch of the second wafer half engaging a hook of the first wafer half.

Embodiment 4 is a wafer assembly of embodiment 2, wherein the first and second wafer halves are assembled to each other by the first wafer half adhering to the second wafer half.

Embodiment 5 is a wafer assembly of embodiment 1, wherein each wire is terminated at the contact portion of the corresponding terminal at a termination region, and wherein the electrically insulative wafer comprises a window extending along the width of the wafer and exposing the termination region of each wire.

Embodiment 6 is a wafer assembly of embodiment 5 further comprising a cap covering and substantially matching the window.

Embodiment 7 is a wafer assembly of embodiment 6, wherein the cap snaps in place over the window.

Embodiment 8 is a wafer assembly of embodiment 6, wherein the cap is electrically conductive.

Embodiment 9 is a wafer assembly of embodiment 5, further comprising a window overmold substantially filling the window.

Embodiment 10 is a wafer assembly of embodiment 9, wherein the window overmold comprises an epoxy.

Embodiment 11 is a wafer assembly of embodiment 1, wherein the electrically insulative wafer comprises a plurality of spaced apart substantially parallel grooves, each groove receiving a corresponding wire in the plurality of wires.

Embodiment 12 is a wafer assembly of embodiment 1 comprising a plurality of electrically insulative wafers, each electrically insulative wafer comprising:

a wire receiving face for receiving a plurality of wires and an opposite mounting face for mounting the wafer assembly onto a circuit board;

a plurality of terminals partially disposed within the wafer and forming a row of spaced apart substantially parallel terminals arranged along a length of the mounting face, each terminal comprising:

a contact portion disposed within the wafer for making contact with a wire;

a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board; and

a connecting portion connecting the contact portion to the press-fit portion; and

a plurality of wires received within the wafer from the wire receiving face of the wafer, each wire terminated at the contact portion of a corresponding terminal, the wafer having a width along the length of the mounting face, a thickness along a width of the mounting face, and a length as a separation between the wire receiving and mounting faces, the thickness being substantially less than the length and the width.

Embodiment 13 is a vertical connector for vertically mounting on a circuit board, comprising a plurality of wafer assemblies of embodiment 1 horizontally stacked.

Embodiment 14 is a vertical connector of embodiment 13, wherein the mounting faces of the insulative wafers lie in a same plane.

Embodiment 15 is the vertical connector of embodiment 13 further comprising a frame comprising:

a body having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board;

a pair of spaced apart opposing top arms extending from opposite top ends of the body proximate the wire receiving faces of the insulative wafers; and

a pair of spaced apart opposing bottom arms extending from opposite bottom ends of the body proximate the mounting faces of the insulative wafers, the pairs of top and bottom arms keeping the plurality of wafer assemblies secure and in alignment.

Embodiment 16 is the vertical connector of embodiment 15, wherein each wafer comprises a plurality of recesses engaging at least some of the arms in the pairs of first and second arms.

Embodiment 17 is the vertical connector of embodiment 15, wherein the means for attaching the frame to the circuit board also facilitate the mounting of the vertical connector on the circuit board.

Embodiment 18 is the vertical connector of embodiment 15, wherein the means for attaching the frame to a circuit board comprises a screw inserted into a screw hole of the frame from a top side of the frame, such that when the vertical connector is mounted on a circuit board, the screw is further inserted into a screw hole of the circuit board from a top side of the circuit board and secures the frame to the circuit board.

Embodiment 19 is the vertical connector of embodiment 18, wherein the means for attaching the frame to a circuit board further comprises a nut, such that when the vertical connector is mounted on a circuit board, the screw engages the nut from a bottom side of the circuit board.

Embodiment 20 is the vertical connector of embodiment 18, wherein the screw hole of the circuit board is a threaded screw hole, such that when the vertical connector is mounted on a circuit board, the screw is screwed into the threaded screw hole.

Embodiment 21 is the vertical connector of embodiment 15, wherein the frame comprises:

a left pair of spaced apart opposing top arms extending along a left direction from opposite top ends of the body proximate the wire receiving faces of the insulative wafers;

a right pair of spaced apart opposing top arms extending along a right direction from the opposite top ends of the body proximate the wire receiving faces of the insulative wafers;

a left pair of spaced apart opposing bottom arms extending along the left direction from opposite bottom ends of the body proximate the mounting faces of the insulative wafers; and

a right pair of spaced apart opposing bottom arms extending along the right direction from the opposite bottom ends of the body proximate the mounting faces of the insulative wafers, the left pairs of top and bottom arms engaging at least one wafer in the plurality of wafer assemblies, and the right pairs of top and bottom arms engaging at least one other wafer in the plurality of wafer assemblies, the left and right pairs of top and bottom arms keeping the plurality wafer assemblies secure and in alignment.

