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(54) ALIGNMENT MECHANISM FOR A HIGH DENSITY ELECTRICAL CONNECTOR

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(57) **ABSTRACT**

A electrical connector suitable for aligning and connecting a high-density wire bundle to a receiving member. The wire bundle is attached to an adapter positioned within a mounting location containing electronically controlled, adjustable pushrods which are used to make the fine lateral and rotational adjustments to the adapter. A control unit detects the position of the adapter within the mounting location and makes fine adjustments to the adapter position as necessary to insure proper alignment and contact.

Figure 1A

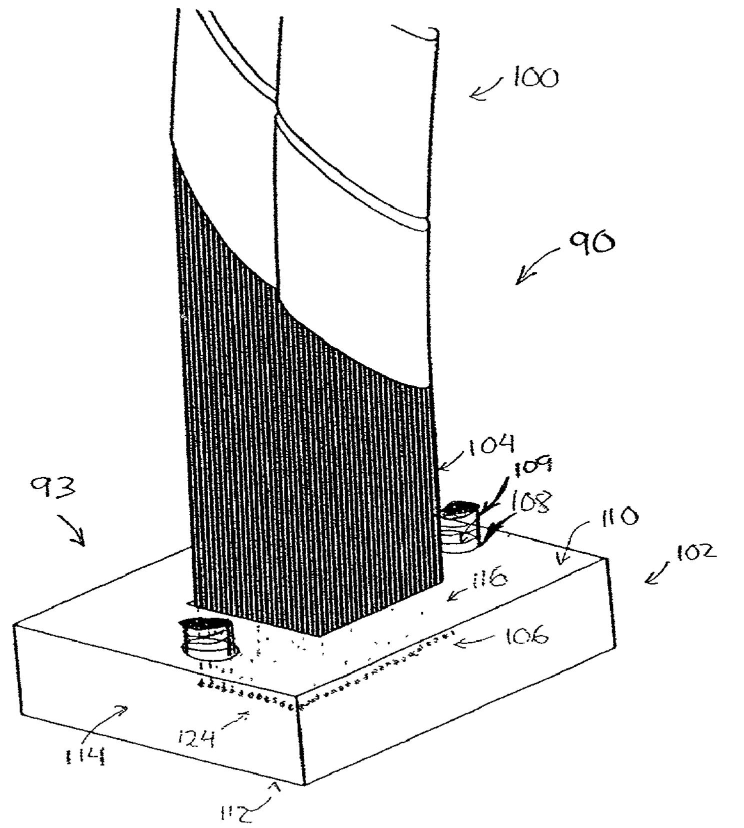
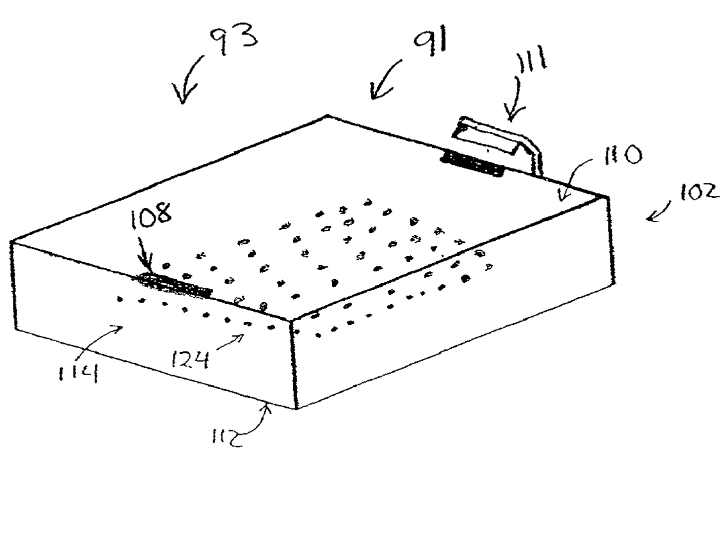


