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(54) Title: THERMAL INTERPOSER SUITABLE FOR ELECTRONIC MODULES

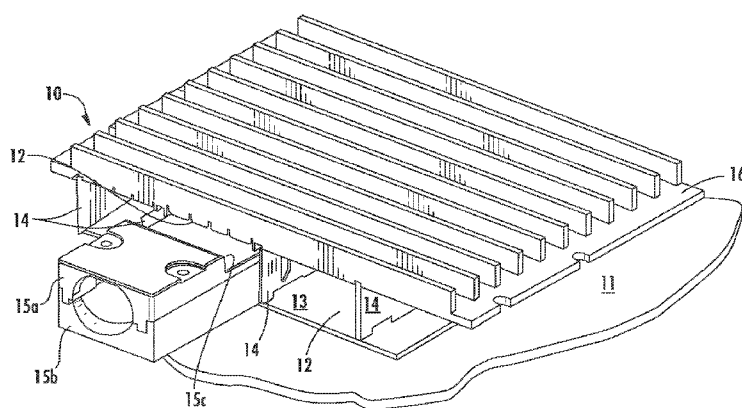


FIG. 1

(57) Abstract: A thermal interposer for use in providing a mating interface between a heat sink and an electronic module includes an elongated body portion having two opposing surfaces. On one surface, a plurality of press-fit pins are defined that extend upwardly and outwardly away from the interposer body portion. On the other, opposing surface, a plurality of contact arms are defined that extend, in cantilevered fashion, downwardly and away from the interposer body portion. The press-fit pins are configured to enter grooves formed in a heat sink in a manner to form intimate, metal to metal, contact while the contact arms are configured to contact the top surface of an electronic module with reliable normal force.

THERMAL INTERPOSER SUITABLE FOR ELECTRONIC MODULES**CROSS REFERENCE TO RELATED APPLICATION**

[0001] The Present Disclosure claims priority to United States Provisional Patent Application
5 No. 61/839,414, entitled "Thermal Interposer Suitable For Electronic Modules," and filed 26
June 2013 with the United States Patent And Trademark Office. The content of this
Application is incorporated in its entirety herein.

[0002] The Present Disclosure claims the benefit of U.S. Provisional Patent Application No.
61/839,412 (Molex Docket No. B2-022 US PRO), entitled "Ganged Shielding Cage With
10 Thermal Passages," filed on the same day as the priority claim listed above, the content of
which is hereby incorporated herein.

[0003] Finally, the Present Disclosure also claims the benefit of Co-Pending U.S. Patent
Cooperation Treaty Patent Application No. _____ (Molex Docket No. B2-022
WO), entitled "Ganged Shielding Cage With Thermal Passages," filed on the same day as the
15 Present Disclosure, the content of which is hereby incorporated herein.

BACKGROUND OF THE PRESENT DISCLOSURE

[0004] The Present Disclosure relates, generally, to thermal solutions to heat transfer of
electronic modules, and, more particularly, to a thermal interposer having improved contact
20 characteristics to improve heat transfer between an electronic module and a heat sink.

[0005] There are many different styles of heat sinks used in the field of electronics. In many
electronic devices, such as routers, servers and the like, different sets of circuits need to
connect to associated circuits of other electronic devices. This is commonly accomplished by
way of cable assemblies that typically include an electronic module terminated to each end of
25 the cable. The modules serve to connect the cable to a corresponding connector on a circuit
board within the device and with respect to routers and servers, these cable assemblies
operate at high data transfer speeds, the operation of which generates heat.

[0006] Heat sinks are utilized to transfer heat generated by the module to the exterior of
shielding cage in which the module is inserted. Most of these heat sinks are applied directly
30 to the surface of the module and thus require particular configuration for each module.
Others rely upon a thermal interface material, referred to as a "TIM," and these TIM
materials increase the thermal resistance of the overall assembly, as well as the cost. Other
heat sinks are rigidly attached by adherent materials, such as solder, which may add to the

overall thermal resistance and also may affect the structural and mechanical operation of the attachment. Solder also creates problems with certain materials used in heat sinks, such as aluminum as oxide barrier may form on the aluminum during soldering. Still further, due to the dissimilarity of solder with aluminum, galvanic corrosion may occur in the finished heat sink.

[0007] Some have developed a thermal interposer that utilizes a plurality of cantilevered contact arms arranged in a pattern on the interposer. The interposer is rigidly attached to the heat sink by soldering, which inhibits the contact arms from operating in an elastic manner. This rigid attachment results in a permanent set across the face of the interposer and induces plastic strain in the contact arms. This plastic strain does not promote good Hertzian contact, and diminishes the elasticity of the contact arms. When this occurs, the normal force between the contact arms and the opposing surface of the module is reduced.

[0008] The Present Disclosure is therefore directed to an improved thermal interposer that does not require a continuous rigid attachment and which is particularly suitable for use with electronic modules, the interposer having an attachment structure that retains a reliable normal force and good Hertzian contact between the interposer and the electronic module.

SUMMARY OF THE PRESENT DISCLOSURE

[0009] Accordingly, there is provided a thermal interposer suitable for electronic module applications, providing a reduced cost structure for attachment to a heat sink and further providing reliable, beneficial contact between the interposer and the electronic module. In accordance with an embodiment of the following Present Disclosure, a thermal interposer is provided for positioning between a heat sink and an electronic module and the interposer is provided with a structure that permits good, reliable contact with both the heat sink and the module, without the need to use any thermal interface material.

[0010] The interposers of the Present Disclosure are formed from a flat plate-like member that has a width matching or exceeding to some extent, the width of the electronic module. On one surface of the module, preselected, discrete portions of the plate-like member are bent upwardly. These bent portions define a series of pegs or the like that are configured to fit within selected grooves, or channels, that are formed in the bottom surface of a heat sink member. Such a fit is a press fit attachment accomplished with high mechanical pressure, creating in effect, a solid joint between the interposer pegs and the heat sink. Such a joint has low thermal resistance, much lower, and typically minimal, at best, than that obtained using a

thermal interface material. The press fit application also serves to remove oxides from the aluminum surfaces of the heat sink grooves which would otherwise increase the thermal resistance and thereby improves heat transfer between the heat sink and the module, by way of the interposer.