Embodiment 22 is the vertical connector of embodiment 15 further comprising a frame comprising

a body having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board;

a plurality of left arms extending from the body along a left direction; and

a plurality of right arms extending from the body along a right direction, the plurality of left and right arms keeping the plurality of wafer assemblies secure and in alignment.

Embodiment 23 is a vertical connector for vertically mounting on a circuit board, comprising:

a plurality of wafer assemblies horizontally stacked, each wafer assembly comprising:

an electrically insulative wafer comprising:

a wire receiving face and an opposite mounting face for mounting the wafer assembly onto a circuit board;

a plurality of terminals forming a row of spaced apart substantially parallel terminals arranged along a length of the mounting face, each terminal comprising:

a contact portion disposed within the wafer for making contact with a wire;

a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board; and

a connecting portion connecting the contact portion to the press-fit portion; and

a plurality of wires received within the wafer from the wire receiving face of the wafer, each wire terminated at the contact portion of a corresponding terminal; and

a frame keeping the plurality of wafer assemblies secure and in alignment such that the mounting faces of the insulative wafers lie in a same plane, the frame having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board.

Embodiment 24 is the vertical connector of embodiment 23 further comprising an electrically conductive shield at least partially covering the plurality of wafer assemblies.

All references and publications cited herein are expressly incorporated herein by reference in their entirety into this disclosure, except to the extent they may directly contradict this disclosure. Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations can be substituted for the specific embodiments shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is intended that this disclosure be limited only by the claims and the equivalents thereof. The disclosed embodiments are presented for purposes of illustration and not limitation.

What is claimed is:

1. A wafer assembly for electrically connecting a plurality of wires to a circuit board, comprising:

an electrically insulative wafer comprising:

a wire receiving face for receiving a plurality of wires and an opposite mounting face for mounting the wafer assembly onto a circuit board;

a plurality of terminals partially disposed within the wafer and forming a row of spaced apart substantially parallel terminals arranged along a length of the mounting face, each terminal comprising:

a contact portion disposed within the wafer for making contact with a wire;

a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board; and

a connecting portion connecting the contact portion to the press-fit portion; and

a plurality of wires received within the wafer from the wire receiving face of the wafer, each wire terminated at the contact portion of a corresponding terminal, the wafer having a width along the length of the mounting face, a thickness along a width of the mounting face, and a length as a separation between the wire receiving and mounting faces, the thickness being substantially less than the length and the width.

2. The wafer assembly of claim 1, wherein each wire is terminated at the contact portion of the corresponding terminal at a termination region, and wherein the electrically insulative wafer comprises a window extending along the width of the wafer and exposing the termination region of each wire.

3. The wafer assembly of claim 2 further comprising a cap covering and substantially matching the window.

4. A vertical connector for vertically mounting on a circuit board, comprising a plurality of wafer assemblies of claim 1 horizontally stacked.

5. The vertical connector of claim 4 further comprising a frame comprising:

a body having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board;

a pair of spaced apart opposing top arms extending from opposite top ends of the body proximate the wire receiving faces of the insulative wafers; and

a pair of spaced apart opposing bottom arms extending from opposite bottom ends of the body proximate the mounting faces of the insulative wafers, the pairs of top and bottom arms keeping the plurality of wafer assemblies secure and in alignment.

6. The vertical connector of claim 5, wherein each wafer comprises a plurality of recesses engaging at least some of the arms in the pairs of first and second arms.

7. The vertical connector of claim 5, wherein the means for attaching the frame to a circuit board comprises a screw inserted into a screw hole of the frame from a top side of the frame, such that when the vertical connector is mounted on a circuit board, the screw is further inserted into a screw hole of the circuit board from a top side of the circuit board and secures the frame to the circuit board.