Figure 1B



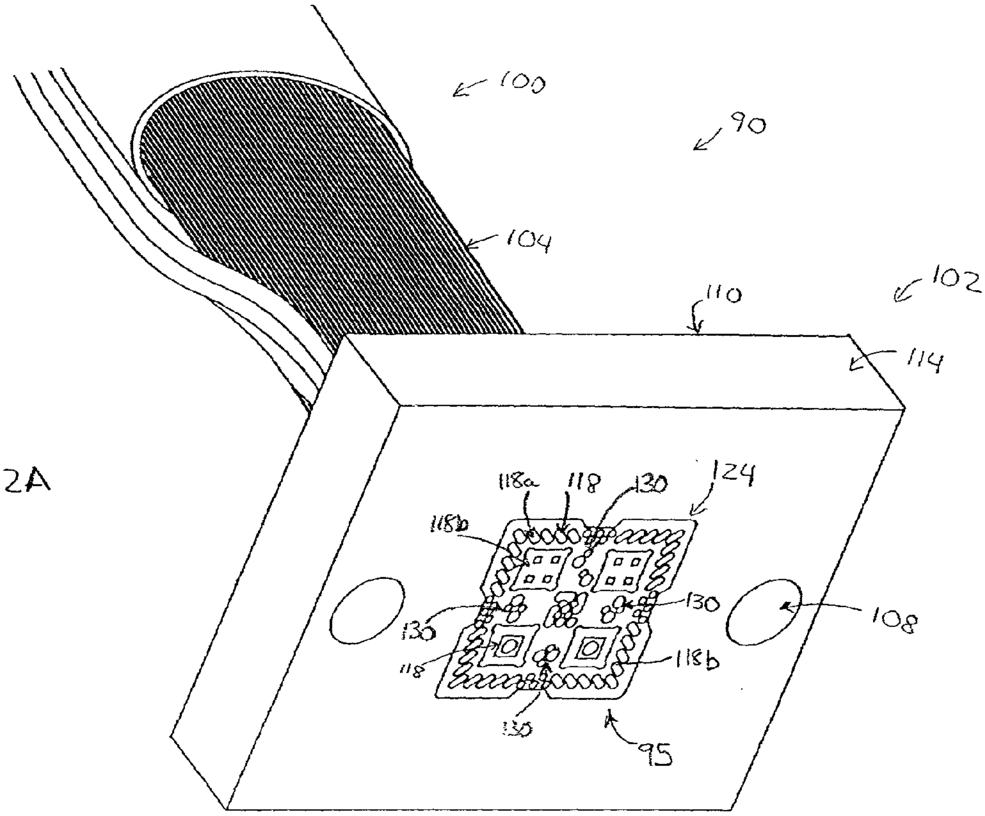


Figure 2A

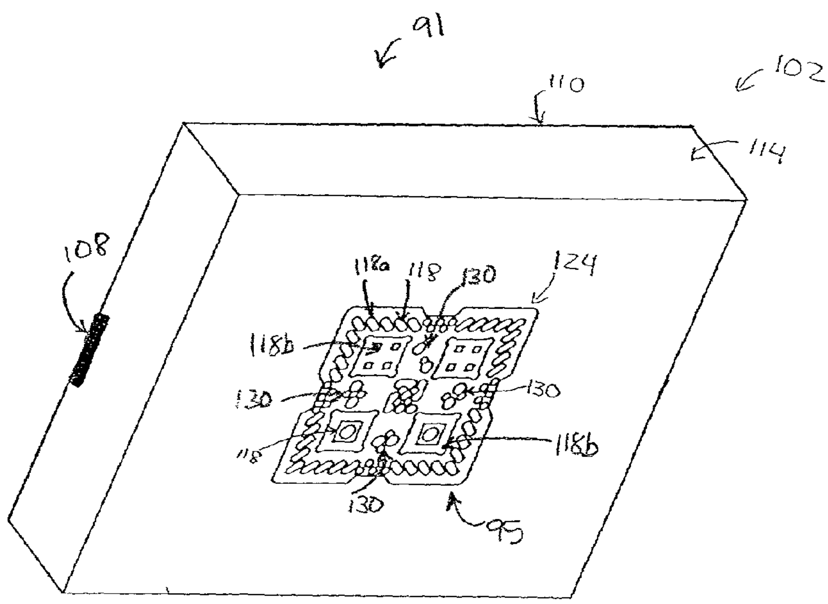


Figure 2B

FIGURE 3A

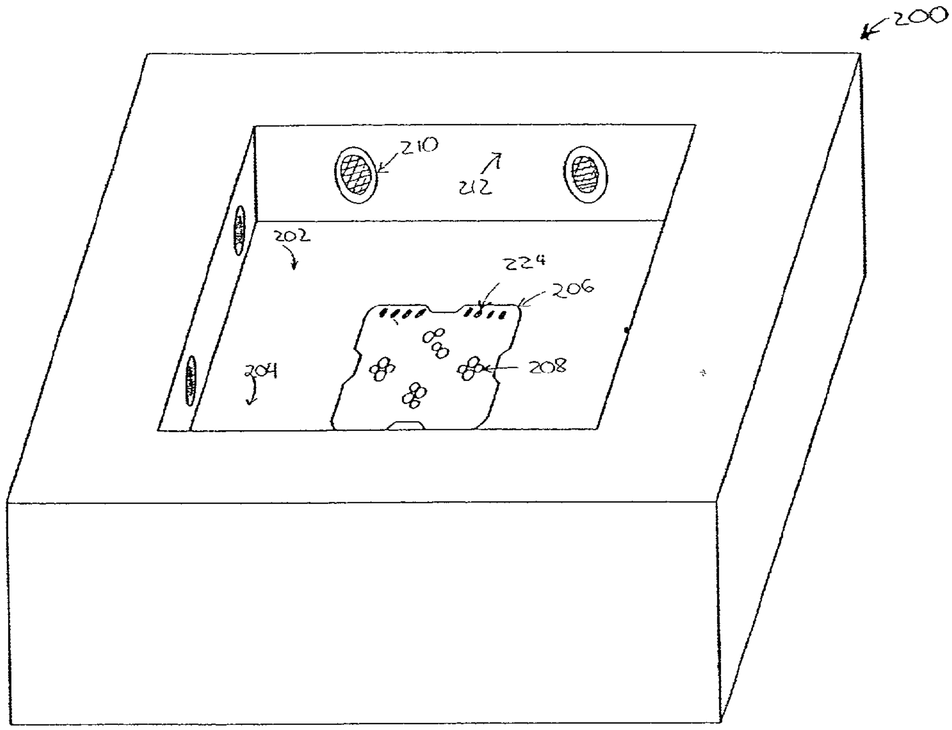
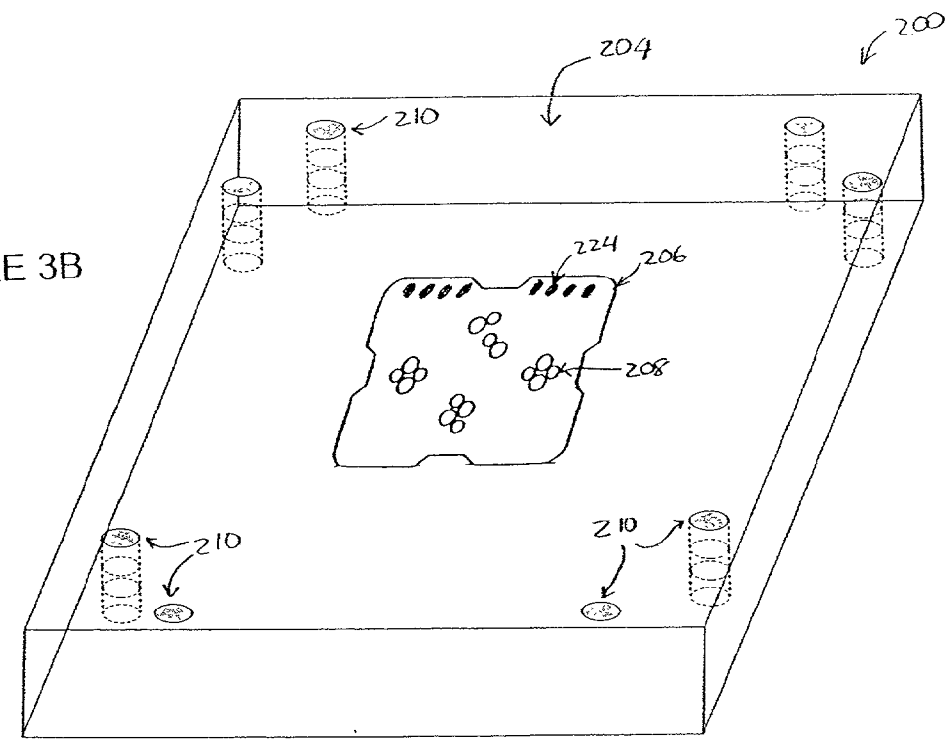