5 [0011] The press-fit pegs eliminate the need for a continuous rigid manner of attachment of the interposer to the heat sink. This is important because the interposer has a series of cantilevered contact arms stamped, or otherwise, formed therein and these contact arms have their free ends bent downwardly toward an opposing surface of the electronic module. These arms are intended to be elastic and they remain so due to the press-fit attachment. If the
10 interposer were to be rigidly attached to the heat sink, such as by way of solder, welding or the like, the solder would form an attachment to the contact arms, especially near the radius around which the contact arms flex. The presence of the continuous rigid attachment would cause the contact arms to become plastic, rather than elastic, and this condition would inhibit the application of reliable normal forces by the contact arms onto the module surface.

15 [0012] The press-fit pegs are arranged in a pattern that separates them into two distinct groups. A first group of such pegs are arranged around a portion of the perimeter of the interposer body portion and in one embodiment described herein, along two opposing, longitudinal edges of the interposer. The second group of press-fit pegs are disposed interior of the perimeter and are arranged between adjacent rows of contact arms. The base portion
20 of the press-fit pegs are arranged longitudinally as are the contact arms but the press-fit pegs have their base portion oriented perpendicular to the base portions of the contact arms. In this manner, as described in one embodiment of the Present Disclosure, a series of L-shaped heat transfer paths are defined between pairs of associated press-fit pegs and contact arms.

[0013] These and other objects, features and advantages of the Present Disclosure will be
25 clearly understood through a consideration of the following detailed description.

BRIEF DESCRIPTION OF THE FIGURES

[0014] The organization and manner of the structure and operation of the Present Disclosure, together with further objects and advantages thereof, may best be understood by reference to
30 the following Detailed Description, taken in connection with the accompanying Figures, wherein like reference numerals identify like elements, and in which:

[0015] Figure 1 is a perspective view of a single electronic module, in place within one bay of a ganged shielding cage, utilizing an interposer constructed in accordance the Present Disclosure;

[0016] Figure 2A is a perspective view, taken from the bottom of the shielding cage-module assembly of Fig. 1, with the bottom and some of the side walls of the shielding cage removed for clarity, along with the bottom half of the electronic module;

[0017] Figure 2B is the same view as Fig. 2A, but with the electronic module removed for clarity and illustrating the thermal interposer in place on the bottom surface of the heat sink;

[0018] Figure 3A is the same view as Fig. 2B, but with the cage side wall removed and enlarged to illustrate the array of contact arms formed on the thermal interposer;

[0019] Figure 3B is a front elevational view of the thermal interposer in place upon the heat sink and illustrating the manner of connection therebetween;

[0020] Figure 4A is a perspective view of the thermal interposer taken from the bottom surface thereof;

[0021] Figure 4B is a perspective view of the thermal interposer of Fig. 4A, but in an inverted fashion, illustrating the top surface thereof with the heat sink engaging pegs;

[0022] Figure 4C is a top plan view of the thermal interposer of Fig. 4A;

[0023] Figure 4D is a side elevational view of the thermal interposer of Fig. 4A, along Line D-D;

[0024] Figure 4E is an end elevational view of the thermal interposer of FIG. 4A, along Line E-E;

[0025] Figure 4F is an enlarged perspective view of a single contact arm used in a known interposer attached to the heat sink rigidly by way of solder in the shaded area; and

[0026] Figure 4G is an enlarged view of a contact arm used in the interposers of the Present Disclosure attached to the heat sink by way of the attachment members.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] While the Present Disclosure may be susceptible to embodiment in different forms, there is shown in the Figures, and will be described herein in detail, specific embodiments, with the understanding that the Present Disclosure is to be considered an exemplification of the principles of the Present Disclosure, and is not intended to limit the Present Disclosure to that as illustrated.

[0028] As such, references to a feature or aspect are intended to describe a feature or aspect of an example of the Present Disclosure, not to imply that every embodiment thereof must have the described feature or aspect. Furthermore, it should be noted that the description illustrates a number of features. While certain features have been combined together to illustrate potential system designs, those features may also be used in other combinations not expressly disclosed. Thus, the depicted combinations are not intended to be limiting, unless otherwise noted.

[0029] In the embodiments illustrated in the Figures, representations of directions such as up, down, left, right, front and rear, used for explaining the structure and movement of the various elements of the Present Disclosure, are not absolute, but relative. These representations are appropriate when the elements are in the position shown in the Figures. If the description of the position of the elements changes, however, these representations are to be changed accordingly.

[0030] Fig. 1 illustrates a partial shielding cage 10 typically mounted to a circuit board 11.

The shielding cage 10 is of the ganged type, meaning it has a plurality of bays 12 defined therein between side walls 14 of the cage. Each bay 12 is configured to receive an electronic module 15 therein that provides a connection between a cable containing a plurality of wires (not shown) and a connector mounted to the circuit board 11 and disposed within the bay 12 of the cage 10. The electronic module 15 may be designed for high speed data transmission and as such, generates heat during its operation. This heat must be dissipated and therefore a heat sink 16 is provided that either lies on top of the cage 10, or forms a top wall, or ceiling 17, thereof.

[0031] As illustrated in Fig. 2B, an interposer, or leadframe, 20 is provided for the bay 12 in which the module 15 resides. The module 15 is shown removed in Fig. 2B, as is the cage bottom, for clarity. The interposer 20 can be seen to have an elongated body portion 21, illustrated as a rectangle in the Figures. The interposer has a plurality of side edges 22a-d that cooperatively define the body portion 21. The interposer further has two opposing surfaces, shown as top and bottom surfaces 23, 24, respectively and these surfaces make contact with the heat sink 16 and the electronic module 15 as explained in further detail below.

[0032] In order for the interposer 20 to function as a thermal interposer – that is, one that transfers heat from the module 15 to the heat sink 16 – the interposer 20 is firstly provided with a plurality of contact members, illustrated as cantilevered contact arms 25 that may be

stamped and formed in the interposer body portion. These contact arms 25 are defined by U-shaped openings 26 formed in the interposer body portion; three parts of the openings 26 provide the cantilevered configuration to the contact arms 25. The contact arms 25 have elongated base portion 27 aligned lengthwise within the interposer body portion 21, and which terminate in free ends 28, which may be coined, or otherwise treated, to form contact surfaces 29 at the free ends. In use, these contact surfaces 29 make contact with the top surface 15c of the electronic module 15.