8. The vertical connector of claim 5, wherein the frame comprises:

a left pair of spaced apart opposing top arms extending along a left direction from opposite top ends of the body proximate the wire receiving faces of the insulative wafers;

a right pair of spaced apart opposing top arms extending along a right direction from the opposite top ends of the body proximate the wire receiving faces of the insulative wafers;

a left pair of spaced apart opposing bottom arms extending along the left direction from opposite bottom ends of the body proximate the mounting faces of the insulative wafers; and

a right pair of spaced apart opposing bottom arms extending along the right direction from the opposite bottom ends of the body proximate the mounting faces of the insulative wafers, the left pairs of top and bottom arms engaging at least one wafer in the plurality of wafer assemblies, and the right pairs of top and bottom arms engaging at least one other wafer in the plurality of wafer assemblies, the left and right pairs of top and bottom arms keeping the plurality wafer assemblies secure and in alignment.

9. The vertical connector of claim 5 further comprising a frame comprising

a body having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board;

a plurality of left arms extending from the body along a left direction; and

a plurality of right arms extending from the body along a right direction, the plurality of left and right arms keeping the plurality of wafer assemblies secure and in alignment.

10. A vertical connector for vertically mounting on a circuit board, comprising:

a plurality of wafer assemblies horizontally stacked, each wafer assembly comprising:

an electrically insulative wafer comprising:

a wire receiving face and an opposite mounting face for mounting the wafer assembly onto a circuit board;

a plurality of terminals forming a row of spaced apart substantially parallel terminals arranged along a length of the mounting face, each terminal comprising:

a contact portion disposed within the wafer for making contact with a wire;

a substantially straight press-fit portion extending beyond and perpendicular to the mounting face for being inserted into a conductive via of a circuit board; and

a connecting portion connecting the contact portion to the press-fit portion; and

a plurality of wires received within the wafer from the wire receiving face of the wafer, each wire terminated at the contact portion of a corresponding terminal; and

a frame keeping the plurality of wafer assemblies secure and in alignment such that the mounting faces of the insulative wafers lie in a same plane, the frame having means for attaching the frame to a circuit board when the vertical connector is mounted on the circuit board.

