US006877993B2

(12) United States Patent
Palaniappa et al.

(10) **Patent No.: US 6,877,993 B2**
(45) **Date of Patent: Apr. 12, 2005**

(54) **PACKAGED DEVICE ADAPTER ASSEMBLY WITH ALIGNMENT STRUCTURE AND METHODS REGARDING SAME**

(75) Inventors: **Ilavarasan Palaniappa**, Apple Valley, MN (US); **Mickiel Fedde**, Eagan, MN (US); **Jason Allen Cramer**, St. Paul, MN (US)

(73) Assignee: **Ironwood Electronics, Inc.**, Eagan, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/449,542**

(22) Filed: **May 30, 2003**

(65) **Prior Publication Data**

US 2004/0242030 A1 Dec. 2, 2004

(51) **Int. Cl.**^{7} **H01R 12/00**
(52) **U.S. Cl.** **439/73**; 439/70; 439/526
(58) **Field of Search** 439/83, 70–74, 439/91, 178, 876, 591, 331, 630, 68, 525, 526

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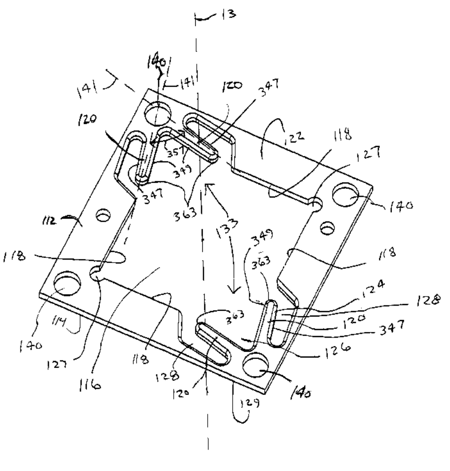
Primary Examiner—Gary Pauman
Assistant Examiner—Edwin A. Leon
(74) *Attorney, Agent, or Firm*—Mueting, Raasch & Gebhardt, P.A.

(57) **ABSTRACT**

A packaged device adapter assembly for use with high density integrated circuit packages, e.g., micro lead frame packages, micro lead chip carriers, quad flat no lead packages, and micro ball grid array packages, etc., includes an alignment structure for aligning a packaged device therein.

52 Claims, 10 Drawing Sheets



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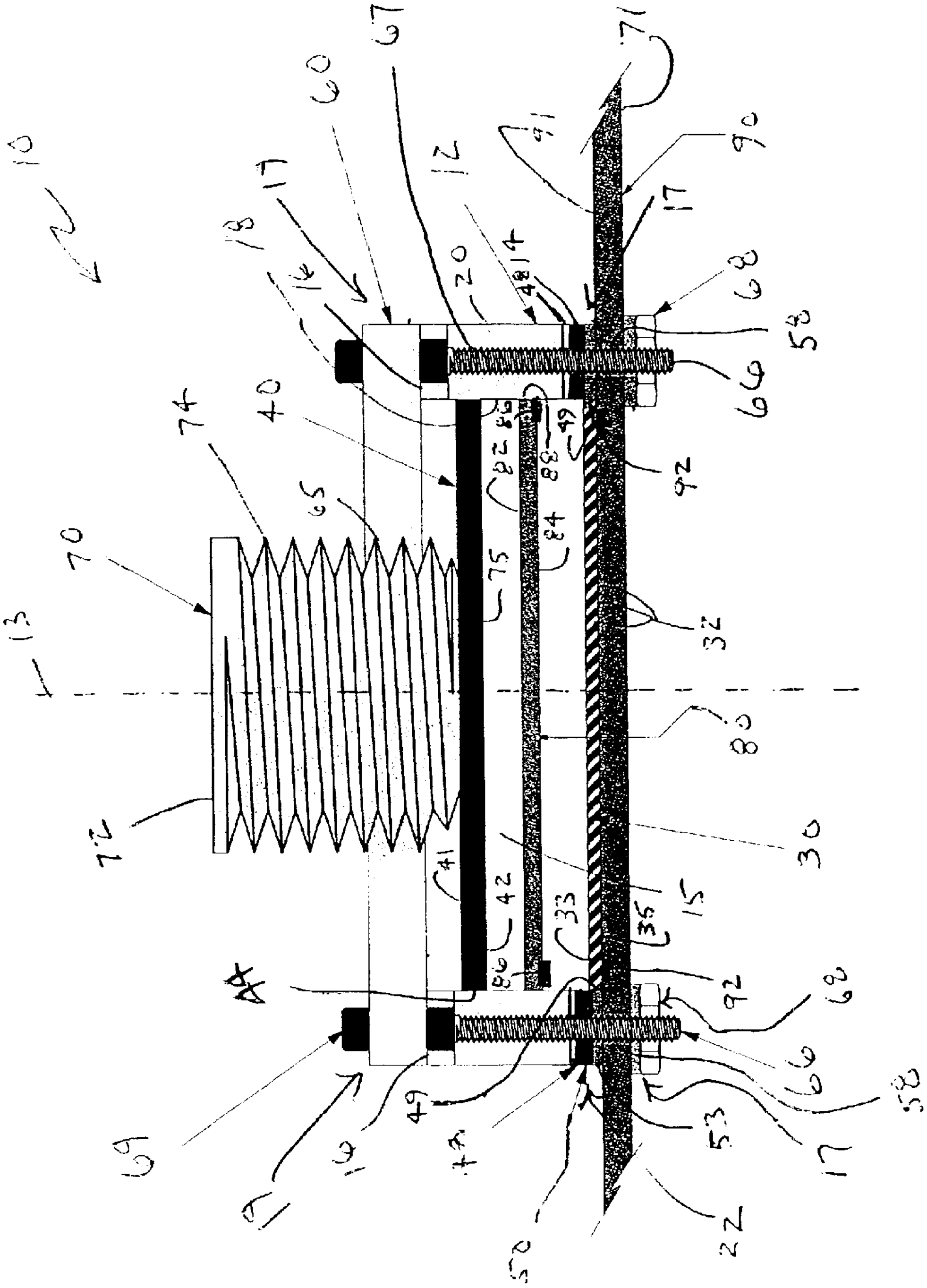
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FIG. 1

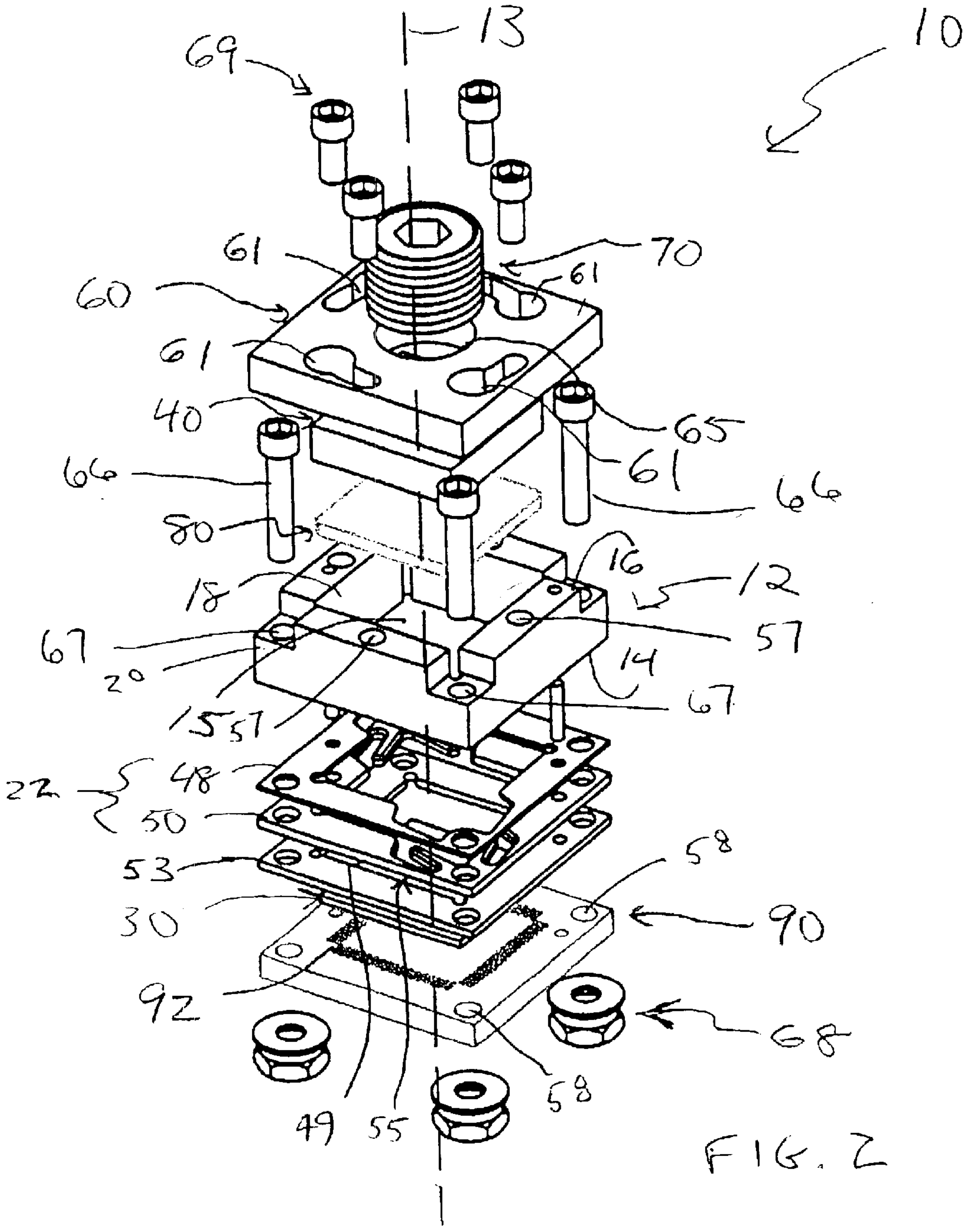
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FIG. 2

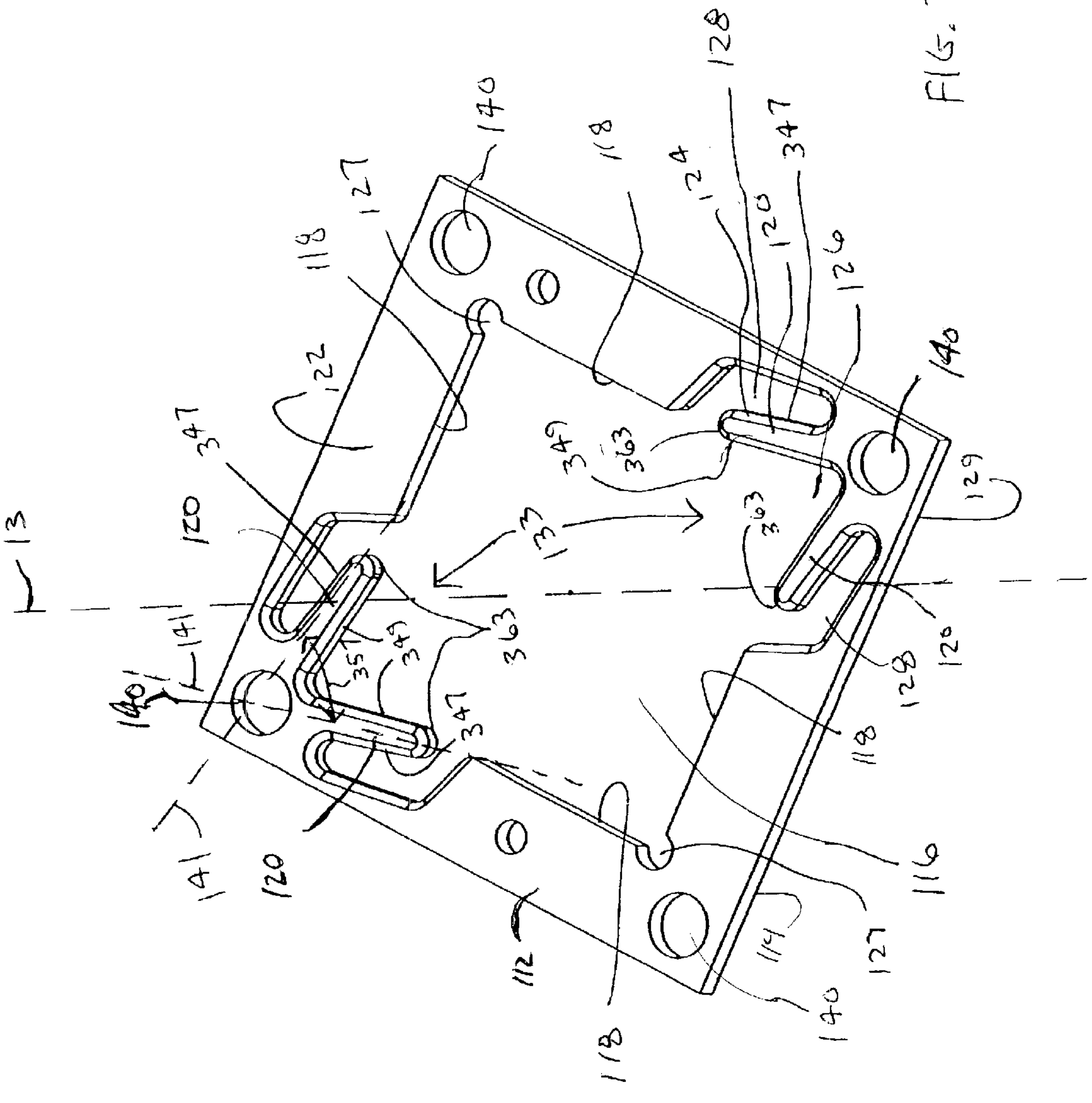
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FIG. 3A