FIGURE 3B



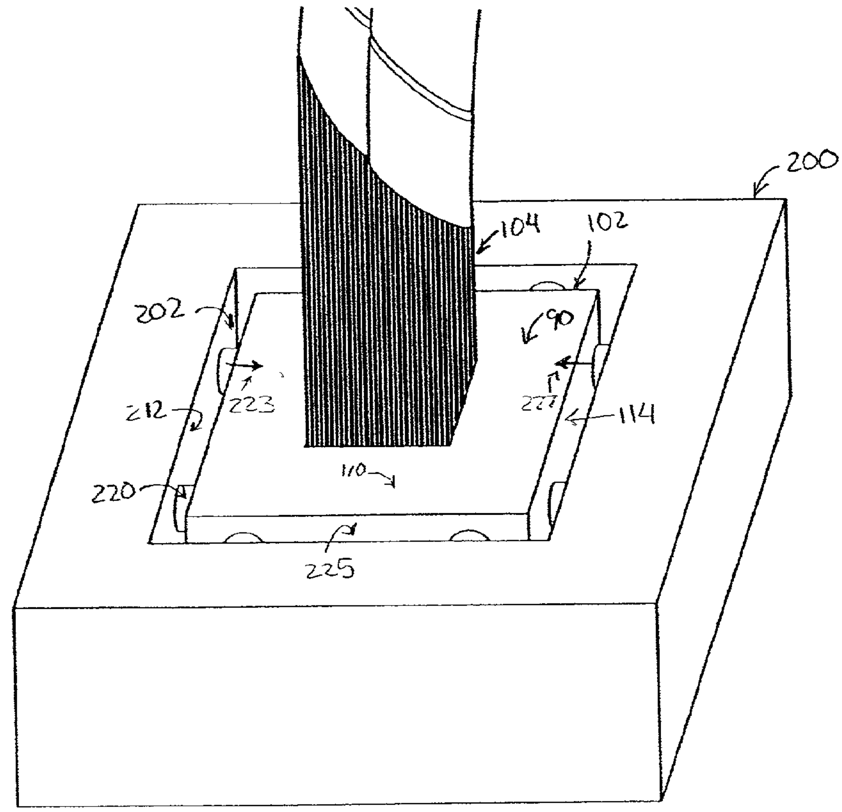


Figure 4A

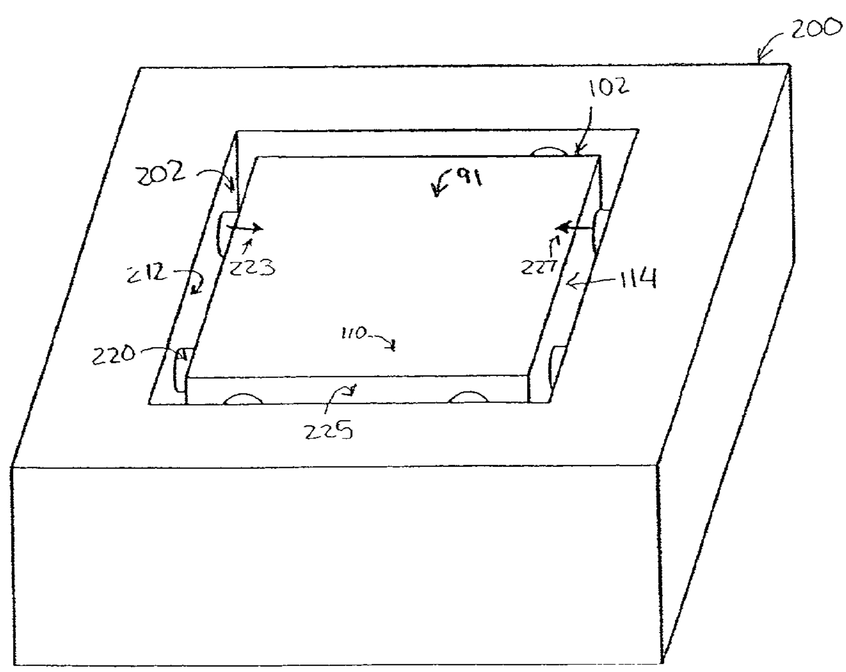


Figure 4B

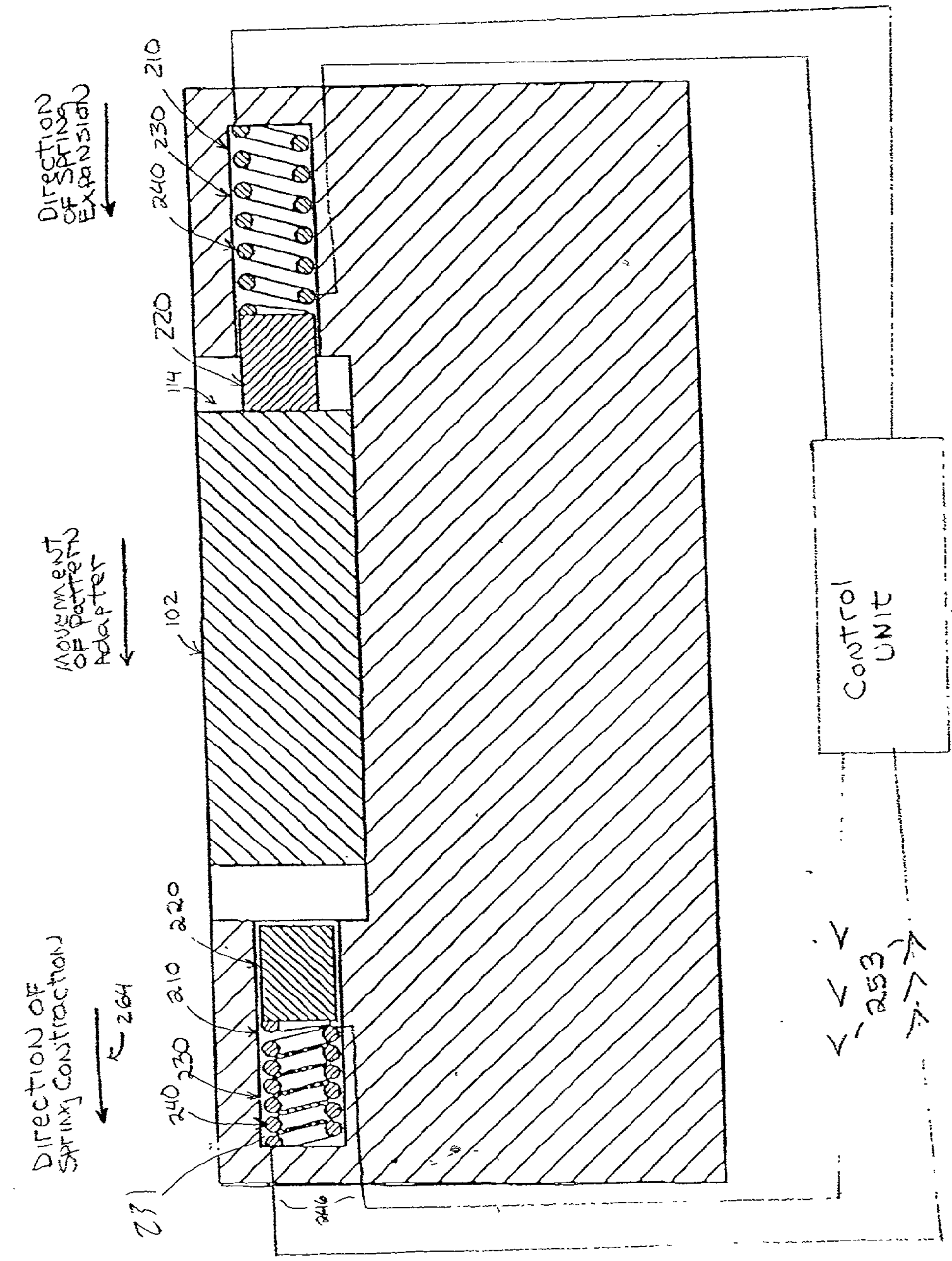

Direction of Spring Expansion
210
230
240
220
114
Movement of Pattern Adapter
102
Control Unit
249
220
210
230
240
231
246
Direction of Spring Contraction
264
253