[0033] A plurality of attachment members 30 are disposed on the other (top) surface of the interposer. These attachment members 30 are illustrated as press-fit pegs 32 having base portions 33 where they are bent up from the interposer body portion. These base portions 33 terminate in pointed ends 34 having a generally triangular configuration, although other configurations may be suitable. The interior attachment members 30 have U-shaped openings that define their shape and permit them to be bent out of the plane of the interposer body portion into the desired upright shape. These attachment members 30 are configured to be received within grooves 40 formed in the bottom surface 16b of the heat sink 16. The pointed ends 34 of the attachment members 30 permits the attachment members to be reliably inserted into the heat sink grooves 40 in such a manner that good and intimate metal-to-metal contact is made, with good heat transfer capabilities and low thermal resistance properties, about equal to that obtained from a solid attachment. Thus, it is preferred that the attachment members 30 are slightly thicker than the width of the heat sink grooves 40.

[0034] As shown in the Figures, the grooves 40 run lengthwise within the heat sink 16 and the spacing between the grooves 40 defines an intended spacing between the attachment members 30. It can be seen that the contact arms are arranged on the interposer body portion in a manner that defines a plurality of rows, running both lengthwise and crosswise (transversely) within the perimeter of the interposer 20. The attachment members 30 are arranged in what may be considered as two distinct groups of attachment members 30. The first group of attachment members 30 are those that are disposed substantially around the perimeter of the interposer, shown as positioned on side edges 22a, 22b, 22c in Fig. 4C and will be referred to herein as an “exterior” group of attachment members 30.

[0035] The second group of attachment members 30 are those remaining members disposed inwardly from the side edges of the interposer and will be referred to herein as an “interior” group of attachment members 30. The interior attachment members 30 are disposed in rows that are positioned between rows of contact arms in Fig. 4C. As such, the interior attachment

members serve to divide the contact arms 25 into groups. In Fig. 4C, two imaginary lines LA and CA are drawn in respective longitudinal and crosswise directions, interconnecting interior attachment members for the CA line and both interior and exterior attachment members for the LA line. The CA lines define crosswise rows of contact arms, while the LA lines define lengthwise rows of contact arms 25. Cooperatively, the lines define imaginary boxes CAB that surround groups of contact arms 25. These groups can either be arranged in the lengthwise or crosswise direction. Likewise, the imaginary lines separate adjacent contact arms 25 from each other. Still further it is preferred that the interior attachment members 30 are disposed close to where the contact arm body portions meet the interposer body portion. As illustrated, the location of the attachment members 30 with respect to the contact arms defines a series of individual thermal transfer paths "TP" between associated pairs of contact arms and attachment members 30. As shown, the thermal transfer paths are L-shaped.

[0036] The structure of this interposer and the grooves of the heat sink provide for a semi-rigid attachment of the interposer that differs from other rigid attachment structures, such as solders. With interposers 20 of the Present Disclosure, heat generated within the module 15 is transferred to the interposer 20 by way of conduction between the contact arms 25 and the interposer body portion 21. The heat then travels from the interposer body portion 21 to the attachment members via the thermal transfer paths TP, and into the body of the heat sink by way of contact with the walls of the heat sink grooves 40. Most heat sinks 16 are made out of aluminum, which is prone to oxidation, and the use of dissimilar metals promotes galvanic corrosion. The oxidation that occurs on aluminum surfaces makes soldering difficult and moreover, increases the thermal resistance of the overall structure, as does any thermal interface material such as adhesive, tape, gap filling pads, etc. Still further, as shown in Fig. 4F, a solder attachment method creates problems with the contact arms of such an interposer in that the body portion of the interposer and part of the base of the contact arm are attached to the heat sink as shown in the shaded area of Fig. 4F. Because of this area of attachment, plastic strains will occur along the entire width of the contact arm where it is joined to the body of the interposer, at arrow Z. Deflection of the interposer contact arms in this structure when the module is inserted into the shielding cage bay will cause plastic strain and the contact arm no longer becomes entirely elastic. This will detrimentally affect the normal forces required between the contact arms and the electronic module top surfaces.

[0037] Utilizing interposers of the Present Disclosure eliminates these problems. The plastic strains which occur in the interposer contact arms occur in the body portion 21 of the interposer 20 as shown by Arrow Z in Fig. 4G, thereby reducing, if not altogether eliminating, permanent set in the contact arms. This will maintain the normal force applied
5 by the contact arms in the range desired by the designer to achieve good Hertzian contact. The attachment between the interposer and the heat sink is metal-to-metal and thus there is an overall reduced thermal resistance.

[0038] While a preferred embodiment of the Present Disclosure is shown and described, it is envisioned that those skilled in the art may devise various modifications without departing
10 from the spirit and scope of the foregoing Description and the appended Claims.

CLAIMS

WHAT IS CLAIMED IS:

5 1. A thermal interposer for providing a thermal interface between a surface of an electronic module and a heat sink, the thermal interposer comprising:

 a body portion, the body portion having opposing first and second sides, the first and second sides configured to respectively contact the electronic module surface and the heat sink, the body portion including a plurality of cantilevered contact arms formed
10 therein, each contact arm including a base portion attached to the body portion and a free end opposite the base portion, the contact arm being bent outwardly away from the first side at an angle thereto, the free end terminating in a contact face for contacting the electronic module surface when installed; and

 the body portion further including a plurality of attachment members disposed
15 along the second side thereof, each attachment member extending upward and away from the second side, each attachment member having a base portion and an attachment point opposite the base portion, each attachment member being received within corresponding opposing grooves of the heat sink in a manner wherein the attachment members intimately contact the grooves.

20 2. The thermal interposer of Claim 1, wherein the attachment members include pegs with pointed ends.

 3. The thermal interposer of Claim 1, wherein the contact arms are arranged in
25 rows upon the body portion, and the attachment members are arranged around a perimeter of the body portion.

 4. The thermal interposer of Claim 3, wherein the attachment members are further disposed on the body portion to surround each row of contact arms.

30 5. The thermal interposer of Claim 3, wherein the attachment members are arranged in rows disposed between adjacent rows of contact arms.

6. The thermal interposer of Claim 5, wherein pairs of attachment members in different rows are aligned with each other such that an imaginary line drawn through one of the pairs separates adjacent contact arms from each other.

5 7. The thermal interposer of Claim 1, wherein the attachment members are arranged in a pattern on the body portion to divide the contact arms into distinct rows of contact arms.

10 8. The thermal interposer of Claim 1, wherein some of the attachment members are disposed on the body portion proximate the contact arms base portions such that each contact arm base portion has at least one attachment member associated therewith to define a thermal transfer path between the attachment member and the contact arm.

15 9. The thermal interposer of Claim 1, wherein the attachment members have a thickness equal to or greater than a width of the heat sink grooves.