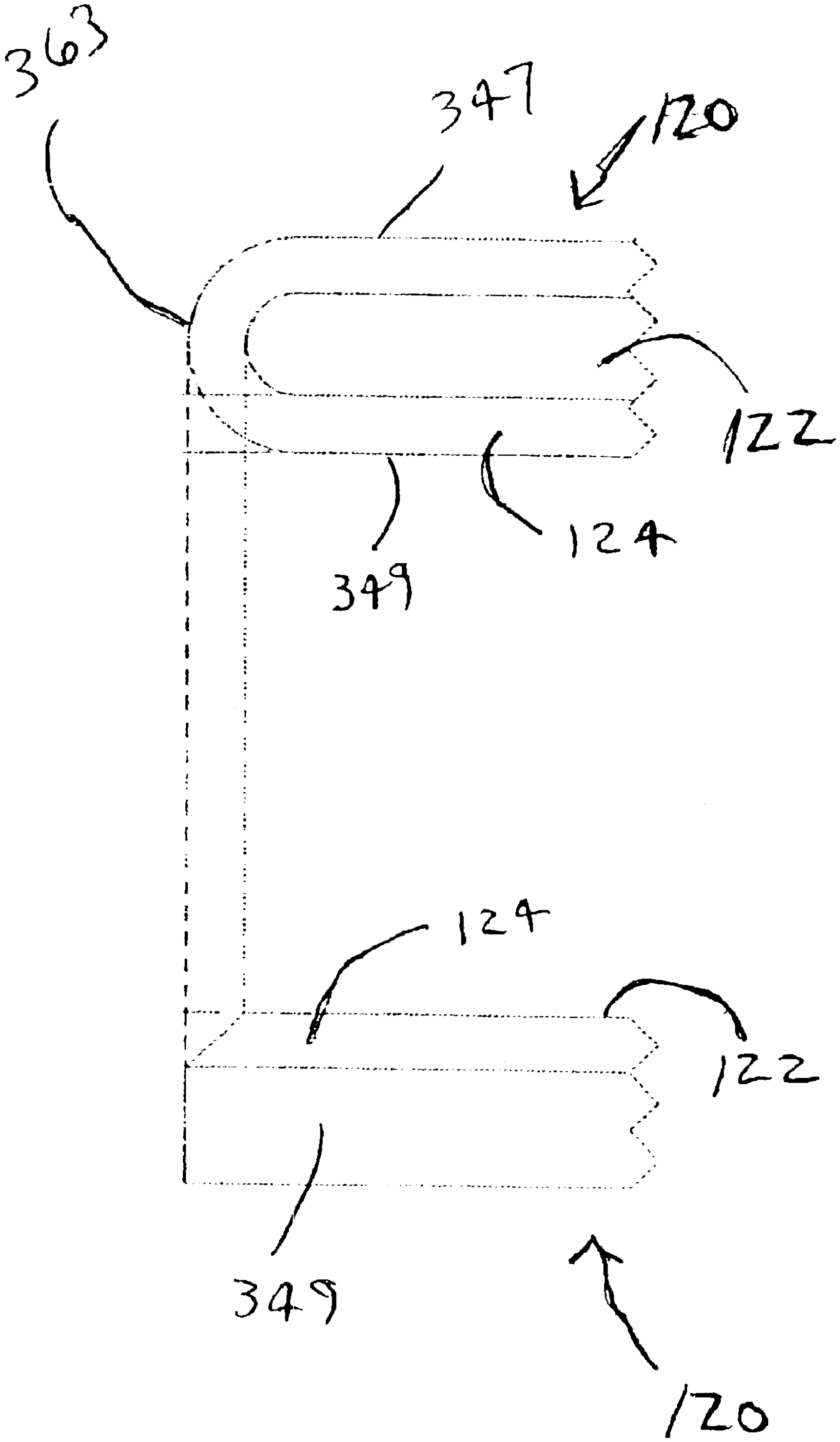

FIG. 3B

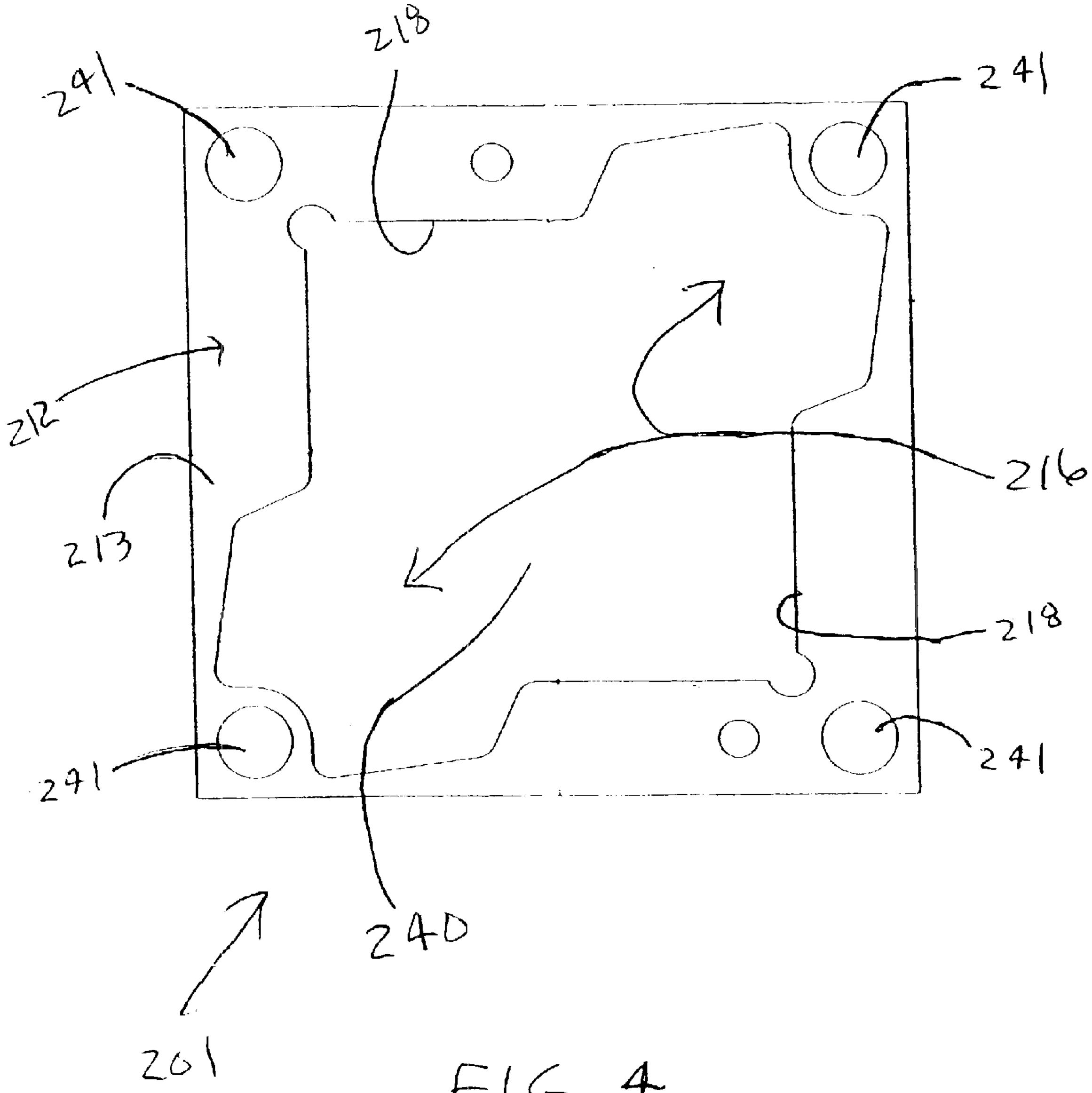

FIG. 4

FIG. 5A

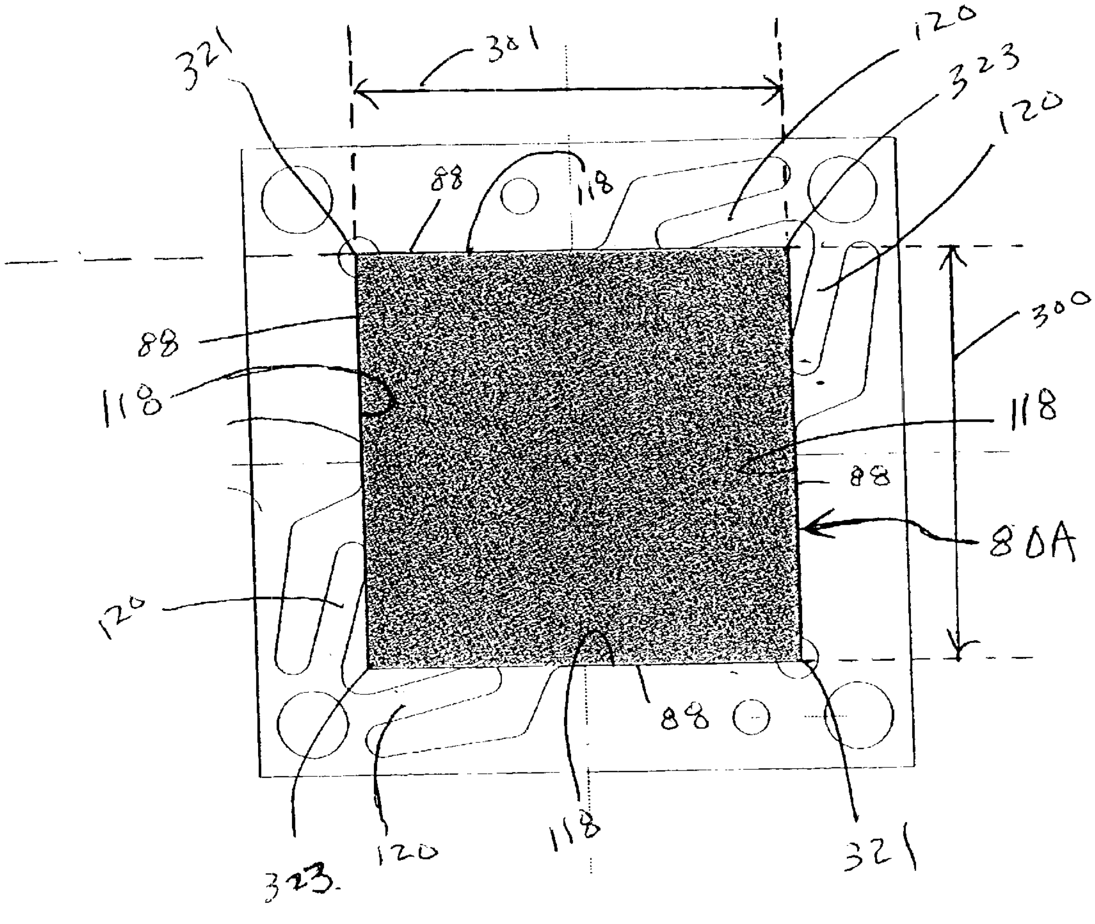
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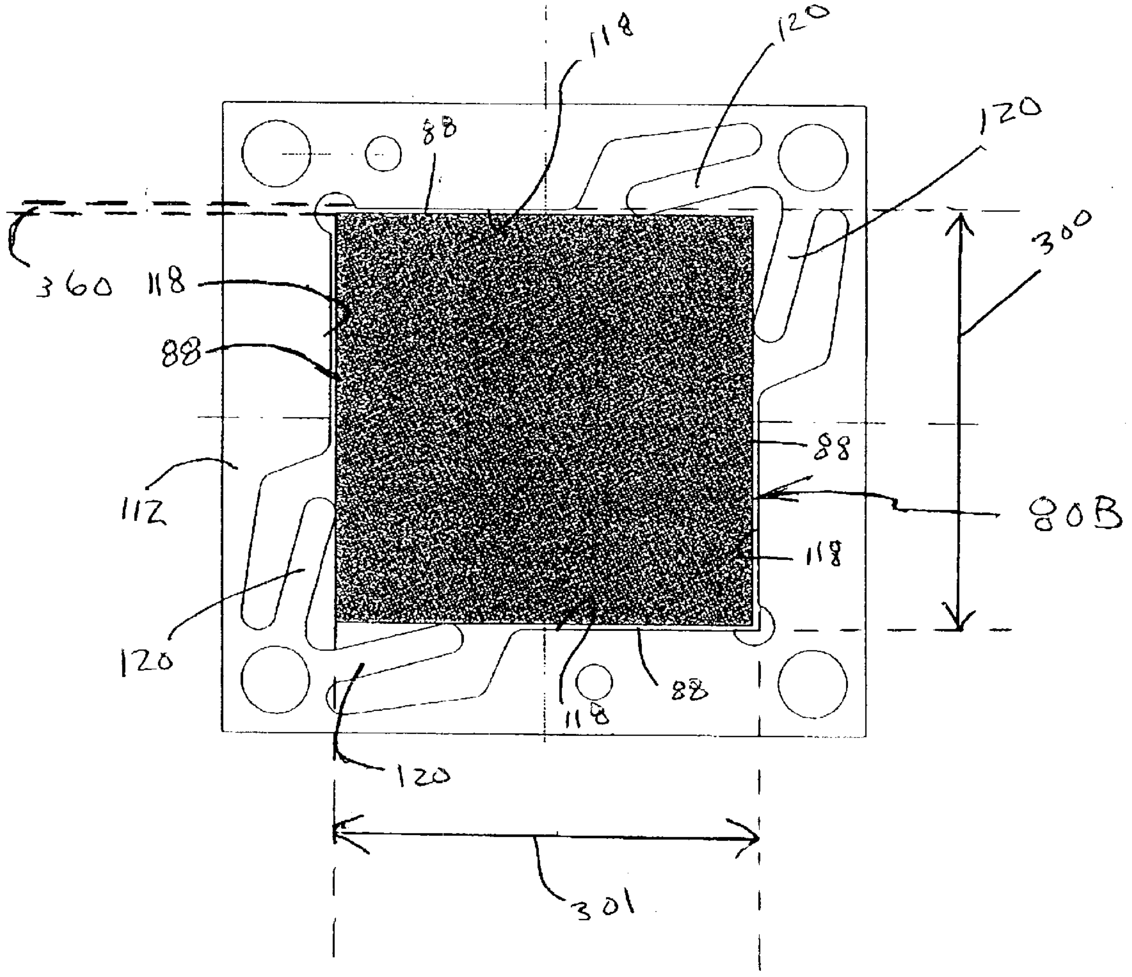
FIG. 5B