FIG. 5

FIGURE 6A

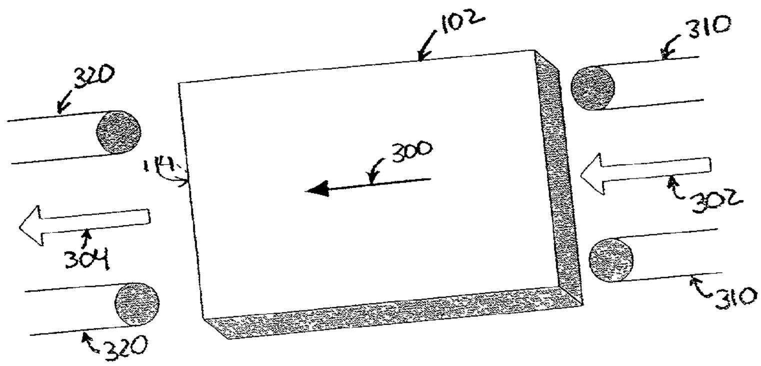
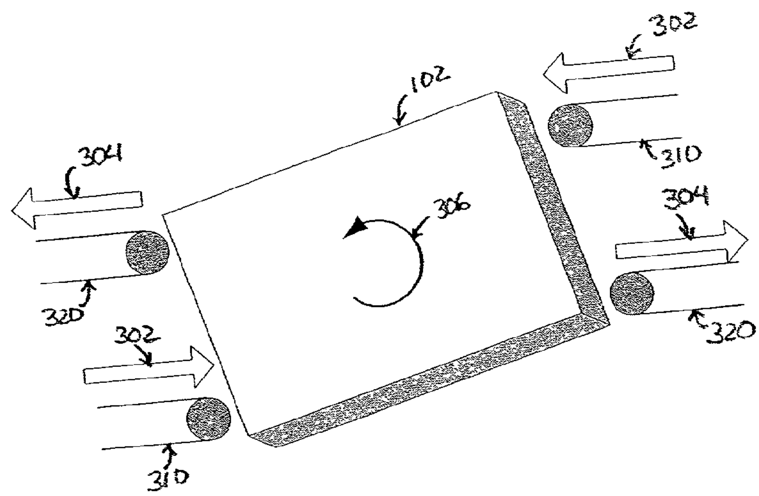