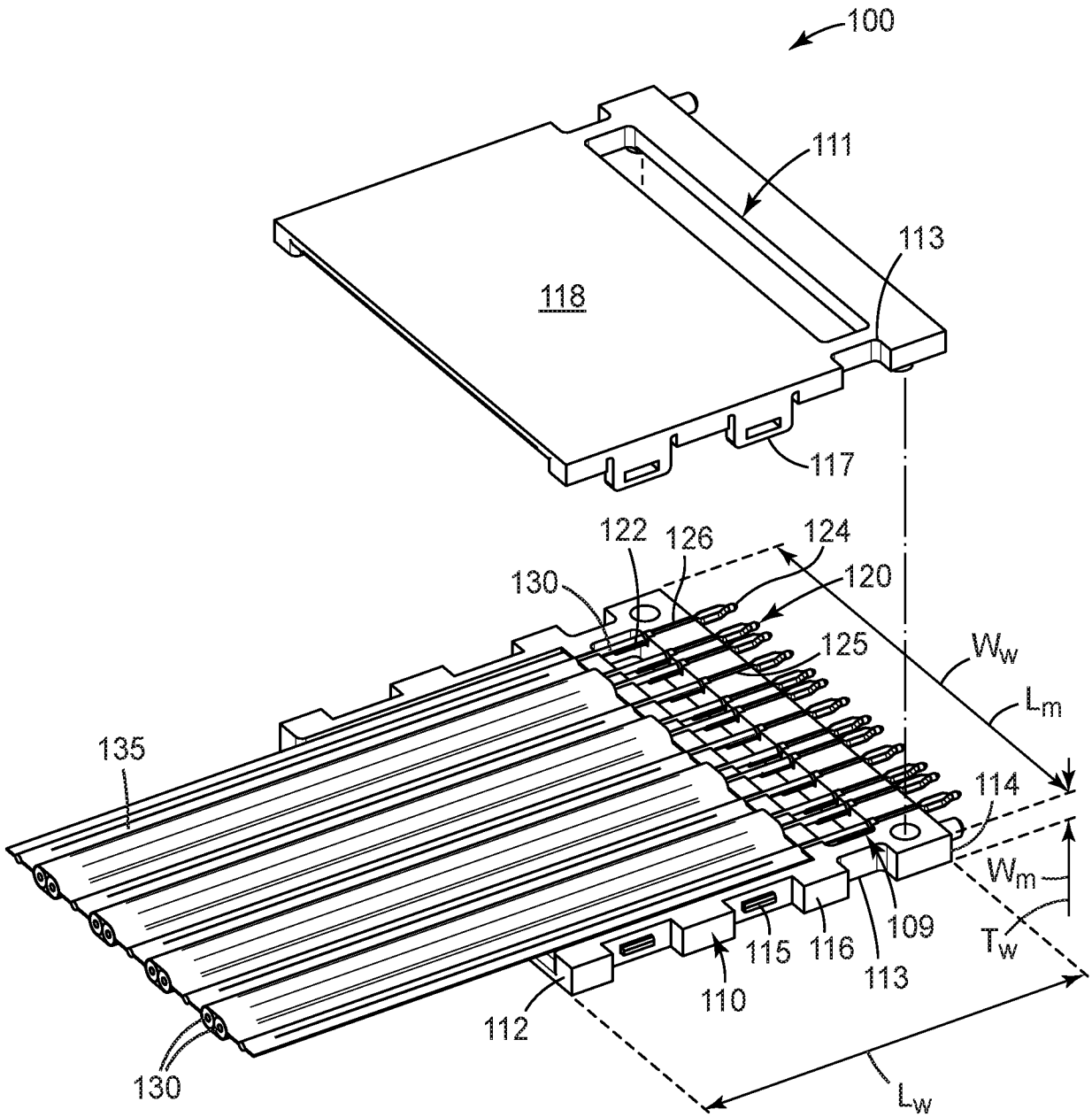

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126
124
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L_m
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T_w
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115
116
113
110
112
130
L_w