10 10. The thermal interposer of Claim 1, wherein the contact arms and the attachment members are aligned lengthwise with respect to the body portion.

20 11. The thermal interposer of Claim 1, wherein the attachment members are arranged in distinct first and second groups, the attachment members of the first group being disposed along a portion of the perimeter of the interposer, and the attachment members of the second group being disposed interior of the interposer perimeter and aligned lengthwise with respect to the body portion.

25 12. The thermal interposer of Claim 11, wherein some of the contact arm base portions and the attachment member base portions are disposed perpendicular to each other.

30 13. The thermal interposer of Claim 11, wherein the body portion further includes a plurality of U-shaped openings, each opening being associated with and disposed proximate a respective one of the second group attachment members.

14. An interposer for providing a thermal interface between a surface of an electronic module and a heat sink, the interposer comprising:

a body portion, the body portion including a plurality of sides cooperatively defining a perimeter thereof, first and second surfaces extending between opposing sides for respectively contacting an electronic module surface and a heat sink when the interposer is disposed between the electronic module and heat sink, and a plurality of cantilevered contact arms disposed thereon, each contact arm including a base portion attached to the body portion and a free end disposed opposite the base portion, each contact arm being bent away at an angle from the body portion first surface, each contact arm free end terminating in a contact face for contacting the electronic module surface; and

a plurality of attachment members formed as part of the body portion and disposed on the body portion second surface, each attachment member extending away from the body portion second surface in a direction opposite that of the contact arms, and having a base portion at one end joining with the body portion and an attachment point at an opposite end of the attachment member, some of the attachment members being disposed around the perimeter of the interposer body portion and others of the attachment members being disposed on the interposer body portion interior of the interposer body portion perimeter;

wherein the contact arm base portions and the attachment member base portions are arranged perpendicular to each other to define a plurality of heat transfer paths between the attachment members and the contact arms.

15. The interposer of Claim 14, wherein some of the heat transfer paths are L-shaped.

16. The interposer of Claim 14, wherein the attachment members are configured to be received within corresponding opposing grooves of the heat sink in a manner wherein the attachment members intimately contact the heat sink grooves.

17. The interposer of Claim 14, wherein the attachment members are arranged in distinct first and second groups, the attachment members of the first group being disposed along a portion of the perimeter of the interposer, and the attachment members of the second group being disposed interior of the interposer perimeter and aligned lengthwise with respect to the body portion.

18. The interposer as set forth in Claim 14, wherein the attachment members are arranged in a pattern on the body portion to divide the contact arms into distinct rows of contact arms.

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19. The interposer as set forth in Claim 14, wherein pairs of attachment members in different rows are aligned with each other such that an imaginary line drawn through one of the pairs separates adjacent contact arms from each other.

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20. The interposer as set forth in Claim 14, further including a heat sink, the heat sink including a plurality of grooves formed therein, the interposer attachment members being aligned with and received within the grooves.