FIGURE 6B



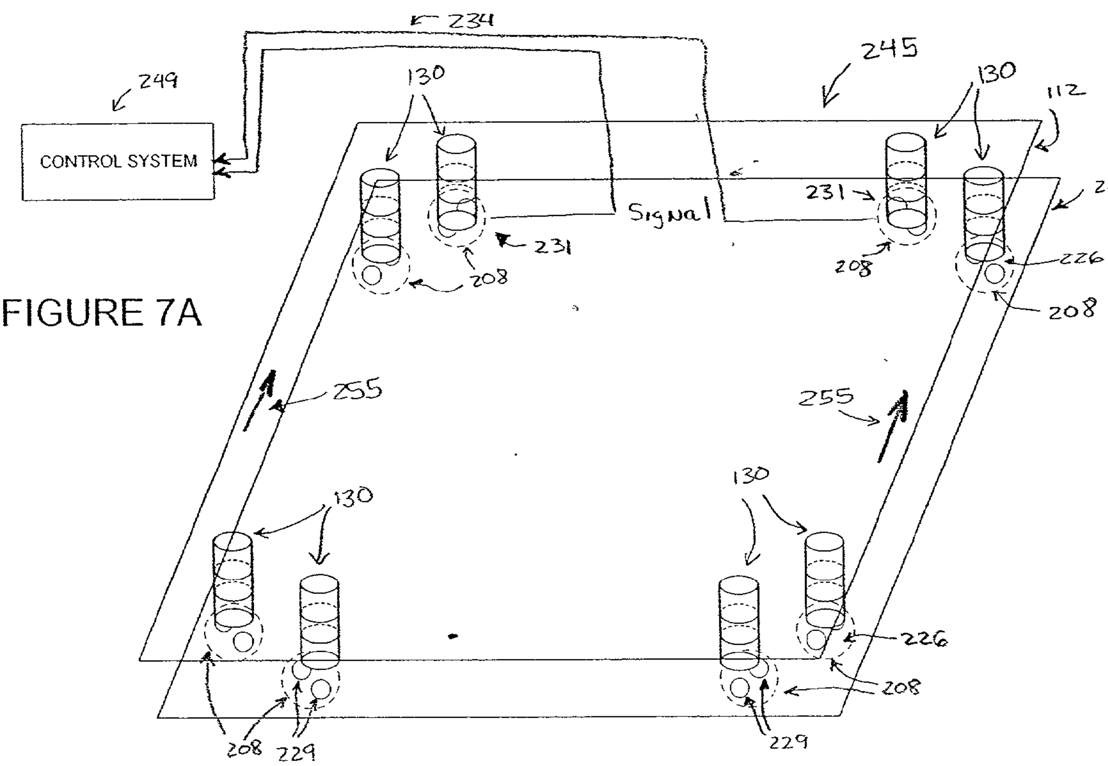


FIGURE 7A

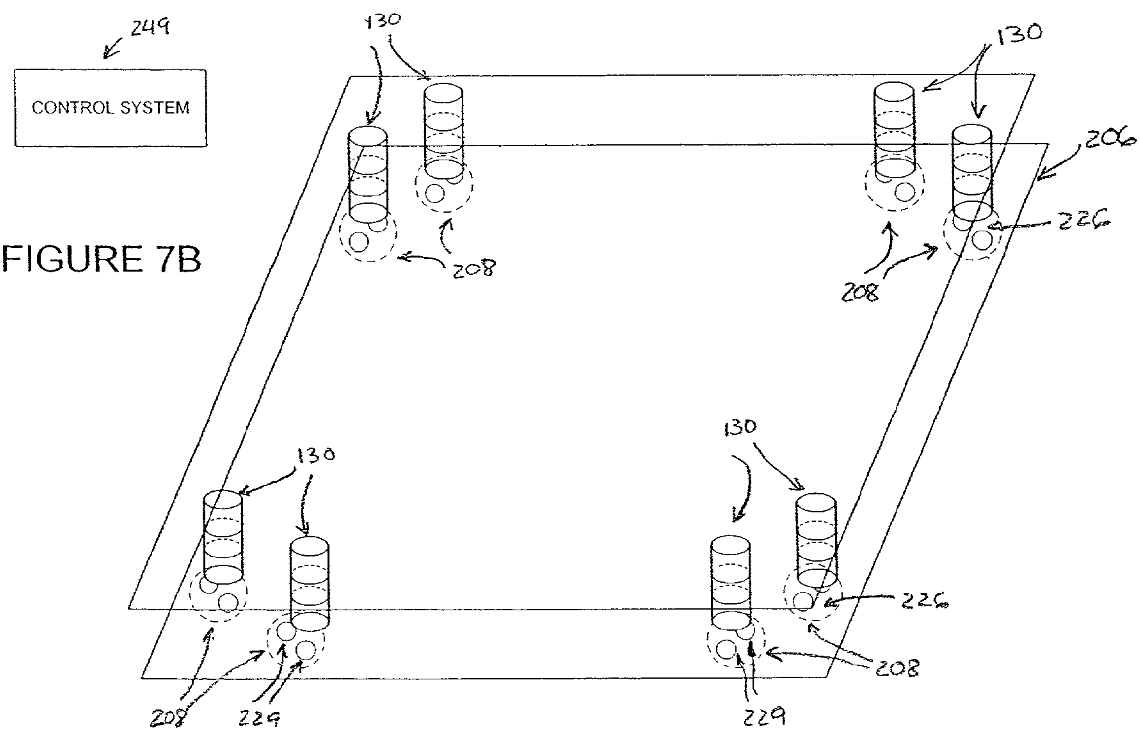


FIGURE 7B

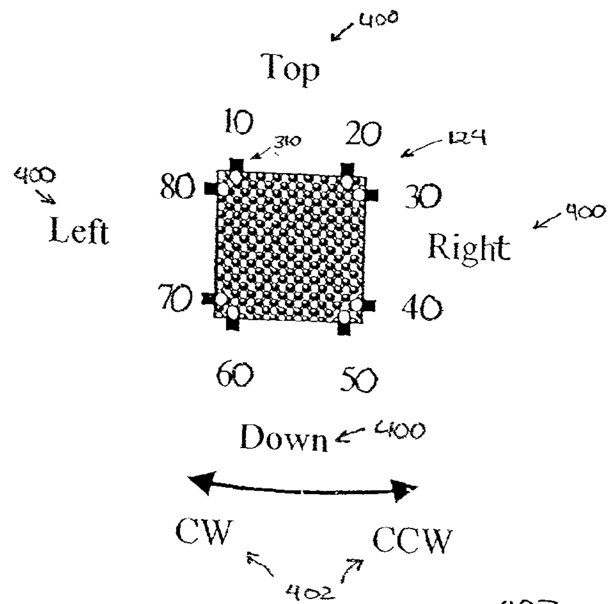


Figure 8A

Figure 8B

410 / 420 / 400 / 402

Sensor	Direction									
Position	Top	Right	Down	Left	CW	CW	CCW	CCW	Nul	Nul
State	1	2	3	4	5	6	7	8	9	10
1	1	0	0	0	1	0	0	0	0	1
2	1	0	0	0	0	0	1	0	0	1
3	0	1	0	0	0	1	0	0	0	1
4	0	1	0	0	0	0	0	1	0	1
5	0	0	1	0	1	0	0	0	0	1
6	0	0	1	0	0	0	1	0	0	1
7	0	0	0	1	0	1	0	0	0	1
8	0	0	9	1	0	0	0	1	0	1

Figure 8C

430 / 408 / 404 / 406