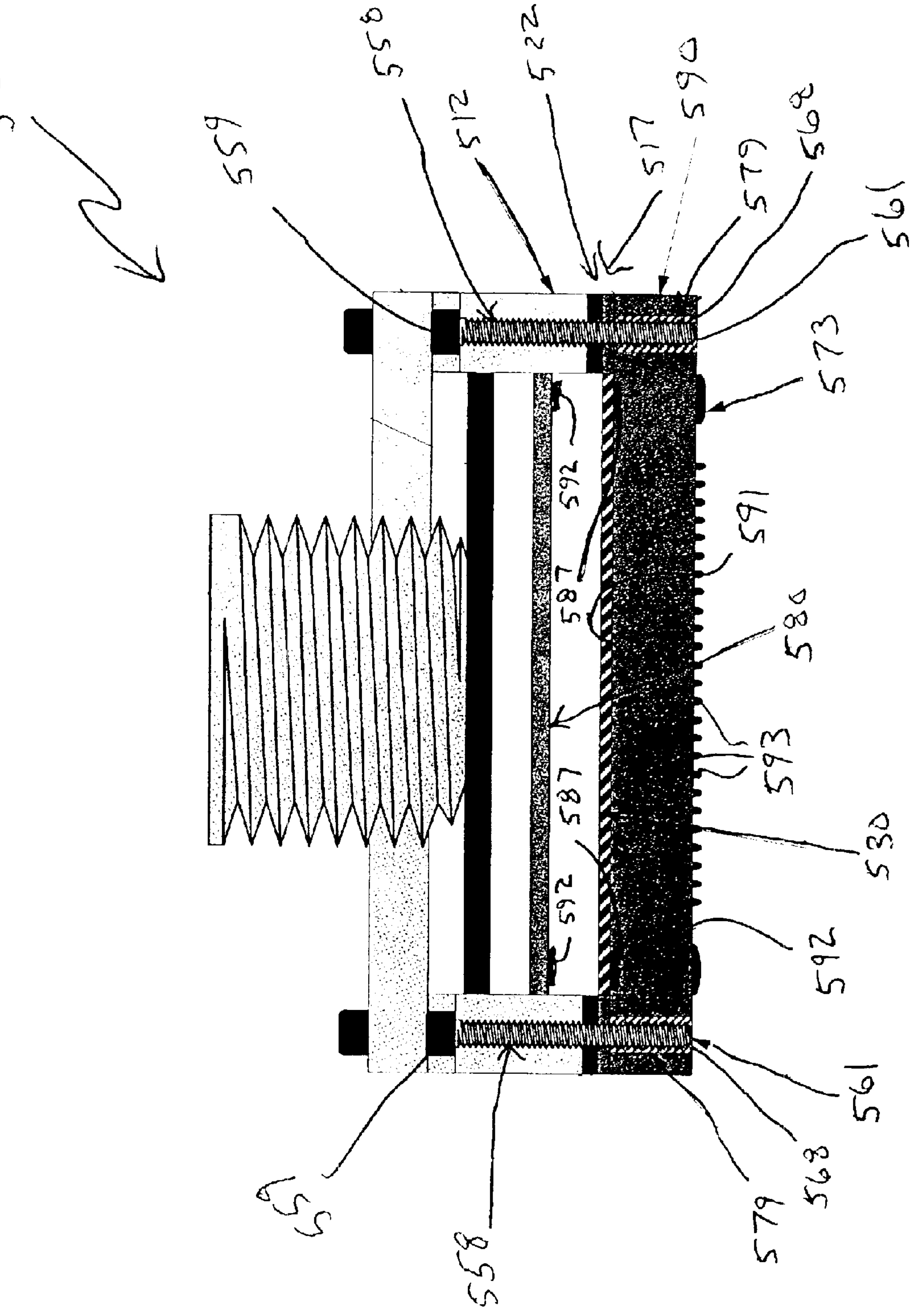

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FIG. 6

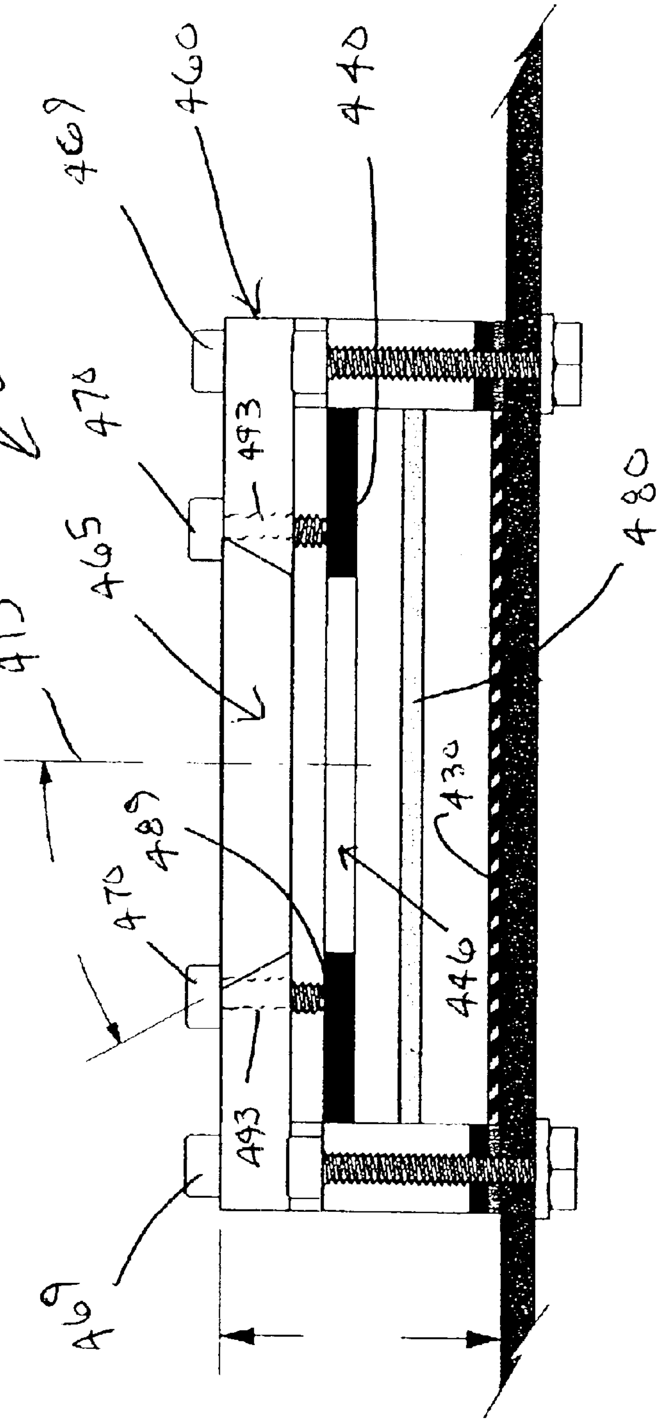

FIG. 7A

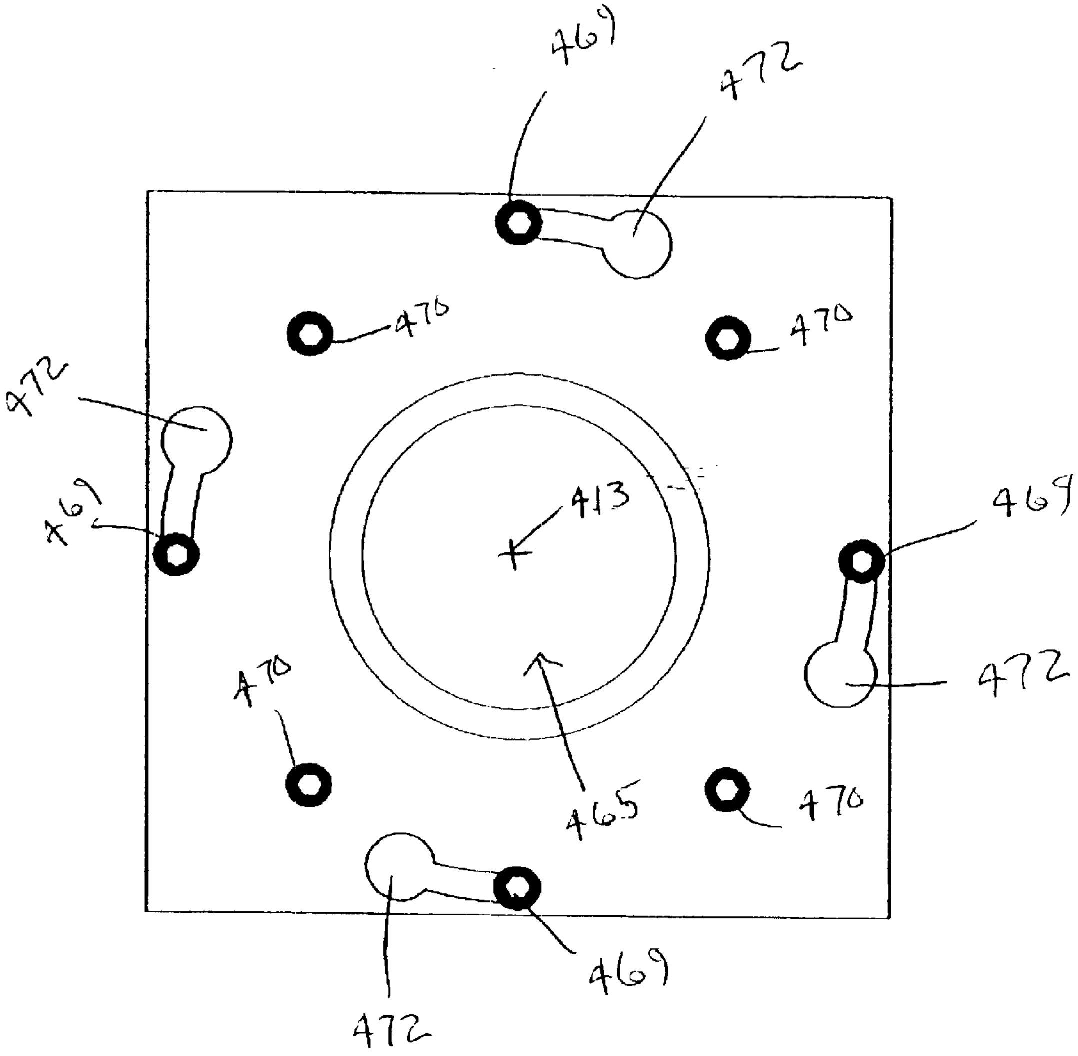

FIG. 7B

PACKAGED DEVICE ADAPTER ASSEMBLY WITH ALIGNMENT STRUCTURE AND METHODS REGARDING SAME

BACKGROUND OF THE INVENTION

The present invention relates to electrical adapters and methods using such adapters. More particularly, the present invention pertains to adapters for packaged integrated circuit devices, e.g., micro lead frame packages, micro lead chip carriers, quad flat no lead packages, and micro ball grid array packages, etc., and methods for using such adapters.