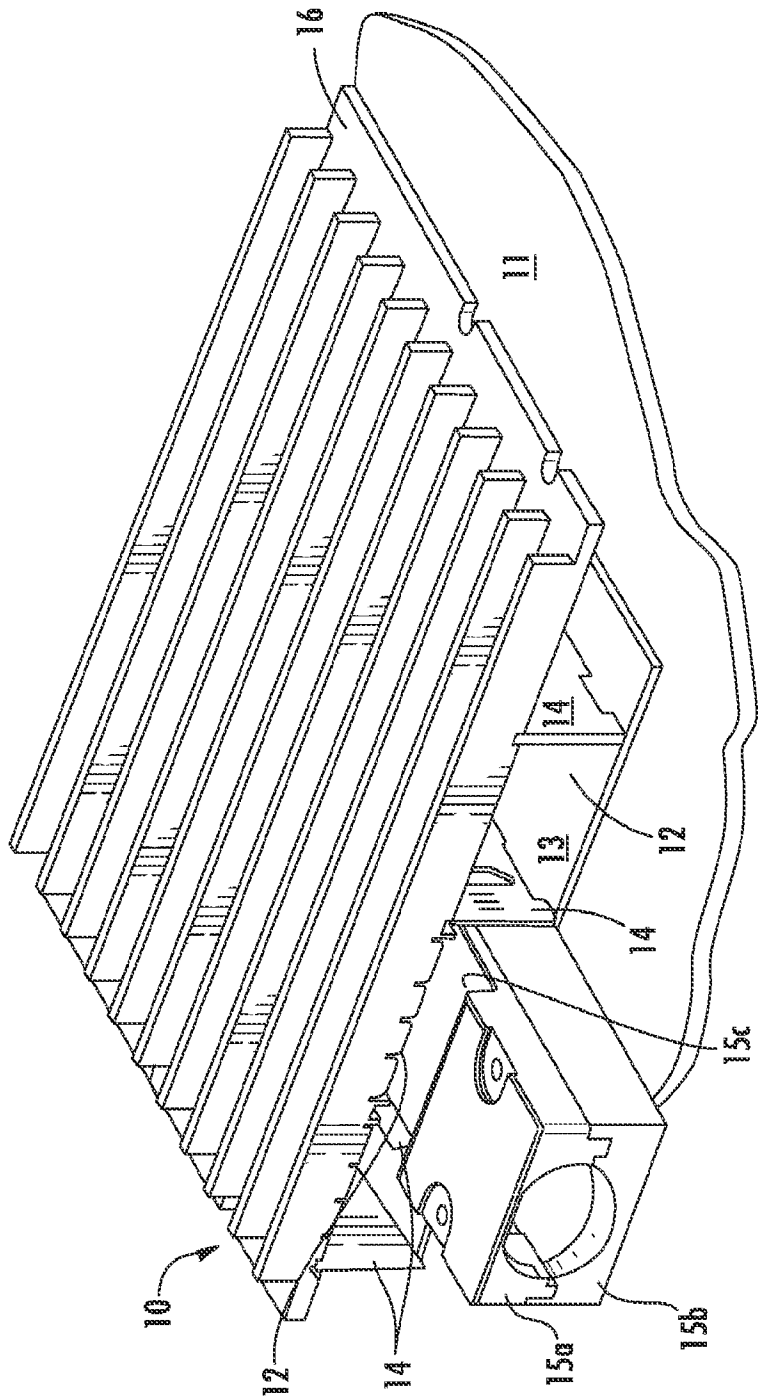


FIG. 1

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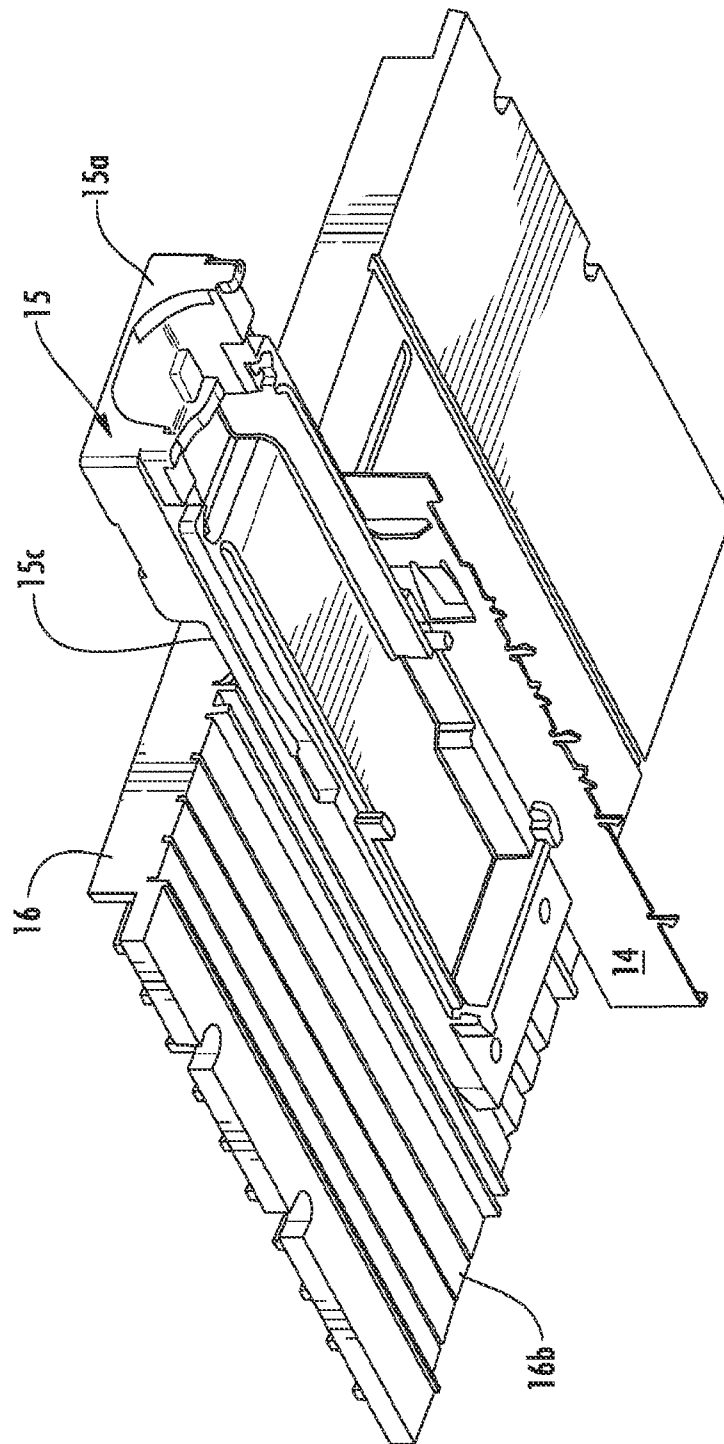