	TOP	Right	Down	Left	CW	CW	CCW	CC.W	NUL	NUL
Actuator										
1	1	0	0	0	1	0	0	0	0	0
2	1	0	0	0	0	0	1	0	0	0
3	0	1	0	0	0	1	0	0	0	0
4	0	1	0	0	0	0	0	1	0	0
5	0	0	1	0	1	0	0	0	0	0
6	0	0	1	0	0	0	1	0	0	0
7	0	0	0	1	0	1	0	0	0	0
8	0	0	0	1	0	0	0	1	0	0

Figure 9A

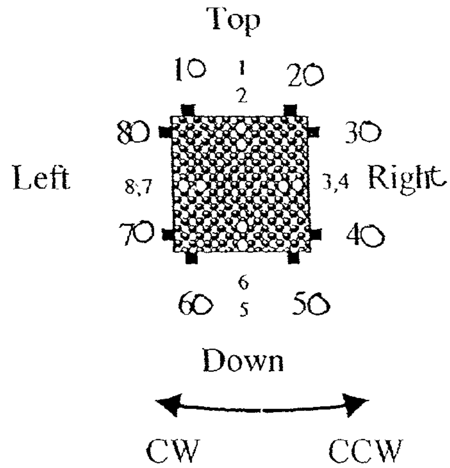


Figure 9B

450

Sensor	Direction							
Position	Top	Right	Down	Left	CW	CCW	Nul	Nul
State	1	2	3	4	5	6	9	10
1	1	x	0	x	x	x	0	1
2	x	0	x	1	0	1	0	1
3	0	x	1	x	1	0	0	1
4	x	1	x	0	x	x	0	1
5	0	x	1	x	x	x	0	1
6	x	1	x	0	0	1	0	1
7	1	x	0	x	1	0	0	1
8	x	0	x	1	x	x	0	1