Certain types of integrated circuit packages are becoming increasingly popular due to their occupancy area efficiency. In other words, they occupy less area on a target board on which they are mounted while providing a high density of contact terminals. For example, one such high density package type is a micro lead frame package. Generally, such packages contain an integrated circuit having its die bond pads electrically connected to respective conductive contact lead elements (e.g., lands) that are distributed on a surface of the package (e.g., the bottom surface of the package, for example, in an array).

A target printed circuit board upon which the package is to be mounted typically has formed on its surface a corresponding array of conductive pads which are aligned with the conductive contact lead elements of the package for electrically mounting the package on the target board. The target board typically includes other conductive traces and elements which lead from the array of conductive pads used for mounting the package to other circuitry on the board for connecting various components mounted thereon.

Typically, to mount such a package to a target board, solder spheres are provided in a manner corresponding to the array of conductive pads on the target board. The package is positioned with the contact lead elements in contact with the solder spheres corresponding to the array of conductive pads on the target board. The resulting structure is then heated until the solder spheres are melted and fused to the contact lead elements of the package.

Such area efficient packaging, e.g., micro lead frame packages or micro ball grid array packages, provide a high density of terminals at a very low cost. Also, this packaging provides for limited lead lengths. The limited lead lengths may reduce the risk of damage to such leads of the package, may provide for higher speed product, etc.

Generally, circuit boards and/or components mounted thereon are tested by designers as the circuit boards are being developed. For example, for a designer to test a circuit board and/or a package mounted thereon, the designer must first electrically connect the package to the target circuit board (e.g., using solder balls).

As described above, this may include mounting the package on the target board and heating the solder spheres to fuse the solder spheres to the contact lead elements of the package. Therefore, the package may be prevented from being used again. It is desirable for various reasons to use package adapters for mounting the packages and reuse such packages after testing. For example, such device packages may be relatively expensive. Further, for example, once attached, the solder spheres are not accessible for testing. In addition, it is often difficult to rework the circuit board with the packages soldered thereon.

Various adapters are available to electrically connect a package to a target printed circuit board without requiring that the contact lead elements on the package be fused to the target board. However, the high density of terminals for certain packages, e.g., micro lead frame packages, lead to various interconnect problems for adapters being used with such packages. For example, alignment of the contact lead elements of the packaged device to the contact pads of the target board is generally problematic when an electrical adapter is used. Such problems may arise from the dimensional differences between device packages (e.g., even if such packages are within manufacturing tolerances).

SUMMARY OF THE INVENTION

The present invention provides packaged device adapter assemblies useable for high density integrated circuit packages, e.g., micro lead frame packages, micro lead chip carriers, quad flat no lead packages, and micro ball grid array packages, etc.

An adapter apparatus according to the present invention for receiving a packaged device is described. The packaged device includes a plurality of contact elements disposed on a surface thereof and one or more perimeter side surfaces defining an outer perimeter of the packaged device. The adapter apparatus includes a perimeter wall member comprising a length along an adapter axis between a first end region of the adapter apparatus and a second end region of the adapter apparatus and a conductive element layer having a plurality of arranged conductive elements. The conductive element layer is positioned at the first end region of the adapter apparatus orthogonal to the adapter axis. The perimeter wall member and the conductive element layer define a socket cavity adapted to receive the packaged device with the plurality of contact elements thereof adjacent the conductive element layer. An alignment structure is positioned at the first end region to align the packaged device within the socket cavity. The alignment structure includes an alignment plate positioned orthogonal to the adapter axis. The alignment plate includes at least one opening defined therein adapted to allow the contact elements of the packaged device to be in electrical contact with the arranged conductive elements of the conductive element layer. Further, the alignment plate includes a plurality of movable elements configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer.

In one embodiment, the plurality of movable elements may include two sets of movable elements configured in opposing relation to one another such that each of the two sets of movable elements are adapted to movably engage at least one of the one or more perimeter side surfaces of the packaged device when the packaged device is received in the socket cavity adjacent the conductive element layer.

In another embodiment, the packaged device is a packaged device having at least two opposing corners with two perimeter side surfaces of the packaged device intersecting at each of the at least two opposing corners. The plurality of movable elements may include two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the two perimeter side surfaces that intersect at one of the two opposing corners when the packaged device is received in the socket cavity adjacent the conductive element layer.

In another embodiment, the plurality of movable elements may include one or more surfaces adapted to engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer. The plurality of movable elements may be adapted to move from a normal state when a packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer. The position of the one or more surfaces of the plurality of movable elements are at a distance further from the adapter axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

In one or more other embodiments, the plurality of movable elements may have a thickness in the direction of the adapter axis that is less than a thickness of the packaged device; one or more of the plurality of movable elements may include a beveled edge at an upper surface thereof; the plurality of movable elements may be operable to provide opposing forces on the one or more perimeter side surfaces of the packaged device; and/or the conductive element layer may include a conductive elastomer layer.

Yet further, in another embodiment, the alignment plate may include a body portion having one or more fixed inner perimeter surfaces defining the at least one opening. The one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device to be received in the socket cavity. In addition, the body portion may correspond to and may be positioned adjacent an end of the perimeter wall member at the first end region of the adapter apparatus. The plurality of movable elements extend from the body portion of the alignment plate.

In another embodiment, the alignment structure may include a spacer structure that is adapted to define a free space adjacent the plurality of movable elements so as to allow the plurality of movable elements to move from a normal state when the packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer (e.g., a spacer may be used to provide the free space).

In yet another embodiment, the adapter apparatus may include an actuator apparatus that includes a floating member movable in the socket cavity and an actuator element. The actuator element is operable to provide a force on the floating member such that a corresponding force is distributed to the packaged device when received in the socket cavity such that the plurality of contact elements are in electrical contact with the arranged conductive elements of the conductive element layer. The apparatus may also include a cover member positioned at the second end region of the adapter apparatus to close the socket cavity; the cover member being movable to allow the packaged device to be removed from the socket cavity (e.g., a cover member having at least one opening defined therein and also through the floating member to allow access to the packaged device when it is positioned in the socket cavity adjacent the conductive element layer).

The adapter apparatus may be coupled to a target board such that the arranged conductive elements are electrically coupled to contact pads of the target board. Further, the adapter apparatus may be coupled to an interconnect board such that the arranged conductive elements are electrically coupled to contact pads of the interconnect board; the interconnect board being mountable (e.g., surface mountable) to a printed circuit board.

An apparatus for use in an adapter configured to receive a packaged device according to the present invention is also provided. The package device includes a plurality of contact elements disposed on a surface thereof and one or more perimeter side surfaces defining an outer perimeter of the packaged device. The apparatus includes an alignment plate. The alignment plate includes a body portion having one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate. The one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device. Further, the apparatus includes a plurality of movable elements extending from the body portion of the alignment plate. The plurality of movable elements are configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening. The alignment plate may be configured as described in one or more of the embodiments described herein with respect to the adapter apparatus.

Yet further, a method of aligning a packaged device in an adapter apparatus is also described. The packaged device includes a plurality of contact elements disposed on a surface thereof and one or more perimeter side surfaces defining an outer perimeter of the packaged device. The method includes providing an adapter apparatus defining a socket cavity for receiving the packaged device. The adapter apparatus includes an alignment plate with the alignment plate including a body portion having one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate. The alignment plate further includes a plurality of movable elements extending from the body portion thereof. The plurality of movable elements are in a normal state when a packaged device has not been received in the opening. The method further includes positioning the packaged device in the socket cavity such that the plurality of movable elements are moved to a flex state. A position of one or more surfaces of the plurality of movable elements are at a distance further from the axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

In one embodiment of the method, one or more of the plurality of movable elements include a beveled edge at an upper surface thereof. As such, positioning the packaged device in the socket cavity includes engaging one or more edges of the packaged device with the beveled edge of one or more of the plurality of movable elements forcing the movable elements from the normal state to the flex state.

In another embodiment of the method, the method includes providing, with use of the plurality of movable elements, opposing forces on the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening to hold the packaged device in an aligned position in the socket cavity.

The above summary of the present invention is not intended to describe each embodiment or every implementation of the present invention. Advantages, together with a more complete understanding of the invention, will become apparent and appreciated by referring to the following detailed description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-section side view of a packaged device adapter assembly according to the present invention mounted on a target board.

FIG. **2** is a top exploded perspective view of the packaged device adapter assembly of FIG. **1**.

FIG. **3**A is a top perspective view of one embodiment of an alignment plate for an alignment structure for use in a packaged device adapter assembly such as that shown in FIGS. **1–2** according to the present invention.

FIG. **3**B is a top view and side view of a portion of the alignment plate shown in FIG. **3**A.

FIG. **4** is a top view of a spacer of an alignment structure for use in a packaged device adapter assembly such as that shown in FIGS. **1–2** and useable with an alignment plate such as that shown in FIGS. **3**A–**3**B according to the present invention.

FIG. **5**A is a top view of the alignment plate shown in FIG. **3**A having a packaged device of near maximum perimeter being aligned thereby according to the present invention.

FIG. **5**B is a top view of the alignment plate shown in FIG. **3**A having a packaged device with a smaller perimeter than that shown in FIG. **5**A being aligned thereby according to the present invention.

FIG. **6** is a cross-section side view of an alternate packaged device adapter assembly according to the present invention coupled to an interconnect board; the interconnect board being mountable (e.g., surface mountable) to a printed circuit board.

FIG. **7**A is a cross-section side view of yet another alternate embodiment of a packaged device adapter assembly similar to that shown in FIGS. **1–2** including a particular cover structure according to the present invention.

FIG. **7**B shows a top view of the packaged device adapter assembly shown in FIG. **7**A.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Generally, packaged device adapter assemblies for use with packaged devices, e.g., high density devices, along with methods using such assemblies, shall be described herein. An illustrative packaged device adapter assembly **10** according to the present invention shall be described with reference to illustrative FIGS. **1–2**. Various other illustrative embodiments of packaged device adapter assemblies according to the present invention, including features which may be included in combination with features or structure of the other assemblies as described herein, shall be described with reference to FIGS. **3–7**.

One skilled in the art will recognize from the description herein, that the various illustrative embodiments described include some features or elements included in other illustrative embodiments and/or exclude other features. However, a packaged device adapter assembly according to the present invention may include any combination of elements selected from one or more of the various embodiments as described herein with reference to FIGS. **1–7**. For example, as will be readily apparent from the description below, a cover structure as shown in FIGS. **7**A–**7**B may be used with one or more of the various adapter assembly embodiments described with reference to FIGS. **1–2**, FIG. **6**, etc. Further, for example, the alignment structure as described herein may be use in combination with any other embodiments of adapter assemblies described herein, and also other adapter assemblies that may benefit from the features thereof (e.g., those adapter assemblies that may not be described herein).

FIGS. **1–2** show a cross-section side view and a top exploded perspective view, respectively, of an illustrative packaged device adapter assembly **10** for use with a packaged device **80** according to the present invention. Generally, the packaged device adapter assembly **10** is for mounting on a target board **90**. The packaged device adapter assembly **10** includes a perimeter wall member **12** having a length along an adapter axis **13**. Generally, the length of the perimeter wall member **12** extends between a first end **14** of the perimeter wall member **12** at a first end region **17** of the packaged device adapter assembly **10** to a second end **16** of the perimeter wall member **12** at a second end region **19** of the packaged device adapter assembly **10**. The perimeter wall member **12** includes an inner surface **18** facing towards the adapter axis **13** and an opposing outer surface **20** facing away from the adapter axis **13**.

The packaged device adapter assembly **10** further includes a conductive element layer **30** including a plurality of arranged conductive elements **32** therein, e.g., a conductive elastomer layer. The perimeter wall member **12** and the conductive element layer **30** including the plurality of arranged conductive elements **32** generally define a socket cavity **15** sized for receiving a packaged device **80** that is aligned using an alignment structure **22** positioned at the first end region **17** of the packaged device adapter assembly **10** as will be described in further detail herein.