FIG. 2A

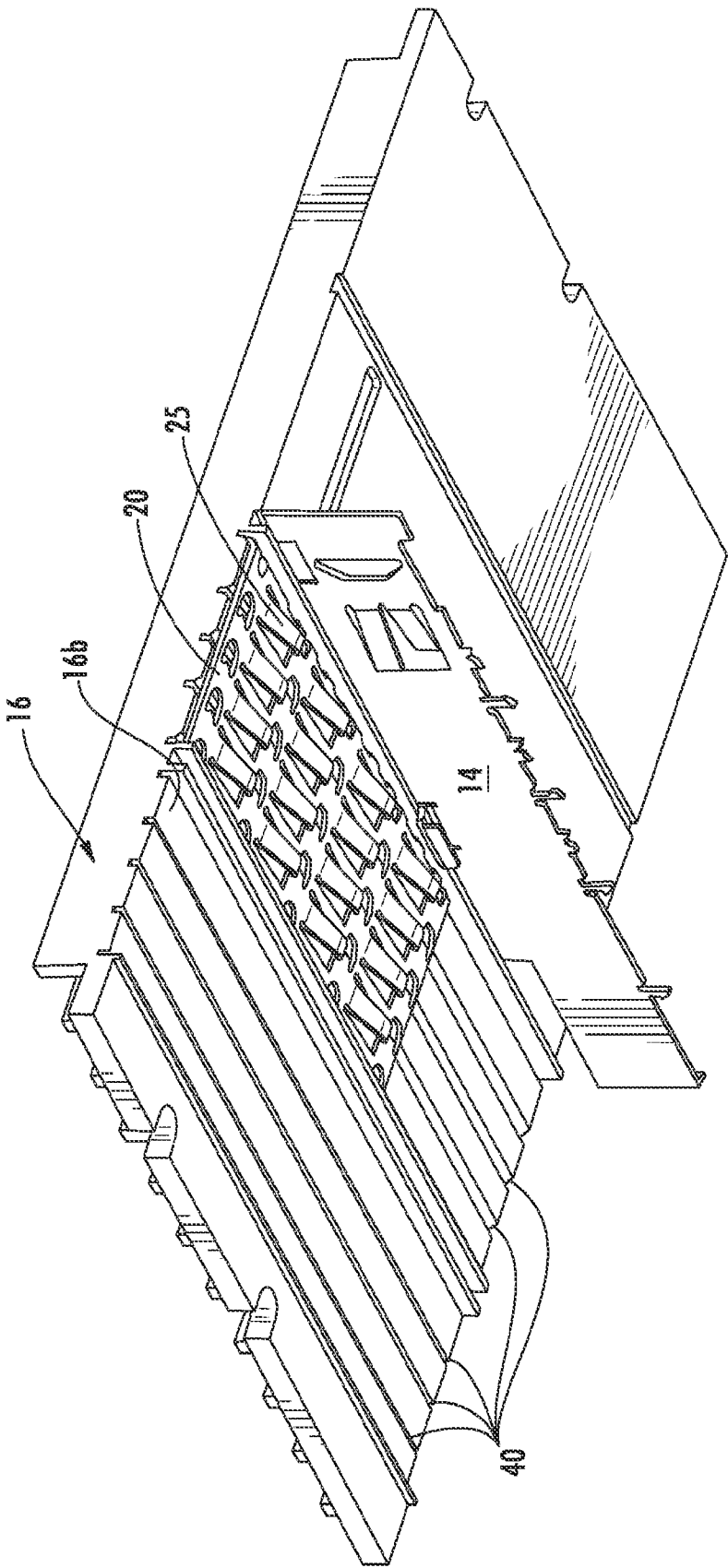
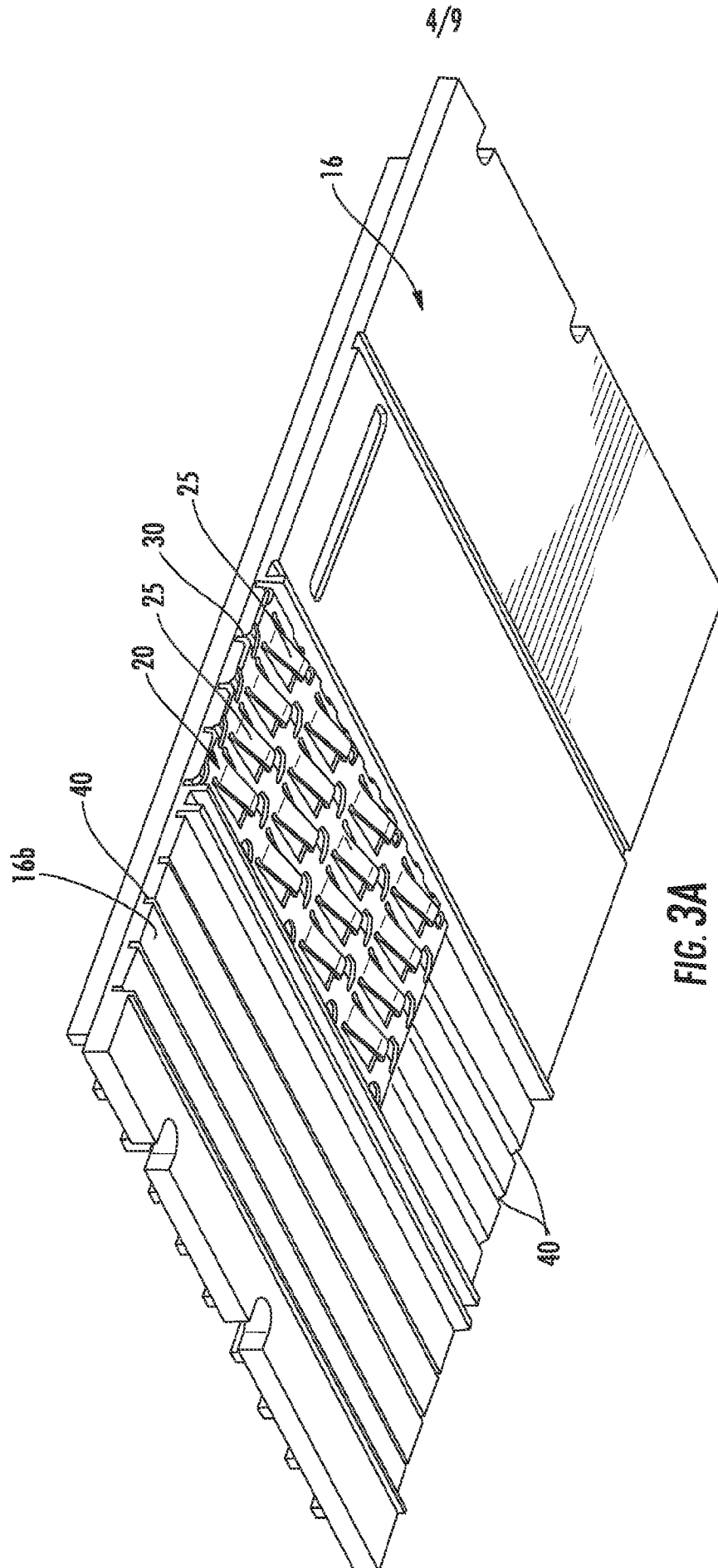