460

465

Figure 9C

470

Actuator								
1	1	0	0	0	1	0	0	0
2	1	0	0	0	0	0	0	0
3	0	1	0	0	0	1	0	0
4	0	1	0	0	0	0	0	0
5	0	0	1	0	1	0	0	0
6	0	0	1	0	0	0	0	0
7	0	0	0	1	0	1	0	0
8	0	0	0	1	0	0	0	0

ALIGNMENT MECHANISM FOR A HIGH DENSITY ELECTRICAL CONNECTOR

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 60/127,638 filed Apr. 2, 1999, the disclosure of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to the field of electrical connectors and, in particular to a mechanism for aligning an electrical connector such as a coupling for a printed circuit board (PCB) and another electronic component. Specifically, this invention is an alignment mechanism having a sensing device and alignment mechanism which automatically position the electrical connector.

[0004] 2. Description of the Related Art

[0005] In the design of many electronic circuits and components, factors such as space savings and connection integrity are pivotally important. High-density electrical connectors are typically used in a number of electronic applications to conductively join components which contain numerous discrete paths of conductivity to be precisely aligned and joined while maintaining a small connector size. High-density electrical connectors are typically used in the interconnection between packaged integrated circuits (PIC) and printed circuit boards (PCB). In these devices, permanent attachment of one component to another by methods such as soldering may not be desirable due to the inflexibility of the solder connections which are prone to breakage under stress. Furthermore, permanent attachment precludes the desirable ability to disconnect the two components as needed.

[0006] Still other applications of high-density electrical connectors can be found in wiring applications where cable, ribbon, or wire bundle arrangements are used to interconnect components within electronic devices which may not be suitable for direct attachment to each other. These wiring arrangements and connectors are likewise configured to be removably attached to one or more of the components which they interconnect. In both of the abovementioned applications, the high-density electrical connector possesses a large number of discrete conductors which must be properly oriented and securely positioned so as to insure connection integrity between the components to be joined.

[0007] Conventional pin/socket or plug/receptacle arrangements which are manually positioned, oriented, and joined to provide connectivity between electronic components are inadequate for use in many high-density conductor applications. These connectors are cumbersome to work with and are prone to interconnect failure, breakage, and short-circuiting because of the close proximity of the contacts and fine control over positioning required to achieve sufficient conductivity along all contact points. Furthermore, such connectors are often not suitable for use in applications requiring repeated coupling/uncoupling of the connector and may rapidly become worn resulting in reduced connection efficacy.

[0008] In an effort to improve reliability in high-density connection arrangements, various types of connectors have been developed to use thermally responsive electrical elements which employ shape metal alloys (SMA) to secure or release the connector. Using the SMA property of heat induced phase transformation, these connectors typically operate by securing or releasing the connector based on electrical current flow through the alloy. SMA actuated clamps and fasteners for electronic devices have been described for high-density electrical applications and may provide a reversible locking mechanism. Such devices, however, are still subject to the inherent problems of component movement and connection failure should the connection interface be improperly oriented or misaligned. Furthermore, SMA connectors described in the prior art do not provide precise control over the positioning and orientation of the connector interface and suffer from alignment problems associated with manual positioning and attachment. Thus, it is difficult to achieve satisfactory connectivity in high-density connector applications using existing SMA connectors. Additionally, these devices lack a suitable method for detecting the position of the connector which, if known, can be helpful in determining what corrections should be made to the connector position to achieve proper connectivity. These problems are exacerbated in high-density electrical connection applications due to the relatively small size of the connector and the number of contacts which must be made.

[0009] From the foregoing, it can be appreciated that there is an ongoing need for a device and method for providing connectivity between electronic components using high-density connection arrangements. Accordingly, there is a need for a device capable of detecting the orientation of a component with a high-density pattern of contacts and making fine adjustments as needed to achieve connection integrity.

SUMMARY OF THE INVENTION

[0010] The aforementioned needs are satisfied by the present invention, which in one aspect comprises a high-density electrical connector. The connector comprises a first connector member with a first and second side with a plurality of electrical conductors connected to the first side. A first contact pattern comprising a first plurality of electrical contacts is further defined on the second side of the connector with the electrical contacts connected to the corresponding electrical conductors. The connector allows many electrical conductors to be oriented and positioned in a simultaneous manner using a simplified connector interface. A benefit derived from use of the connector resides in the reduced difficulty in deciphering proper wiring arrangements and conductor orientations. A further benefit of the connector stems from the ability to fashion the connector to occupy a reduced amount of space compared to the amount of space used by traditional electrical connectors.

[0011] In the illustrated embodiments, the conductors may comprise wires, cables, or extend from a packaged integrated circuit assembly to be desirably conductively joined to a mounting location or receptacle. The mounting location is further formed on a second connector member having a first surface with a corresponding second contact pattern comprising a second plurality of electrical contacts.

[0012] An alignment mechanism engages with the first connector member and the second connector member to precisely align the contact patterns using a sensor assembly and a positioning assembly. The alignment mechanism detects the state of alignment of the connector members through the use of the sensor assembly and further re-positions the connector to insure that the contact patterns of the connector members are desirably conductively joined. In one aspect, the alignment mechanism comprises electronically-actuated pushrod assemblies which generate a bias against the connector sides to align the connector.