Generally, the packaged device **80** includes an upper surface **82** and a lower surface **84** in addition to one or more side surfaces **88** extending therebetween at the perimeter of the packaged device **80**. A plurality of contact elements **86** are disposed at least at the lower surface **84**. For example, the contact elements **86** may be distributed in an array along x and y axes orthogonal to the adapter axis **13** or the contact elements (e.g., lands) may be distributed along the outer portions of the lower surface **84** proximate the perimeter thereof. However, any arrangement of contact elements **86** may be accommodated according to the present invention.

The packaged device **80** may be any packaged device having a plurality of contact elements **86** disposed on a surface thereof. Preferably, the packaged device is a device having a high density of contact terminals, e.g., lands, solder spheres, bumps, contact pads, leads, etc., disposed on a surface thereof. For example, the high density packaged device may be a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, a micro ball grid array package, or any other type of package such as a ball grid array package, a chip scale package, a flip chip package, a flat package, a quad flat package, a small outline package, a land grid array package, or any other package having contact elements disposed on a surface thereof. Although the present invention is described herein with reference to a micro lead frame package as illustrated in the figures, the present invention is in no manner limited to use of the illustrative adapter apparatus embodiments described herein with only such packages. Rather, the adapter assemblies and adapter concepts described herein may be used with any packaged device having contact elements disposed on a surface thereof.

Further, the packaged device adapter assembly **10** includes a cover member **60** positioned at the second end **16** of the perimeter wall member **12** to close the socket cavity **15**. The cover member **60** is generally movable, e.g., removable via fastening devices **69** as shown in FIGS. **1–2**. However, the cover member may also be moveable about a hinge axis (not shown), or any other manner of removing or moving the cover to open the socket cavity for allowing a packaged device to be received therein. In other words, one or more of the cover member configurations allow the packaged device **80** to be removed from the socket cavity **15** and another packaged device placed therein. The packaged device adapter assembly **10** is generally used to provide electrical contact between the contact elements **86** of the packaged device **80** and contact pads **92** of the target board **90** via the arranged conductive elements **32** of conductive element layer **30** when the packaged device **80** is positioned in the socket cavity **15**.

The packaged device adapter assembly **10** further includes a floating member **40** as shown in FIGS. **1–2**. The floating member **40** is used in combination with an actuator element **70** to provide a distributed force on the packaged device **80** when received in the socket cavity **15** such that the contact elements **86** disposed on the lower surface **84** of the packaged device **80** are in effective electrical contact with the arranged conductive elements **32** of the conductive element layer **30**. As shown in FIG. **1**, the floating member **40** is shown spaced apart from the packaged device **80**, as is the conductive element layer **30**.

At least in one embodiment, the floating member **40** includes an upper surface **41** that is generally planar and orthogonal to the adapter axis **13** when the floating member **40** is positioned in the socket cavity **15**. Further, at least in one embodiment, the floating member **40** includes a lower surface **42** that is configured as a function of the upper surface **82** of the packaged device **80**. For example, as shown in FIG. **1**, lower surface **42** of the floating member **40** is generally planar and in direct contact with the planar upper surface **82** of a packaged device **80**. However, the lower surface of the floating member **40** may be configured in any manner and need not be planar. Further, the floating member may be formed of any number of different components. However, at least a portion of the lower surface **42** of the floating member **40** is in direct contact with the upper surface **82** of the packaged device **80**. The floating member **40** as shown in FIG. **1**, includes an edge surface **44** extending between the upper surface **41** and the lower surface **42** at the perimeter of the floating member **40**. The edge surface **44** lies adjacent, and may even be in contact with, the perimeter member wall **12** and is moveable relative thereto within the socket cavity **15**.

The actuator element **70** may be any actuator element operable to apply a force on the upper surface **41** of the floating member **40**. As a force is applied by the actuator element **70** to the upper surface **41** of the floating member **40**, the force is distributed generally equally along the upper surface **82** of the packaged device **80**. As such, an equivalent force is provided at each contact element **86**, e.g., land, for effective contact between each contact element **86** and one or more conductive elements **32**, e.g., conductive strands of a conductive elastomer layer. Such a distributed force across the entire packaged device **80** reduces the potential application of excessive force on one part of the packaged device **80** versus another part thereof, e.g., the center versus the perimeter.

Generally, in one or more embodiments, the actuator element **70** is an element associated with the cover member **60**. For example, the actuator element may be a spring element, a leaf spring, or any other flexible element capable of applying a force to the floating member **40** via the association with the cover member **60**. Further, although not preferred, the cover member **60** itself may be used to apply a force to the floating member **40** such as by tightening the cover member directly down on the floating member **40** by fastening elements, e.g., screws.

At least in one embodiment as shown in FIG. **1**, the actuator element **70** is a threaded element that includes an upper region **72** with a threaded portion **74** extending therefrom. Further, in such an embodiment, the cover member **60** includes a threaded insert **65** positionable along the axis **13** of the adapter assembly **10** for mating with the threaded portion **74** of the actuator element **70**. The threaded portion **74** terminates in a generally planer surface **75**.

With the packaged device **80** in the socket cavity **15**, the planer surface **75** is placed in direct contact with the upper surface **41** of the floating member **40** by turning the actuator element **70**. As such, the actuator element **70** is adjustable to provide an effective force to the upper surface **41** of floating member **40** such that the distributed force is applied for effective electrical coupling of the contact elements **86** to the arranged conductive elements **32** of conductive element layer **30**. With use of the actuator element **70** and the floating member **40**, a suitable distributed force on the packaged device **80** can be achieved. The minimized load applied to the packaged device **80** and thus to the conductive elements **32** of the conductive element layer **30** allows for operation of the adapter assembly **10** over many insertion cycles as the conductive element layer **30** is not unnecessarily damaged by the force applied to the packaged device **80** in order to achieve contact between all of the contact elements **86** and the arranged conductive elements **32**.

Preferably, the floating member **40** is formed of a heat conductive material, e.g., aluminum, to provide heat sinking capability. Further, actuator element **70** and the perimeter wall member **12** and cover **60** are formed of such heat sinking material. In such a manner, the elements that form the socket cavity **15** which provide electrical coupling of the packaged device **80** to a target board **90** also function to dissipate heat away from the packaged device **80** when the packaged device **80** is operable. This is particularly important for high density packaged devices in that such packaged devices tend to operate with greater heat output.

As can be seen from FIG. **1**, the floating member **40** is sized and configured such that edge **44** thereof is in moveable contact with inner surface **18** of the perimeter wall member **12** which allows heat conduction therethrough and away from the packaged device **80**. Likewise, the contact between the actuator element **70** and the floating member **40**, such as provided by a screw formed of aluminum, allows for heat conduction from the threaded portion **74** (which is in direct contact with the floating member **40**) to the exterior of the socket cavity **15**.

It will be recognized that various elements or portions of the adapter assembly **10** may be formed of multiple layers or components or as single piece elements. For example, it will be recognized that the perimeter wall member **12** may be formed of multiple pieces or it may be formed as a single piece element. Further, for example, the floating member **40** may be formed of one or more layers or components.

The adapter assemblies as described herein may be mounted relative to various target boards as illustrated generally in FIG. **1** by target board **90** and may be mounted to the target board **90** in any number of different manners, many of which would be readily perceived by one skilled in the art. For example, such mounting may be performed as described in U.S. Pat. No. 6,394,820 issued 28 May 2002, entitled "PACKAGED DEVICE ADAPTER ASSEMBLY AND MOUNTING APPARTUS," which is incorporated herein by reference.

The target board **90** may be any substrate including contact pads arranged thereon for electrical connection with the adapter assembly **10**. For example, the target board may be a printed circuit board including various other components mounted thereon or may be a surface mountable substrate (e.g., an interconnect board) as shown and described with reference to FIG. **6**. This is particularly useful when the adapter assembly **10** is to be used with printed circuit boards that do not have mounting holes therein or when it is undesirable to provide mounting holes in the target board **90**.

As shown in FIG. **6**, an interconnect board **590** (e.g., an adapter board) includes an upper surface **591** having a plurality of contact pads **587** disposed thereon for electrical contact with conductive elastomer layer **530**. A plurality of surface mountable solder spheres **593** are disposed on lower surface **592**, e.g., arranged in an array, of the interconnect board **590**. The contact pads **587** are electrically coupled to solder spheres **593** through use of conductive traces or any other conductive elements generally used to provide electrical contact between conductive elements disposed on opposing surfaces of a substrate. Further, for example, the interconnect board **590** may be formed of FR4 material and printed with conductive traces as performed using conventional printed circuit board fabrication techniques. In addition, solder spheres may be positioned on the upper surface **591** as described in U.S. Pat. No. 6,394,820, which is incorporated herein by reference.

As shown in FIG. **6**, the adapter assembly **500** is mounted to interconnect board **590** in a manner unlike that shown in FIG. **1**. As shown in FIG. **6**, interconnect board **590** includes a plurality of openings **579** defined therein for receiving fastening devices **561**, e.g., screws. The openings **579** are provided with inserts **568**, e.g., threaded inserts, for mating with fastening devices **561**. The perimeter wall member **512** has openings **558** defined therein to accept the threaded fastening devices **561** having heads **559** for engaging a portion of the perimeter wall member **512** upon insertion of the fastening devices **561** through the openings **558** and threaded inserts **568**. In other words, in this embodiment, the interconnect board **590** is mounted adjacent the first end region **517** of the adapter assembly **500** by insertion of fastening elements **561** through openings **558** defined in perimeter wall member **512** and coupled with threaded inserts **568** within the interconnect board **590**.

With interconnect board **590** mounted adjacent the adapter assembly **500**, the interconnect board **590** may be mounted on a target board (e.g., a printed circuit board) having a contact pad pattern corresponding to the arrangement of solder spheres **593**. As such, contact elements **592** of packaged device **580** can be electrically coupled to the target board (not shown) via the conductive elastomer layer **530** and interconnect board **590** using the adapter assembly **500**. The larger solder spheres **573** are used for at least providing physical balance when mounting the interconnect board.

With further reference to FIG. **1**, the adapter assembly **10** is mounted relative to target board **90** (e.g., a printed circuit board) in yet another manner using fastening devices (e.g., a threaded bolt **66** and washer/nut **68**). Target board **90** includes openings **58** defined therein for use in attachment of the adapter assembly **10** to the target board **90** using the fastening devices. The threaded bolts **66** extend through openings **67** defined in perimeter wall member **12** and which further extend through openings **58** and beyond the lower surface **71** of the target board **90**. A mating device, e.g., washer/nut **68**, may then be coupled to the threaded bolts **66** which can be tightened to hold the assembly **10** in position relative to the target board **90**.

It will be recognized that the adapter assemblies as described herein may be mounted relative to various configurations of target boards, including but clearly not limited to those described herein (e.g., a surface mountable board, a printed circuit board, etc.). Further, such mounting of the adapter assemblies relative to such target boards may be accomplished in any manner, including but clearly not limited to those described herein (e.g., adhesive, fastening devices including bolts and nuts, threaded inserts, etc.).

The adapter assembly **10**, as more clearly shown in the exploded view of FIG. **2**, is formed in a substantially square configuration. However, one skilled in the art will recognize that the elements used in forming the packaged device adapter assembly **10** may include elements for forming an adapter assembly configured as a rectangle, a circle, or any other configuration sized to accommodate a packaged device received in a socket cavity therein. As such, one skilled in the art will recognize that the present invention is not limited to any particular shape of adapter assembly, or alignment structure as described further herein, but is limited only as described in the appended claims.

As previously mentioned, the cover member **60** of the packaged device adapter assembly **10** may be configured in various manners. The cover member **60** is used to close the socket cavity **15** and includes various other elements associated therewith for facilitating other functionality. For example, as previously described herein, in one embodiment as shown in FIG. **1**, cover member **60** is integrated with threaded insert **65** for receiving the threaded portion **74** of the actuator element **70** (e.g., a compression screw) used in applying a direct force to floating member **40**. Further, cover member **60** as shown in FIG. **1** includes openings **61** for receiving corresponding fastening elements **69**, e.g., screws or threaded bolts, to affix cover member **60** to the perimeter wall member **12**. In such an embodiment, the perimeter wall member **12** includes inserts **57** for receiving the fastening elements **69** therein. For example, as shown in FIG. **1**, inserts **57** may be threaded inserts for retaining threaded screw portions of screws **69** to attach cover member **60** to the perimeter wall member **12**.

However, in another embodiment, the cover member **60** may also be configured as a latchable hinge cover as shown and described in U.S. Pat. No. 6,394,820, e.g., a ZIF type or clam-type lid. Although several cover members are described herein, the present invention is not limited to only such configurations as various other configurations may provide suitable closure function for the adapter.