FIG. 2B



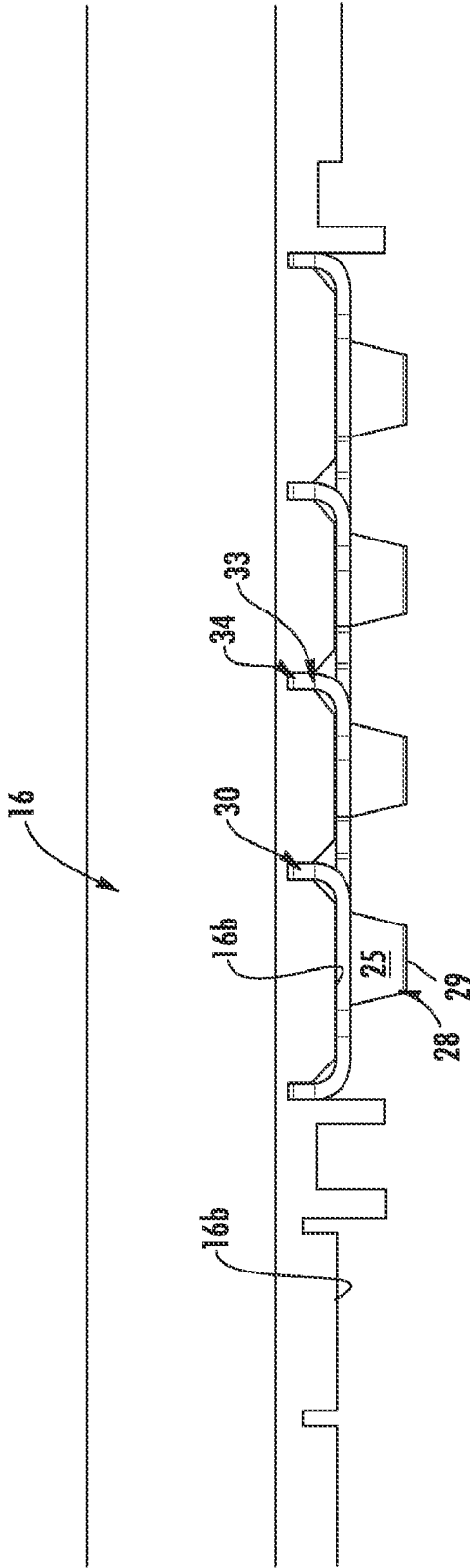


FIG. 3B

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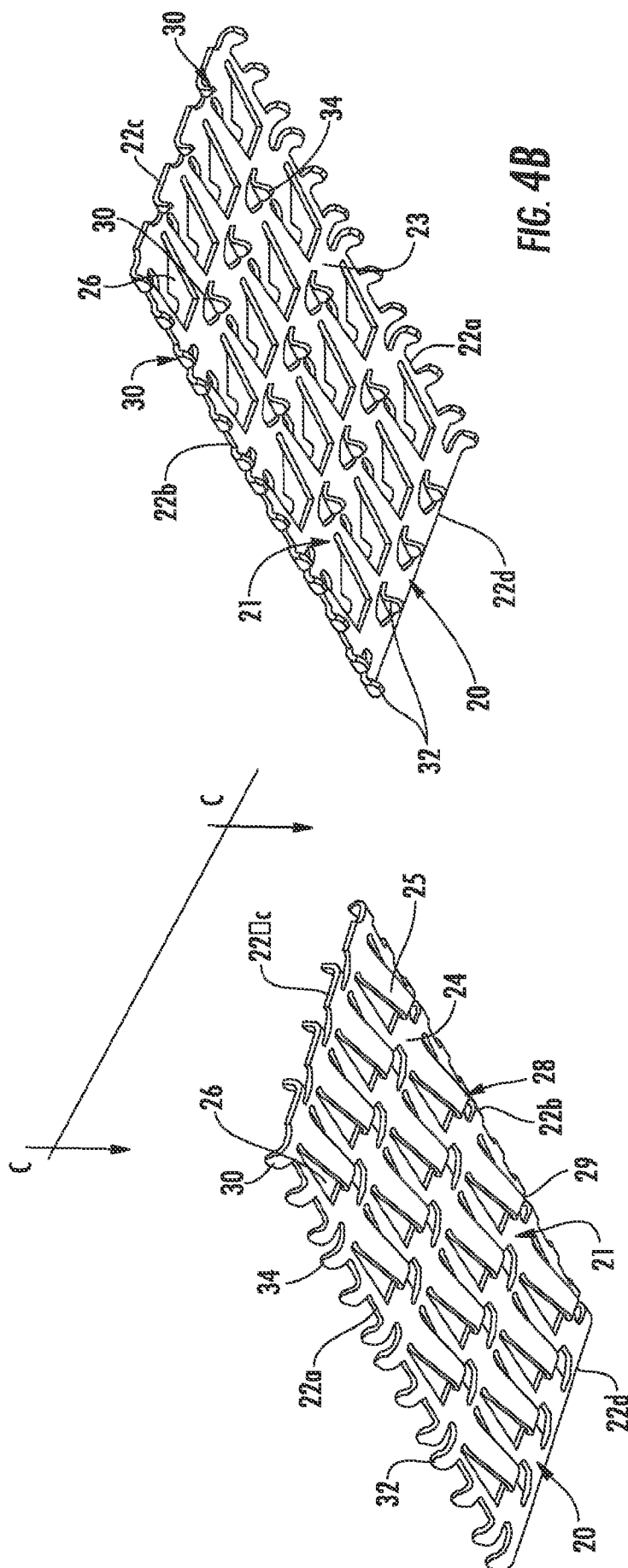