FIG. 1

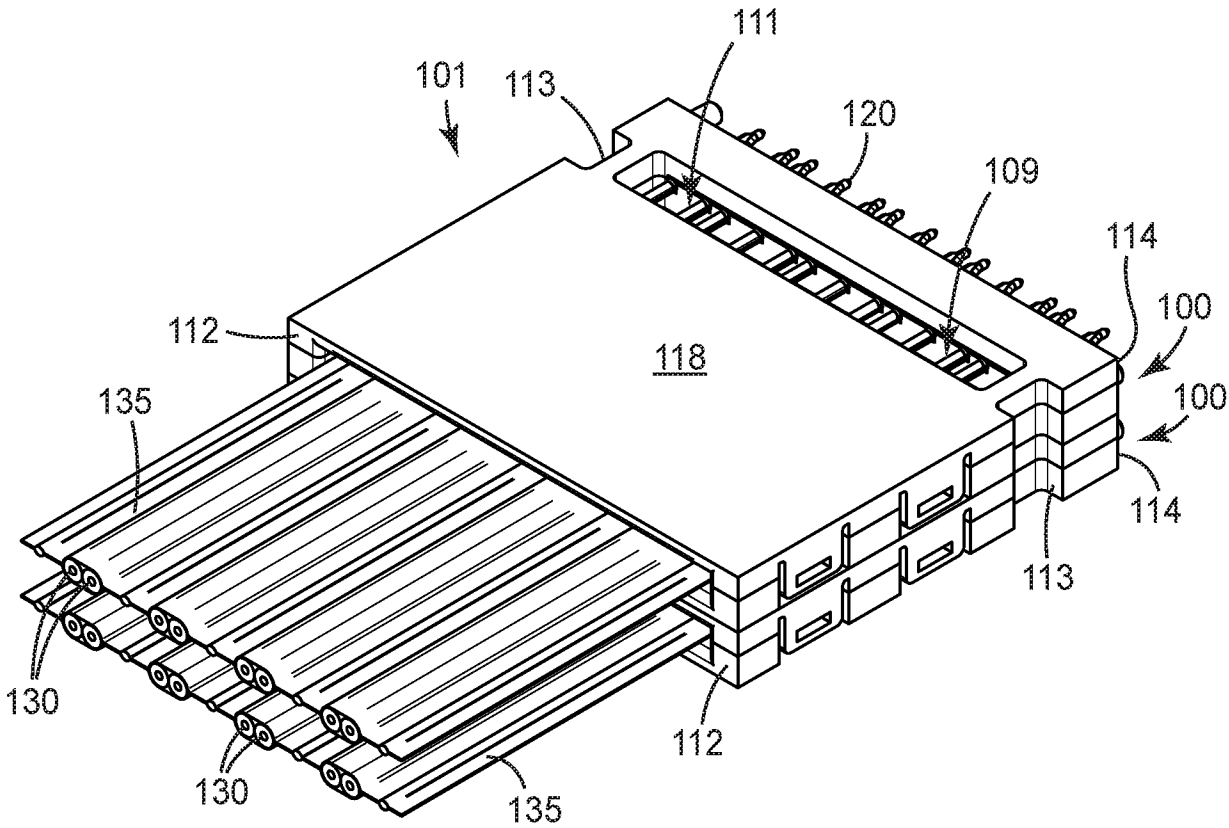

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FIG. 2

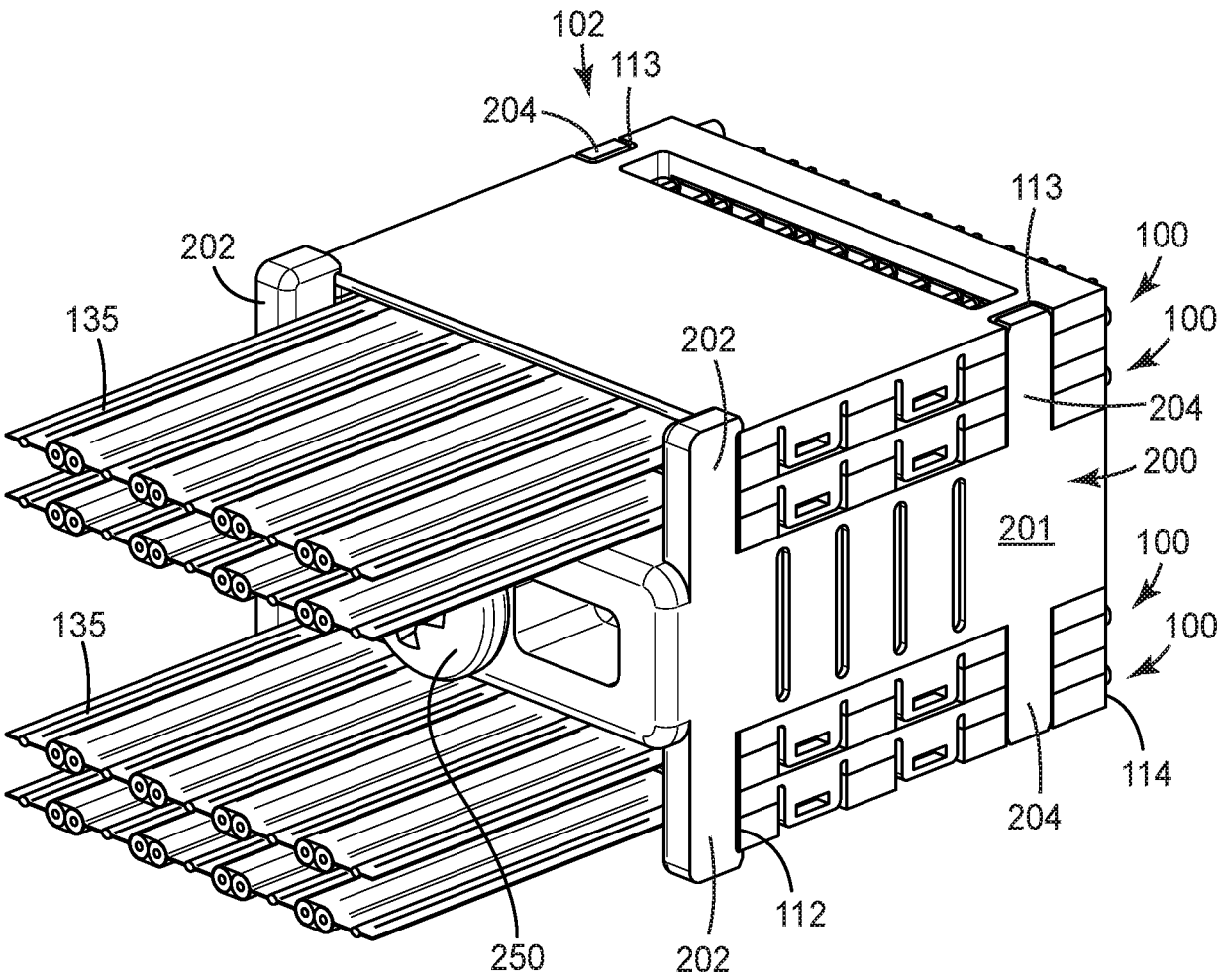

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FIG. 3

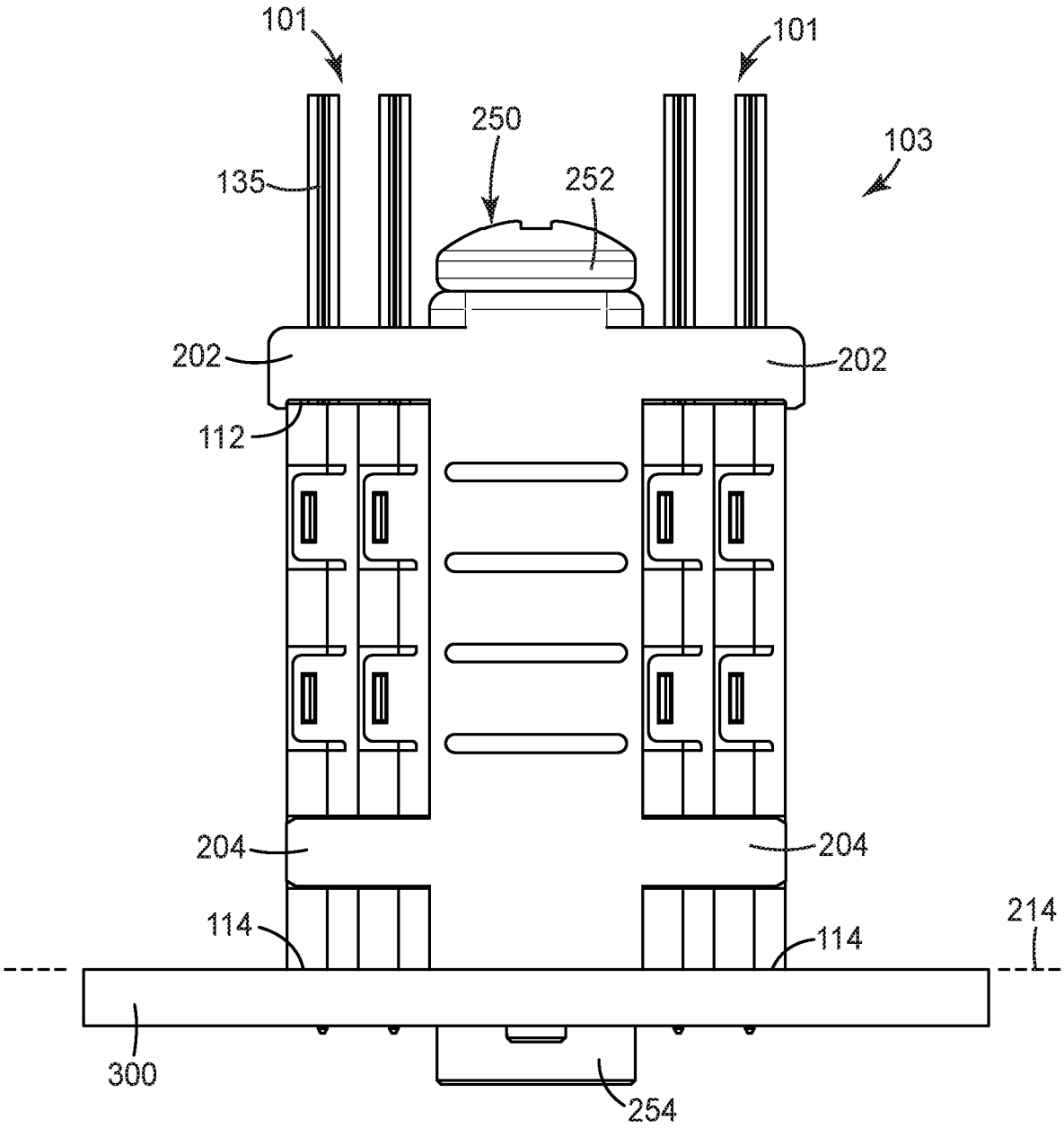


FIG. 4

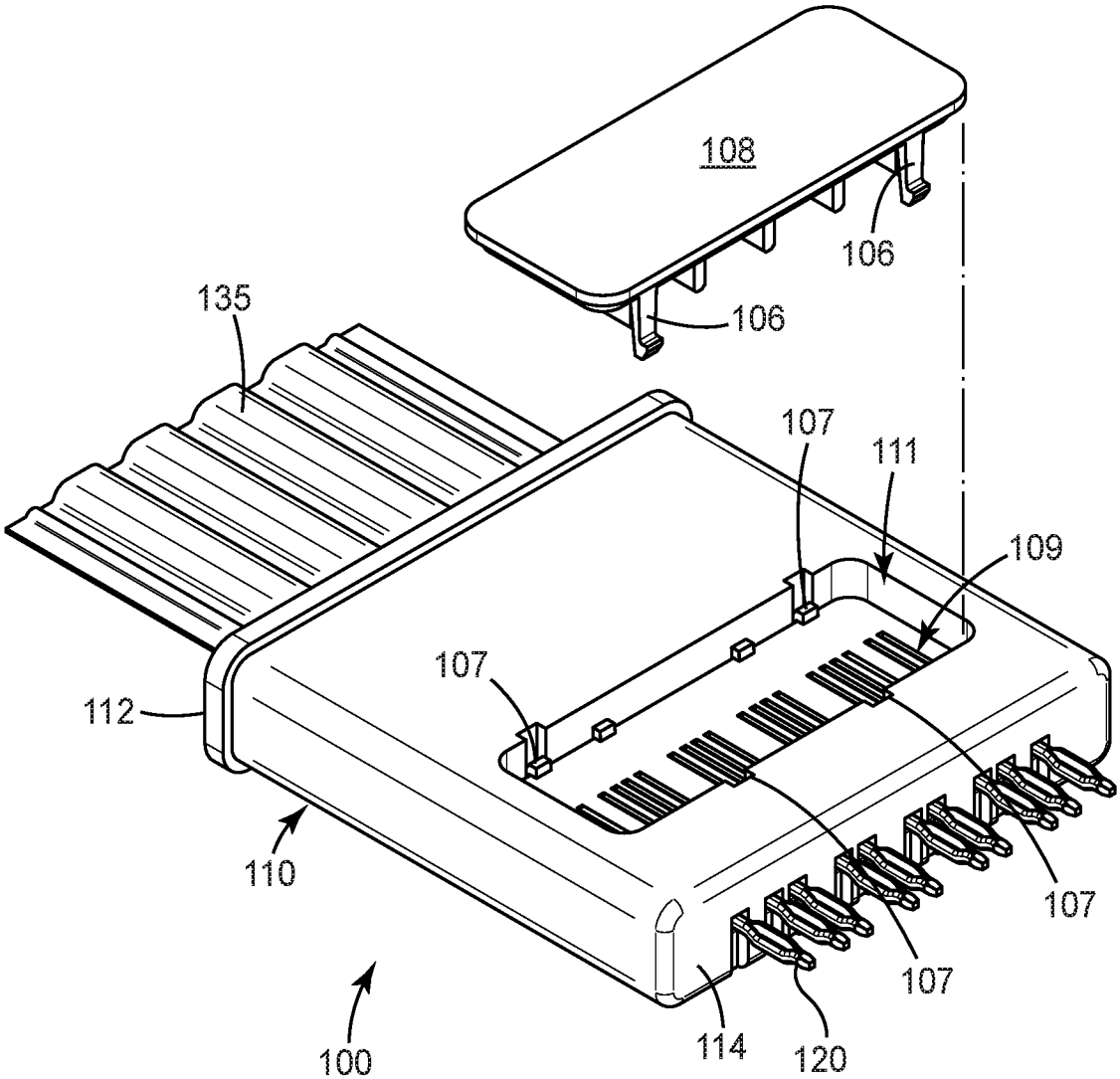


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/050032

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R12/58 H01R12/62
ADD. H01R12/59 H01R12/70 H01R13/518

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)
H01R

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.
X	EP 2 717 386 A1 (VALEO SCHALTER & SENSOREN GMBH [DE]) 9 April 2014 (2014-04-09) paragraph [0026] - paragraph [0035]; figures 1-3	1,2
X	US 2010/190373 A1 (YEH SHIH-KUN [TW]) 29 July 2010 (2010-07-29) paragraph [0020] - paragraph [0031]; claims 1-20; figures 1-7	1-3
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Y	page 5 - page 13; figures 1-9	7
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 December 2016	09/12/2016

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	Oliveira Braga K., A

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/050032

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 2011/159743 A1 (JOHNESCU DOUGLAS M [US] ET AL) 30 June 2011 (2011-06-30) the whole document	1,4-6, 8-10

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