In addition, the cover member **60** may also be configured as shown in FIGS. **7A–7B**. FIGS. **7A–7B** show a cross-section side view of a packaged device adapter assembly **400** which includes a perimeter wall member **412** and a conductive element layer **430** to form a socket cavity for receiving a packaged device **480** in a manner similar to that as shown in FIG. **1**. The cover member **460** includes key slot holes **472** for easy locking and unlocking with mating oval head screws **469** in the same manner as shown in FIG. **2** (e.g., slots **61** and oval head screws **69**). However, instead of an actuator element like that of threaded element **74** with mating insert **65** as shown in FIG. **1**, an opening **465** is provided through the cover member **460** about axis **413**. To provide the actuation function for providing a force on floating member **440**, a plurality of actuator elements in the form of, for example, oval headed screws **470** having flat terminating ends **489** are used. In other words, threaded inserts **493** are provided in the cover member **460** for receiving the screws **470**, allowing them to contact the floating member **440**, and apply an appropriate force thereon. Any number and size of such actuators elements may be used such that the distributed force therefrom is effectively provided to the packaged device **480**.

As further shown in FIG. 7A, the floating member **440** is also provided with an opening **446** about the axis **413**. With the openings **465**, **446** provided in the cover member **460** and the floating member **440**, respectively, access to the packaged device **480** is possible. For example, a test probe may be used through the opening and/or heat may be allowed to escape through the opening.

Further with reference to FIGS. **1–2**, the conductive element layer **30** includes an upper surface **33** and a lower surface **35**. The arranged conductive elements **32** extend from the upper surface **33** to the lower surface **35** through insulative material to provide isolated conductive paths therethrough. The upper surface **33** is configured to allow contact between the contact elements **86** of the packaged device **80** and the conductive elements **32** arranged therein and the lower surface **35** is configured to allow contact between the conductive elements **32** and the contact pads **92** of the target board **90**.

The conductive element layer **30** including the arranged conductive elements **32** is preferably a conductive elastomer layer. For example, the conductive elastomer layer may be formed of a z-axis elastomer material or a slanted axis conductive elastomer material. For example, such material may be that as described in U.S. Pat. No. 4,923,739 to Jin et al., issued 8 May 1990 and entitled "Composite Electrical Interconnection Medium Comprising a Conductive Network, And Article, Assembly, and Method;" that as described in U.S. Pat. No. 4,754,546 to Lee et al., issued 5 Jul. 1988 and entitled "Electrical Connector for Surface Mounting and Method of Making Thereof;" that as described in U.S. Pat. No. 4,729,166 to Lee et al., issued 8 Mar. 1988 and entitled "Method of Fabricating Electrical Connector for Surface Mounting;" that as described in U.S. Pat. No. 4,668,957 to Spohr, issued 26 May 1987 and entitled "Amorphous Glass Matrix Containing Aligned Microscopically Thin Metal Conductors;" or may be any other conductive elastomer material such as that available from Shin-Etsu Polymer America Inc. (Union City, Calif.) under the trade designation GB-Matrix.

Although the conductive element layer **30** is preferably a conductive elastomer material having conductive elements or material arranged therein, various other layers which include arranged conductive elements **32** therein may also be used according to the present invention. For example, the arranged conductive elements **32** may include formed conductive element structures, stamped conductive elements structures, or any other conductive material for connecting contact elements **86** to contact pads **92** on target board **90**, e.g., pins, springs, pogo pins, or fuzz buttons.

According to the present invention, the alignment structure **22** is provided to assist in aligning the packaged device **80** in the socket cavity **15**. Such alignment is necessary for accomplishing suitable electrical contact between the contact elements **86** of the packaged device **80** and the contact pads **92** of the target board **90** through the conductive element layer **30** (e.g., precisely position the packaged device **80** over the contact pads **92** of target board **90**).

Generally, the alignment structure **22** is positioned at the first end region **17** of the adapter assembly **10** to align the packaged device **80** within the socket cavity **15**. The alignment structure **22** includes at least an alignment plate **50** positioned orthogonal to the adapter axis **13**. Generally, the alignment plate **50** includes at least one opening defined therein adapted to allow the contact elements **86** of the packaged device **80** to be in electrical contact with the arranged conductive elements **32** of the conductive element layer **30**. Further, the alignment plate **50** includes a plurality of movable elements configured to movably engage the one or more perimeter side surfaces **88** of the packaged device **80** when the packaged device **80** is positioned in the socket cavity **15** adjacent the conductive element layer **30**.

In one embodiment, the plurality of movable elements include two sets of movable elements (e.g., moveable elements **120** as shown in FIG. 3A) configured in opposing relation to one another such that each of the two sets of movable elements are adapted to movably engage at least one of the one or more perimeter side surfaces **88** of the packaged device **80** when the packaged device **80** is received in the socket cavity **15** adjacent the conductive element layer **30**. In other words, the plurality of movable elements (e.g., movable elements **120**) are operable to provide opposing forces on the one or more perimeter side surfaces **88** of the packaged device **80**.

The alignment structure **22** may also include a spacer structure **48** that is adapted to define a free space adjacent the plurality of movable elements (e.g., moveable elements **120** as shown in FIG. 3A) so as to allow the plurality of movable elements to move from a normal state when the packaged device **80** has not been received in the socket cavity **15** to a flex state when the packaged device **80** is positioned in the socket cavity **15** adjacent the conductive element layer **30**. For example, the spacer structure **48** may be provided as an integral part of the alignment plate **50** (e.g., a portion of the alignment plate **50** corresponding to the perimeter wall member **12** that has a thickness in the direction of the adapter axis **13** that is greater than the remainder of the alignment plate **50** that extends inward toward the adapter axis **13**). Further, for example, the spacer structure may be a separate plate such as that described herein with reference to FIG. **4**. Although several spacer structures are described herein, any spacer structure that provides a void (e.g., an open space) directly above the plurality of movable elements that allows them to move from a normal state to a flex state can be used.

One embodiment of an illustrative alignment plate **50** that may be used in the adapter assembly **10** shown in FIG. **1** is described with reference to the top perspective view of FIG. 3A, the detail top and side view of a portion of a movable element of FIG. **3B**, and the alignment illustrations of FIGS. **5A–5B**. In this particular embodiment, the packaged device **80** being aligned with the alignment plate **50** is a micro lead frame package (i.e., a square package as best shown in the top view of the package type in FIGS. **5A** and **5B**). As previously described, the packaged device **80** includes an upper surface **82** and a lower surface **84**. As further shown in FIGS. **5A–5B**, the packaged device **80** further includes four perimeter side surfaces **88** extending therebetween at the perimeter of the packaged device **80** to define an outer perimeter of the packaged device. In other words, the packaged device **80** has two pairs of opposing corners **321**, **323**. At each corner **321**, **323**, two perimeter side surfaces **88** of the packaged device intersect (e.g., form 90 degree corners).

The alignment plate **50** includes an upper surface **122** and a lower surface **129**. The upper surface **122**, at least in one embodiment, is adjacent the spacer structure **48** of the alignment structure **22**. The lower surface **129** is adjacent an alignment structure **53** for use in aligning the conductive element layer **30** of the adapter assembly **10**.

The alignment plate **50** further includes a body portion **112** that includes one or more fixed inner perimeter surfaces **118** that extend between the upper and lower surfaces and define an opening **116** in which the packaged device **80** is received. The one or more fixed inner perimeter surfaces **118** generally define a maximum outer perimeter of the packaged device **80** to be received in the socket cavity **15**.

As shown in FIG. **5A–5B**, where the device package **80** is positioned within the opening **116** defined by the one or more fixed inner perimeter surfaces **118**, the opening **116** is shaped to correspond to the packaged device **80**. In other words, the opening **116** is configured in this embodiment as a square opening sized to accept a packaged device **80** having the largest dimensions **300, 301** possible for the type of packaged device, e.g., micro lead frame package. As such, the opening **116** shall be referred to as the maximum packaged device opening **116** because the dimensions of the opening substantially correspond to the maximum perimeter dimensions of a package type.

The body portion **112** of the alignment plate **50** corresponds to and is positioned adjacent the end **14** of the perimeter wall member **12** (e.g., may be spaced therefrom by spacer structure **48**) at the first end region **17** of the adapter apparatus **10**. The body portion **112** further includes openings **140** that are aligned with openings **67** of the perimeter wall member **12**. The openings **140** are for allowing the fastening device **66** to be received therethrough. For example, the fastening device, e.g., threaded bolt **66**, is inserted through openings in the perimeter wall member **12**, the spacer structure **48**, the alignment plate **50**, and the alignment structure **53** for aligning the conductive element layer **30**, prior to being inserted into the opening **58** of the target board **90** for use in mounting the adapter assembly **10** to the target board **90**.

The alignment plate **50** further includes two pairs of movable elements **120** that extend from the body portion **112** of the alignment plate **50** in engaging regions **133** of the alignment plate **50**. Each movable element **120** of each pair of movable elements **120** when in a normal state (i.e., when a packaged device **80** is not positioned in the opening **116**) extends into the maximum packaged device opening **116**. The two pairs of movable elements **120** are configured in opposing relation to one another such that each pair of the two pairs of movable elements **120** movably engage two perimeter side surfaces **88** that intersect at one of the two opposing corners **321** of the packaged device **80** when the packaged device **80** is received in the socket cavity **15** adjacent the conductive element layer **30** (e.g., the pairs of movable elements **120** provide equal and opposite forces on the packaged device **80** via the perimeter side surfaces **88** thereof moving the packaged device **80** into alignment).

Alignment plate **50** also includes extended openings **127** defined therein at corners of the alignment plate **50** where no movable elements **120** are present. Such openings **127** provide space in the alignment plate **50** so as to more easily receive the packaged device **80** in the opening **116**.

The alignment plate **50**, along with one or more of the other components described herein, may be provided in any number of ways. For example, such components may be molded, machined, stamped, otherwise formed by one or more known processes. Many of such components are formed of high temperature plastic.

Each pair of movable elements **120** are configured in a v-like shape including a first and second movable element **120** extending along an element axis **141**. An intersection point of the axes **141** for a pair of movable elements **120** forms an angle **357** therebetween that is less than 90 degrees. In other words, the movable elements **120** of each pair are separated by a notch **126**; the notch **126** generally has the shape of an isosceles triangle with each movable element **120** forming a leg thereof. The apex of the triangle formed by the intersection of the movable elements of the pair is of an angle less than 90 degrees.

As shown in FIGS. **3A** and **3B**, each movable element **120** extends from the body portion **112** and terminates at an end **363** with lies in the area defined by the maximum packaged device opening **116** when the movable elements are in the normal state (i.e., a packaged device is not in the opening **116**). Each movable element **120** includes outer side surfaces **347** and inner side surfaces **349** (i.e., inner side surfaces that face the axis **13** of the adapter assembly) that extend between the lower surface **129** of the alignment plate **50** and upper surface **122** of the alignment plate. The inner side surfaces **349** facing the adapter axis **13** are adapted to engage the one or more perimeter side surfaces **88** of the packaged device **80** when the packaged device **80** is positioned in the socket cavity **15** adjacent the conductive element layer **30**. The inner and outer side surfaces **349, 347** are generally faced in opposing directions.

Further, in each engaging region **133** and adjacent the outer side surfaces **347**, openings such as slots **128** are defined. The slots **128** allow the movable elements **120** to have space for flexing outward and away from the axis **13** of the adapter assembly **10** when engaging the perimeter side surfaces **88** of the packaged device **80**.

Further, as shown in FIG. **3B**, at least in one embodiment, the edge **124** of each movable element **120** between the side surfaces **347, 349** and the upper surface **122** is beveled. As used herein, beveled refers to not only a chamfered edge at a particular angle but may also include an edge having a radius, along with any other edge modification that assists the alignment process as described herein. The beveled edge **124** assists in positioning the packaged device **80** in the opening **116** such that alignment is provided using the movable elements **120**. For example, as the packaged device **80** is positioned in the cavity **15**, an edge of the packaged device (e.g., edge between the perimeter side surfaces **88** and the lower surface **84** of the packaged device **80**) contacts the beveled edge **124** and with a slight force on the packaged device **80** the edge of the packaged device **80** slides along the beveled edge **124** urging the moveable elements **120** of each pair of movable elements **120** apart (e.g., into the slots **128** and out of the maximum packaged device opening **116**) such that the perimeter side surfaces **88** of the packaged device **80** can engage with the inner side surfaces **349** of the movable elements **120**. The movable elements **120** provide forces on the packaged device **80** inward toward the axis **13** of the adapter assembly **10** so as to desirably align the packaged device in the opening **116**.