FIG. 4B

FIG. 4A

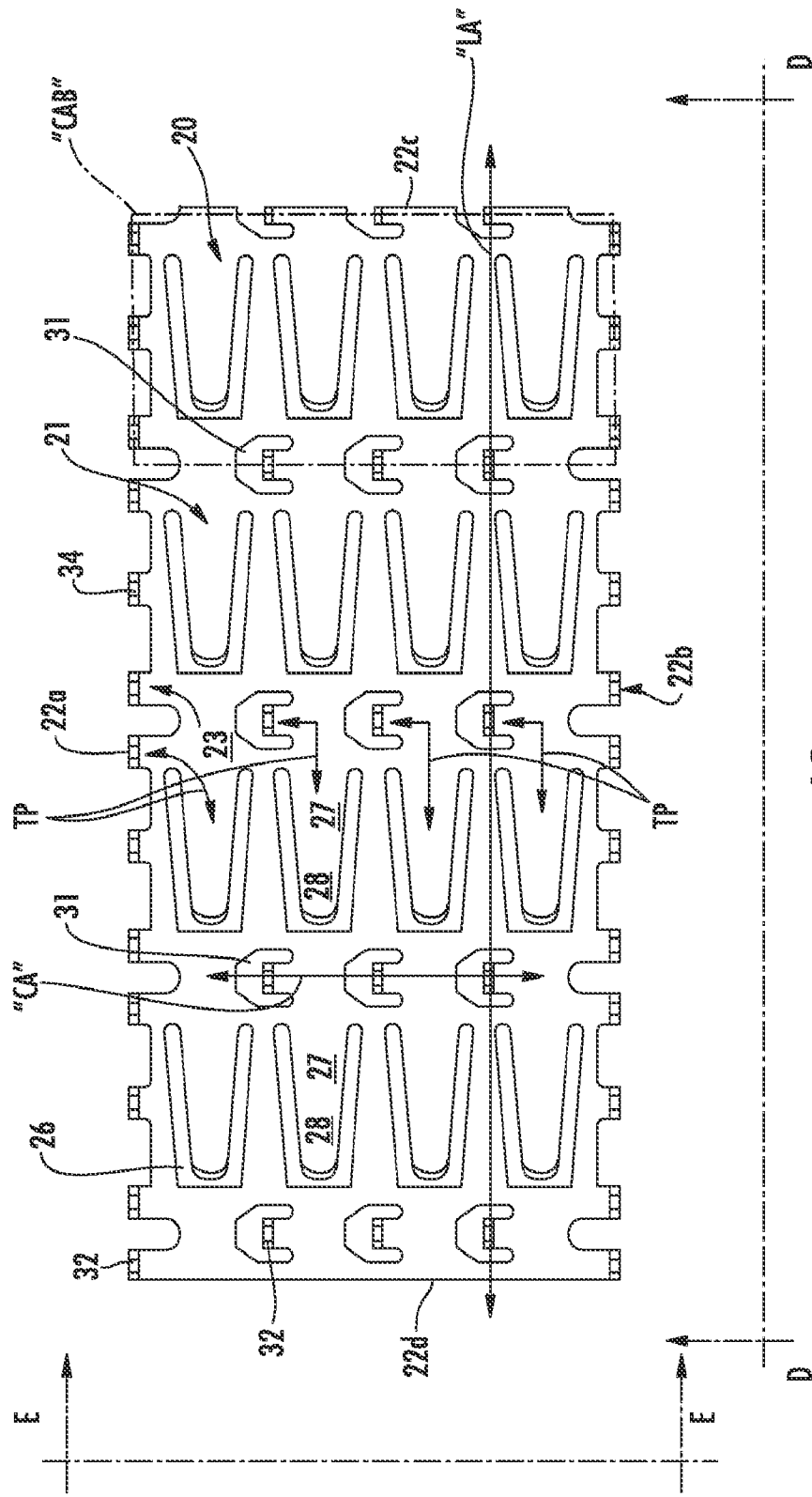


FIG. 4C

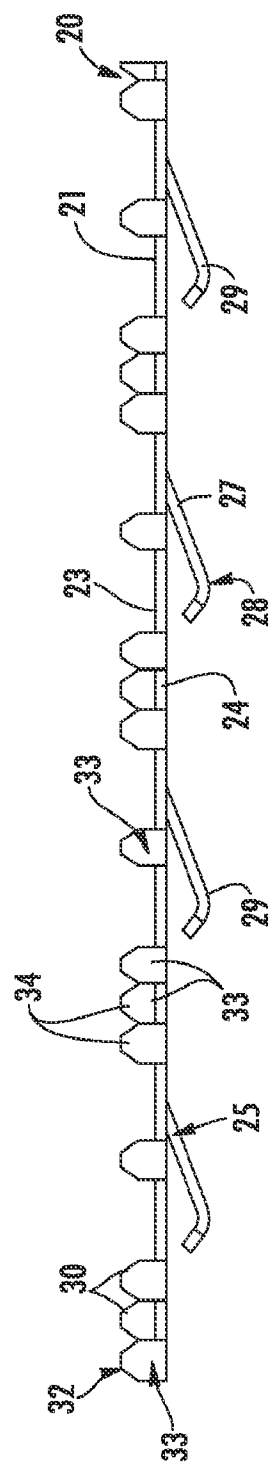


FIG. 4D

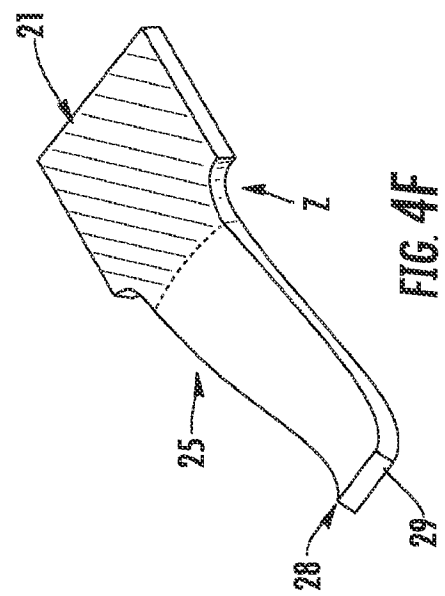


FIG. 4F
PRIOR ART

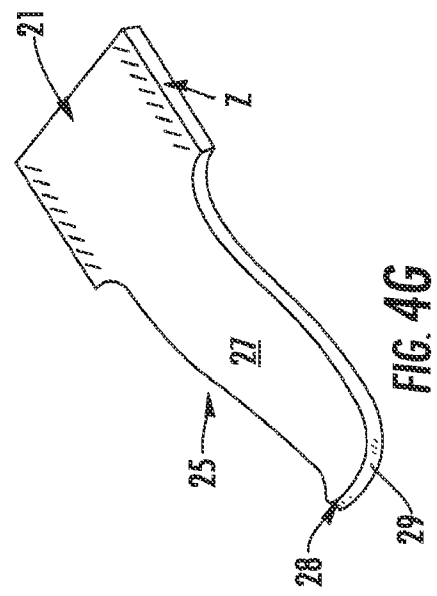


FIG. 4G

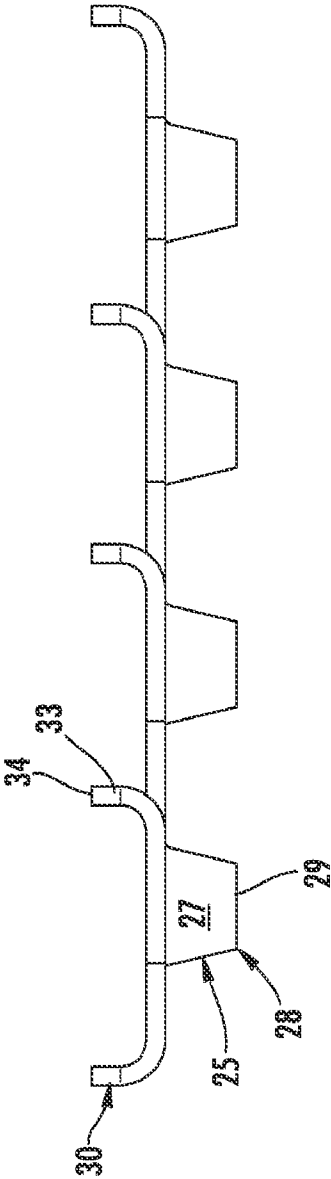


FIG. 4E

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/044013**A. CLASSIFICATION OF SUBJECT MATTER****H05K 7/20(2006.01)i, H01R 24/38(2011.01)i**

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)

H05K 7/20; H01R 1222; H01L 23/34; H01K 3/10; H01L 23/02; H01R 24/38

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: thermal interposer, heat sink, electronic module, cantilevered contact arm, attachment member as press-fit pegs**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007-0267740 A1 (REZAUR RAHMAN KHAN et al.) 22 November 2007 See paragraphs [0048]–[0052], claims 1–22 and figures 3B–3H.	1–20
A	US 2007-0230130 A1 (DAVID J. ALCOE et al.) 04 October 2007 See paragraphs [0037]–[0039] and figure 1.	1–20
A	US 6488513 B1 (DOUGLAS A. NEIDICH et al.) 03 December 2002 See column 3, line 57 – column 6, line 7 and figures 1–4.	1–20
A	US 7856711 B2 (MINHUA LU et al.) 28 December 2010 See column 2, lines 28–58, claims 1–20 and figure 1.	1–20
A	US 2005-0036292 A1 (SURESH K. CHENGALVA et al.) 17 February 2005 See paragraphs [0024]–[0025] and figures 2–3.	1–20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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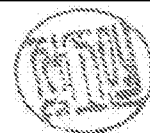
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