The plurality of movable elements **120** are adapted to move from a normal state when a packaged device **80** has not been received in the socket cavity to a flex state when the packaged device **80** is positioned in the socket cavity **15** adjacent the conductive element layer **30**. A position of the inner side surfaces **349** of the plurality of movable elements **120** (e.g., at the terminating end **363** of a movable element) is at a distance further from the adapter axis **13** when the plurality of movable elements **120** are in the flex state as compared to when the plurality of movable elements **120** are in the normal state.

At least in one embodiment, the plurality of movable elements **120** have a thickness in the direction of the adapter axis **13** that is less than a thickness of the packaged device **80**. In this manner, the lower surface **42** of the floating member **40** when used to apply a force on the packaged device **80** as described herein does not contact the upper surface **122** of the movable elements **120**. As such, there is no binding of the movable elements **120** when they extend into the maximum packaged device opening **116** such that they are free to apply alignment forces on the perimeter side surfaces **88** of the packaged device **80**.

The movement of the movable elements **120** is shown further in FIGS. **5A–5B**. FIG. **5A** shows the alignment plate **50** being used to align a packaged device **80A** with substantially maximum perimeter. FIG. **5B** shows the alignment plate **50** being used to align a packaged device **80B** of the same type having a perimeter that is less than the substantially maximum perimeter of packaged device **80A**. As such, in FIG. **5B**, a gap **360** exists between the perimeter side surfaces **88** of the packaged device **80B** and one or more fixed inner perimeter surfaces **118** defining the maximum packaged device opening **116**.

Generally, in operation, a packaged device **80** is aligned in the socket cavity **15** of the adapter assembly **10** using the alignment plate **50**. A packaged device **80** is positioned in the socket cavity **15** such that the plurality of movable elements **120** are moved to the flex state (e.g., see FIG. **5A**). A position of the inner side surfaces **349** of the plurality of movable elements are at a distance further from the axis **13** when the plurality of movable elements **120** are in the flex state as compared to when the plurality of movable elements are in the normal state (e.g., see FIG. **3A**).

When positioning the packaged device **80** in the socket cavity **15**, one or more edges of the packaged device **80** engage the beveled edge **124** of one or more of the plurality of movable elements **120** forcing the movable elements **120** from the normal state to the flex state. The plurality of movable elements **120** provide opposing forces on the one or more perimeter side surfaces **88** of the packaged device **80** when the packaged device **80** is positioned in the opening **116** to hold the packaged device **80** in an aligned position in the socket cavity **15**. In other words, as the moveable elements **120** are moved into the flex state, the packaged device **80** snap fits into the opening **116**.

One skilled in the art will recognize that various configurations of movable elements in the engaging regions **133** may be used to align the packaged device **80** in the adapter assembly **10**. Such configurations need only provide for proper forces to be applied to the packaged device **80** when it is positioned in the opening **116** to align it therein. For example, the shape of the elements need not be elongated legs such as shown in FIG. **3A**, but only need to have a shape and surrounding region (e.g., space to move) that allows the elements to move from a normal to a flex state when the packaged device **80** comes into contact with the movable elements **120**. The movable elements may be formed as an integral part of the alignment plate **50** or may be elements coupled thereto (e.g., a flex element attached to the body portion surrounded by space to move from a normal state to a flex state).

As mentioned herein, at least in one embodiment, a spacer structure **48** is used in combination with the alignment plate **50** to prevent binding of the movable elements **120** by the perimeter wall member **12** of the adapter assembly **10**. For example, as can be recognized by the configuration of the movable elements **120** in FIG. **3A**, such movable elements **120** lie substantially under the perimeter wall member **12** when assembled therewith. Without a spacer structure **48**, the movable elements **120** may be in contact with the end **14** of the perimeter wall member **12** which would prevent the movable elements **120** from effectively providing the forces on the packaged device **80** used to align the packaged device **80** in the opening **116**. The spacer structure **48** prevents such binding from occurring and provides a void above the movable elements allowing them to move freely for providing alignment (e.g., the pairs of movable elements **120** provide equal and opposite forces on the packaged device **80** via the perimeter side surfaces **88** thereof).

As described herein, the spacer structure **48** may be provided as a separate spacer plate **201** such as that illustrated in FIG. **4**. Further, for example, the spacer structure may be incorporated into the body member **112** of the alignment plate. However, any spacer structure that provides for a void above the movable elements allowing them to flex freely is contemplated according to the present invention.

The spacer plate **201** illustrated in FIG. **4** includes a body member **212** that generally corresponds to the perimeter wall member **12** of the adapter assembly **10**. The thickness of the body member **212** is sufficient to provide the free space above the movable elements **120** when incorporated into the adapter assembly **10**.

The spacer plate **201** includes an upper surface **213** and a lower surface (not shown). The upper surface **213**, at least in one embodiment, is adjacent the end **14** of the perimeter wall member **12** of the adapter assembly **10**. The lower surface is adjacent the upper surface **122** of the body portion **112** of the alignment plate **50**. The body portion **212** of the spacer plate **201** includes one or more fixed inner perimeter surfaces **218** that extend between the upper and lower surfaces and define an opening **240** in which the packaged device **80** is received. The one or more fixed inner perimeter surfaces **218** are generally of the same configuration as the alignment plate **50**. However, they need only provide a larger opening **240** than the maximum outer perimeter of the packaged device **80** to be received in the socket cavity **15**.

The spacer plate **201** further includes openings **241** that are aligned with openings **67** of the perimeter wall member **12**. The openings **241** are for allowing the fastening device **66** to be received therethrough. For example, the fastening device, e.g., threaded bolt **66**, is inserted through openings in the perimeter wall member **12**, the spacer structure **48**, the alignment plate **50**, and the alignment structure **53** for aligning the conductive element layer **30**, prior to being inserted into the opening **68** of the target board **90** for use in mounting the adapter assembly **10** to the target board **90**.

The spacer plate **201** further includes extended opening portions **216** in a position that generally corresponds to the engaging regions **133** of the alignment plate **50**. Such extended opening portions **216** lie above the movable elements **120** of each pair of movable elements **120** when assembled with the alignment plate **50**. As such, a void above the moveable elements **120** is provided to allow the movable elements to freely move from the normal sate to the flex state when necessary.

Further, although not shown, the same or slightly modified configuration of the spacer plate **201** described above may be incorporated into the alignment plate **50** to accomplish a similar function. For example, the body portion **112** of the alignment plate **50** corresponding to the perimeter wall member **12** may be increased in thickness in the direction of the adapter axis **13** to a thickness greater than the thickness of the plurality of movable elements **120**. As such, when assembled, the adapter assembly **10** would have a void above the movable elements **120** to allow them to freely move from a normal sate to a flex state.

An alignment structure **53** for precise positioning of the conductive elements **33** of the conductive element layer **30** is also shown in FIG. **1**. The alignment structure **53** lies generally parallel to the adapter axis **13** and corresponds generally to the perimeter wall member **12**. In other words, the alignment structure **53** includes an inner perimeter surface **49** that defines an opening **55** in which the conductive element layer **30** (e.g., a conductive elastomer layer) is positioned. The surface **49** of the alignment structure **53** faces inward toward adapter axis **213** and contacts the conductive element layer **30** for alignment thereof.

The surface **49** that terminates the alignment structure **53** is adjacent the conductive element layer **30**, e.g., a conductive elastomer layer, and may be in one embodiment generally parallel to the adapter axis **13** to accommodate a conductive elastomer layer that has z-axis conductive elements therein (not shown). In such a manner, the lands **86** of packaged device **80** are aligned to contact pads **92** of target board **90** through a desired number of z-axis conductive elements embedded in conductive elastomer layer **30**.

The alignment structure **53** shown in FIG. **1** in adapter assembly **10** is provided to accommodate the use of a conductive elastomer layer **30** having slanted conductive elements **32** embedded therein. As shown in FIG. **1**, the surface **49** that terminates the alignment structure **53** is adjacent the conductive elastomer layer **30** and is at an angle relative to the adapter axis **13**. The angle is determined at least in part by the angle of the slanted conductive elements embedded in the conductive elastomer layer **30**. In such a manner, the contact elements **82** (e.g., lands) disposed on a surface of packaged device **80** can be aligned with contact pads **92** of target board **90** through a desired number of angled conductive elements **32** embedded in conductive elastomer **30**.

All patents and references cited herein are incorporated in their entirety as if each were incorporated separately. This invention has been described with reference to illustrative embodiments and is not meant to be construed in a limiting sense. As described previously, one skilled in the art will recognize that various other illustrative adapter assembly embodiments may be provided which utilize various combinations of the elements described herein, and/or described with reference to U.S. Pat. No. 6,394,820, which is incorporated herein by reference. Various modifications of the illustrative embodiments, as well as additional embodiments of the invention and combinations of various elements herein, will be apparent to persons skilled in the art upon reference to this description. It is therefore contemplated that the patented claims will cover any such modifications or embodiments that may fall within the scope of the present invention as defined by the accompanying claims.

What is claimed is:

1. An adapter apparatus for receiving a packaged device having a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, the adapter apparatus comprising:

a perimeter wall member comprising a length along an adapter axis between a first end region of the adapter apparatus and a second end region of the adapter apparatus;

a conductive element layer comprising a plurality of arranged conductive elements, wherein the conductive element layer is positioned at the first end region of the adapter apparatus orthogonal to the adapter axis, and further wherein the perimeter wall member and the conductive element layer define a socket cavity adapted to receive the packaged device with the plurality of contact elements thereof adjacent the conductive element layer; and

an alignment structure positioned at the first end region to align the packaged device within the socket cavity, wherein the alignment structure comprises an alignment plate positioned orthogonal to the adapter axis, wherein the alignment plate comprises at least one opening defined therein adapted to allow the contact elements of the packaged device to be in electrical contact with the arranged conductive elements of the conductive element layer, and further wherein the alignment plate comprises a plurality of movable elements configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the plurality of movable elements comprise two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is received in the socket cavity, wherein each movable element of each pair of movable elements extends along an element axis, and further wherein the element axes of each pair of movable elements lie at an angle less than 90 degrees relative to one another.

2. The adapter apparatus of claim **1**, wherein the packaged device is a packaged device having at least two opposing corners, wherein two perimeter side surfaces of the packaged device intersect at each of the at least two opposing corners, wherein the two pairs of movable elements are configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the two perimeter side surfaces that intersect at one of the two opposing corners when the packaged device is received in the socket cavity adjacent the conductive element layer.

3. The adapter apparatus of claim **1**, wherein the plurality of movable elements comprise one or more surfaces adapted to engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the plurality of movable elements are adapted to move from a normal state when a packaged device has not been received in the socket cavity to a flex state when die packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the position of the one or more surfaces of the plurality of movable elements are at a distance further from the adapter axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

4. The adapter apparatus of claim **1**, wherein the plurality of movable elements have a thickness in the direction of the adapter axis that is less than a thickness of the packaged device.

5. The adapter apparatus of claim **1**, wherein the packaged device comprises one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro bail grid array, and a micro land grid array.

6. The adapter apparatus of claim **1**, wherein one or more of the plurality of movable elements comprises a beveled edge at an upper surface thereof.

7. The adapter apparatus of claim **1**, wherein the plurality of movable elements are operable to provide opposing forces on the one or more perimeter side surfaces of the packaged device.

8. The adapter apparatus of claim **1**, wherein the adapter apparatus is coupled to an interconnect board such that the arranged conductive elements are electrically coupled to contact pads on a first side of the interconnect board, and further wherein the interconnect board comprises electrical connection elements for mounting the interconnect board relative to a target board.

9. The adapter apparatus of claim **1**, wherein the alignment plate comprises a body portion comprising one or more fixed inner perimeter surfaces defining the at least one opening, wherein the one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device to be received in the socket cavity, wherein the body portion corresponds to and is positioned adjacent an end of the perimeter wall member at the first end region of the adapter apparatus, wherein each of the plurality of movable elements extend along its respective element axis from the body portion of the alignment plate.

10. The adapter apparatus of claim **9**, wherein the alignment structure further comprises a spacer structure that is adapted to define a free space adjacent the plurality of movable elements so as to allow the plurality of movable elements to move from a normal state when the packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer.

11. The adapter apparatus of claim **10**, wherein the spacer structure comprises the body portion, wherein the body portion corresponding to the perimeter wall member has a thickness in the direction of the adapter axis that is greater than the thickness of the plurality of movable elements in the direction of the adapter axis.

12. The adapter apparatus of claim **10**, wherein the spacer structure comprises a spacer plate corresponding to the body portion of the alignment plate and positioned adjacent thereto, wherein the spacer plate when positioned adjacent the alignment plate is void of material in a space directly above the plurality of movable elements.

13. The adapter apparatus of claim **1**, wherein the conductive element layer comprises a conductive elastomer layer.

14. The adapter apparatus of claim **13**, wherein the conductive elastomer layer comprises conductive elements therein that are at an angle relative to the adapter axis, and further wherein the adapter apparatus comprises a conductive element layer alignment structure positioned at the first end region of the adapter apparatus comprising a surface facing the adapter axis that is at an angle relative to the adapter axis for use in positioning the angled conductive elements of the conductive elastomer layer.

15. The adapter apparatus of claim **1**, wherein adapter apparatus further comprises:

an actuator apparatus comprising a floating member movable in the socket cavity and an actuator element, wherein the actuator element is operable to provide a force on the floating member such that a corresponding force is distributed to the packaged device when received in the socket cavity such that the plurality of contact elements are in electrical contact with the arranged conductive elements of the conductive element layer, and

a cover member positioned at the second end region of the adapter apparatus to close the socket cavity, wherein the cover member is movable to allow the packaged device to be removed from the socket cavity.

16. The adapter apparatus of claim **15**, wherein at least one opening is defined in the cover member and the floating member to allow access to the packaged device when positioned in the socket cavity adjacent the conductive element layer.

17. An apparatus for use in an adapter configured to receive a packaged device having a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, the apparatus comprising an alignment plate, wherein the alignment plaza comprises:

a body portion comprising one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate, wherein the one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device; and

a plurality of movable elements extending from the body portion of the alignment plate, wherein the plurality of movable elements are configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening, wherein the plurality of movable elements comprise two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is received in the socket cavity, wherein each movable element of each pair of movable elements extends from the body portion along an element axis, and further wherein the element axes of each pair of movable elements lie at an angle less than 90 degrees relative to one another.

18. The apparatus of claim **17**, wherein the packaged device is a packaged device having at least two opposing corners, wherein two perimeter side surfaces of the packaged device intersect at each of the at least two opposing corners, wherein the two pairs of movable elements are configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the two perimeter side surfaces that intersect at one of the two opposing corners when the packaged device is received in the opening.

19. The apparatus of claim **17**, wherein the plurality of movable elements comprise one or more surfaces adapted to engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening, wherein the plurality of movable elements are adapted to move from a normal state when a packaged device has not been received in the opening to a flex state when the packaged device is positioned in the opening, wherein the position of the one or more surfaces of the plurality of movable elements are at a distance further from the axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

20. The apparatus of claim **17**, wherein the plurality of movable elements have a thickness in the direction of the axis that is less than a thickness of the packaged device.

21. The apparatus of claim **17**, wherein the apparatus further comprises a spacer plate corresponding to the body portion of the alignment plate and positioned adjacent thereto, wherein the spacer plate when positioned adjacent the alignment plate is void of material in a space directly above the plurality of movable elements.

22. The apparatus of claim **17**, wherein the body portion has a thickness in the direction of the adapter axis that is greater than the thickness of the plurality of movable elements in the direction of the adapter axis.

23. The apparatus of claim **17**, wherein the packaged device comprises one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro ball grid array, and a micro land grid array.

24. The apparatus of claim **17**, wherein one or more of the plurality of movable elements comprises a beveled edge at an upper surface thereof.

25. The apparatus of claim **17**, wherein the plurality of movable elements are operable to provide opposing forces on the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening.

26. A method of aligning a packaged device in an adapter apparatus, wherein the packaged device comprises a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, wherein the method comprises:

providing an adapter apparatus defining a socket cavity for receiving the packaged device, wherein the adapter apparatus comprises an alignment plate, wherein the alignment plate comprises a body portion comprising one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate, and further wherein the alignment plate comprises a plurality of movable elements extending from the body portion of the alignment plate, wherein the plurality of movable elements comprise two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is received in the socket cavity, wherein each movable element of each pair of movable elements extends along an element axis, and further wherein the element axes of each pair of movable elements lie at an angle less than 90 degrees relative to one another, wherein the plurality of movable elements are in a normal state when a packaged device has not been received in the opening; and

positioning the packaged device in the socket cavity such that the plurality of movable elements are moved to a flex state, wherein a position of one or more surfaces of the plurality of movable elements are at a distance further from the axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

27. The method of claim **26**, wherein the packaged device comprises one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro ball grid array, and a micro land grid array.

28. The method of claim **26**, wherein one or more of the plurality of movable elements comprise a beveled edge at an upper surface thereof, wherein positioning the packaged device in the socket cavity comprises engaging one or more edges of the packaged device with the beveled edge of one or more of the plurality of movable elements forcing the movable elements from the normal state to the flex state.

29. The method of claim **26**, wherein the method further comprises providing, with use of the plurality of movable elements, opposing forces on the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening to hold the packaged device in an aligned position in the socket cavity.

30. An adapter apparatus for receiving a packaged device having a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, the adapter apparatus comprising:

a perimeter wall member comprising a length along an adapter axis between a first end region of the adapter apparatus and a second end region of the adapter apparatus;

a conductive element layer comprising a plurality of arranged conductive elements, wherein the conductive element layer is positioned at the first end region of the adapter apparatus orthogonal to the adapter axis, and further wherein the perimeter wall member and the conductive element layer define a socket cavity adapted to receive the packaged device with the plurality of contact elements thereof adjacent the conductive element layer; and

an alignment structure positioned at the first end region to align the packaged device within the socker cavity, wherein the alignment structure comprises an alignment plate positioned orthogonal to the adapter axis, wherein the alignment plate comprises at least one opening defined therein adapted to allow the contact elements of the packaged device to be in electrical contact with the arranged conductive elements of the conductive element layer, wherein the alignment plate comprises a plurality of movable elements configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the alignment plate comprises a body portion comprising one or more fixed inner perimeter surfaces defining the at least one opening, wherein the one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device to be received in the socket cavity, wherein the body portion corresponds to and is positioned adjacent an end of the perimeter wall member at the first end region of the adapter apparatus, wherein the plurality of movable elements extend from the body portion of the alignment plate, and further wherein the alignment structure comprises a spacer structure that is adapted to define a free space adjacent the plurality of movable elements so as to allow the plurality of movable elements to move from a normal state when the packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer.

31. The adapter apparatus of claim **30**, wherein the plurality of movable elements comprise two sets of movable elements configured in opposing relation to one another such that each of the two sets of movable elements are adapted to movably engage at least one of the one or more perimeter side surfaces of the packaged device when the packaged device is received in the socket cavity adjacent the conductive element layer.

32. The adapter apparatus of claim **30**, wherein the packaged device is a packaged device having at least two opposing corners, wherein two perimeter side surfaces of the packaged device intersect at each of the at least two opposing corners, wherein the plurality of movable elements comprise two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the two perimeter side surfaces that intersect at one of the two opposing corners when the packaged device is received in the socket cavity adjacent the conductive element layer.

33. The adapter apparatus of claim **30**, wherein the plurality of movable elements comprise one or more surfaces adapted to engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the plurality of movable elements are adapted to move from a normal state when a packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein the position of the one or more surfaces of the plurality of movable elements are at a distance further from the adapter axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

34. The adapter apparatus of claim **30**, wherein the plurality of movable elements have a thickness in the direction of the adapter axis that is less than a thickness of the packaged device.

35. The adapter apparatus of claim **30**, wherein the spacer structure comprise the body portion, wherein the body portion corresponding to the perimeter wall member has a thickness in the direction of the adapter axis that is greater than the thickness of the plurality of movable elements in the direction of the adapter axis.

36. The adapter apparatus of claim **30**, wherein the spacer structure comprises a spacer plate corresponding to the body portion of the alignment plate and positioned adjacent thereto, wherein the spacer plate when positioned adjacent the alignment plate is void of material in a space directly above the plurality of movable elements.

37. The adapter apparatus of claim **30**, wherein the packaged device comprising one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro ball grid array, and a micro land grid array.

38. The adapter apparatus of claim **30**, wherein one or more of the plurality of movable elements comprises a beveled edge at an upper surface thereof.

39. The apparatus of claim **30**, wherein the conductive element layer comprises a conductive elastomer layer.

40. The adapter apparatus of claim **30**, wherein adapter apparatus further comprises:

an actuator apparatus comprising a floating member movable in the socket cavity and an actuator element, wherein the actuator element is operable to provide a force on the floating member such that a corresponding force is distributed to the packaged device when received in the socket cavity such that the plurality of contact elements are in electrical contact with the arranged conductive elements of the conductive element layer; and

a cover member positioned at the second end region of the adapter apparatus to close the socket cavity, wherein the cover member is movable to allow the packaged device to be removed from the socket cavity.

41. The adapter apparatus of claim **30**, wherein the adapter apparatus is coupled to an interconnect board such that the arranged conductive elements are electrically coupled to contact pads on a first side of the interconnect board, and further wherein the interconnect board comprises electrical connection elements for mounting the interconnect board relative to a target board.

42. An apparatus for use in an adapter configured to receive a packaged device having a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, the apparatus comprising an alignment plate, wherein the alignment plate comprises:

a body portion comprising one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate, wherein the one or more fixed inner perimeter surfaces define a maximum outer perimeter of the packaged device, and

a plurality of movable elements extending from the body portion of the alignment plate, wherein the plurality of movable elements are configured to movably engage the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening; and

further wherein the apparatus comprises a spacer plate corresponding to the body portion of the alignment plate and positioned adjacent thereto, wherein the spacer plate when positioned adjacent the alignment plate is void of material in a space directly above the plurality of movable elements, wherein the spacer plate is adapted to define a free space adjacent the plurality of movable elements so as to allow the plurality of movable elements to move from a normal state when the packaged device has not been received in the socket cavity to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer.

43. The apparatus of claim **42**, wherein the plurality of movable elements comprise two sets of movable elements configured in opposing relation to one another such that each of the two sets of movable elements are adapted to movably engage at least one of the one or more perimeter side surfaces of the packaged device when the packaged device is received in the opening.

44. The apparatus of claim **42**, wherein the packaged device is a packaged device having at least two opposing corners, wherein two perimeter side surfaces of the packaged device intersect at each of the at least two opposing corners, wherein the plurality of movable elements comprise two pairs of movable elements configured in opposing relation to one another such that each pair of the two pairs of movable elements movably engage the two perimeter side surfaces that intersect at one of the two opposing corners when the packaged device is received in the opening.

45. The apparatus of claim **42**, wherein the plurality of movable elements have a thickness in the direction of the axis that is less than a thickness of the packaged device.

46. The apparatus of claim **42**, wherein the body portion has a thickness in the direction of the adapter axis that is greater than the thickness of the plurality of movable elements in the direction of the adapter axis.

47. The apparatus of claim **42**, wherein the packaged device comprises one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro ball grid array, and a micro land grid array.

48. The apparatus of claim **42**, wherein one or more of the plurality of movable elements comprises a beveled edge at an upper surface thereof.

49. A method of aligning a packaged device in an adapter apparatus, wherein the packaged device comprises a plurality of contact elements disposed on a surface thereof, wherein the packaged device further comprises one or more perimeter side surfaces defining an outer perimeter of the packaged device, wherein the method comprises:

providing an adapter apparatus defining a socket cavity for receiving the packaged device, wherein the adapter apparatus comprises an alignment plate, wherein the alignment plate comprises a body portion comprising one or more fixed inner perimeter surfaces defining an opening about an axis orthogonal to the alignment plate, and further wherein the alignment plate comprises a plurality of movable elements extending from the body portion of the alignment plate, wherein the plurality of movable elements are in a normal state when a packaged device has not been received in the opening, wherein the adapter apparatus further comprises a spacer structure corresponding to the body portion of the alignment plate and positioned adjacent thereto, wherein the spacer structure when positioned adjacent the alignment plate is void of material in a space directly above the plurality of movable elements; and

positioning the packaged device in the socket cavity, wherein the spacer structure plate is adapted to define a free space adjacent the plurality of movable elements so as to allow the plurality of movable elements to move from the normal state to a flex state when the packaged device is positioned in the socket cavity adjacent the conductive element layer, wherein a position of one or more surfaces of the plurality of movable elements are at a distance further from the axis when the plurality of movable elements are in the flex state as compared to when the plurality of movable elements are in the normal state.

50. The method of claim **49**, wherein the packaged device comprises one of a micro lead frame package, a micro lead chip carrier, a quad flat no lead package, micro ball grid array, and a micro land grid array.

51. The method of claim **49**, wherein one or more of the plurality of movable elements comprise a beveled edge at an upper surface thereof, wherein positioning the packaged device in the socket cavity comprises engaging one or more edges of the packaged device with the beveled edge of one or more of the plurality of movable elements forcing the movable elements from the normal state to the flex state.

52. The method of claim **49**, wherein the method further comprises providing, with use of the plurality of movable elements, opposing forces on the one or more perimeter side surfaces of the packaged device when the packaged device is positioned in the opening to hold the packaged device in an aligned position in the socket cavity.

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