[0013] Signals generated by the sensor assemblies can be efficiently received and interpreted by a control unit which decodes the current state of alignment of the connector and directs electrical current, corresponding to positioning responses, to the alignment mechanism. The electrical current, received by the alignment mechanism, activates the positioning assembly and alters the bias generated by the pushrod assemblies to result in the lateral and rotational movements of the connector member required to conductively align the contact patterns.

[0014] The connector is beneficially used to align high-density contact patterns in an automated manner with an increased degree of precision. The method for precisely aligning the contacts of the contact patterns is initiated by first grossly aligning the contact patterns by positioning the first connector member in proximity to the second connector member. The connector then electrically senses whether the first and second connector members are precisely aligned and electrically induces movement between the connector members in response to the electrical sensing of whether the connector members are aligned.

[0015] These and other advantages and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1A** is a perspective view of a high-density cable and position adapter according to the invention;

[0017] **FIG. 1B** is a perspective view of a packaged integrated circuit adapter according to the invention;

[0018] **FIG. 2A** is a perspective view of the high-density cable and pattern adapter illustrating the second surface and a first contact pattern of the pattern adapter;

[0019] **FIG. 2B** is a perspective view of the packaged integrated circuit adapter illustrating the second surface and a first contact pattern of the pattern adapter;

[0020] **FIG. 3A** is a perspective view of one embodiment of the mounting location having pushrod assemblies located along recess sidewalls;

[0021] **FIG. 3B** is a perspective view of another embodiment of the mounting location having pushrod assemblies co-planarly located with a second contact pattern;

[0022] **FIG. 4A** is a perspective view of the high-density cable and pattern adapter showing the operation of the pushrod assemblies;

[0023] **FIG. 4B** is a perspective view of the packaged integrated circuit adapter showing the operation of the pushrod assemblies;

[0024] **FIG. 5** is a cutaway view of the high-density cable and pattern adapter showing the operation of the pushrod assemblies;

[0025] **FIGS. 6A and 6B** are illustrate of the moveable positioning of the pattern adapter in lateral and rotational directions by the pushrod assemblies;

[0026] **FIG. 7A** illustrates one embodiment of the present invention for correcting a misaligned contact pattern and sensors;

[0027] **FIG. 7B** illustrates one embodiment of the present invention showing the properly aligned contact pattern and sensors;

[0028] **FIG. 8A** illustrates one embodiment of the present invention showing a pattern of sensing contacts on the pattern adapter;

[0029] **FIGS. 8B and 8C** illustrate the state tables used by the control unit to decode the position of the pattern adapter and issue re-positioning commands based on the pattern shown in **FIG. 8A**;

[0030] **FIG. 9A** illustrate another embodiment of the present invention showing a pattern of sensing contacts on the pattern adapter; and

[0031] **FIGS. 9B and 9C** illustrate the state tables used by the control unit to decode the position of the pattern adapter and issue re-positioning commands based on the pattern shown in **FIG. 9A**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0032] Reference will now be made to the drawings wherein like numerals refer to like parts throughout. **FIG. 1A** illustrates a perspective view of a high-density electrical connector **90**, comprising a wiring array or conductor cable **100**, attached to a first connector member **93**. In the illustrated embodiment, the first connector member **93** comprises a pattern adapter **102** which secures a plurality of wires **104** (comprising the high-density wiring array or cable **100**) wherein all of the wires **104** are aligned in a simultaneous manner by movement of the pattern adapter **102** through various spatial positions and orientations. The wires **104** of the conductor cable **100** may further comprise multiple types and sizes (gauges) of wire which, by way of example, may include; coaxial wire, shielded wire, unshielded wire, solid wire, stranded wire, insulated wire, uninsulated wire, and optical fiber. In one aspect, the wire ends **106** are affixed to the pattern adapter **102** in a conductively isolated manner so as to allow discrete signals or currents to be conducted through the wires **104** and pattern adapter **102**.

[0033] In one aspect, the pattern adapter **102** further comprises a substantially rectangular structure having a first **110** and second **112** surface and side surfaces **114**. Additionally, in the illustrated embodiment, the pattern adapter **102** contains a plurality of centrally disposed embedded channels **116** permitting the passage of the wires **104** through the pattern adapter **102**. Each channel **116** extends from the first surface **110** in a throughgoing path to the second surface **112** of the pattern adapter **102**. The material from which the pattern adapter **102** is constructed allows closely arranged channels **116** to be formed to accommodate the tightly packed arrangement of wires **104** of the conductor cable **100**. A number of materials are suitable for construction of the pattern adapter **102** and may include, for example: plastic, nylon, epoxy, and metal, among other materials. In one aspect, the pattern adapter surfaces **110**, **112** are further dimensioned to contain an area approximately equivalent to the cross sectional area of wire array or conductor cable **100** to which the pattern adapter **102** is attached. Additionally, the pattern adapter **102** desirably accommodates the conductive joining of a wire or cable density between approximately **100** wires or cables per cm^2 and **1600** wires or cables per cm^2.

[**0034**] In one aspect, the channels **116** of the pattern adapter **102** comprise openings through which individual wires **104** may pass. When passed through the channel **116**, each wire **104** may be further secured in position by adhesive bonding, solder or welding forming a first plurality of electrical contacts **118** (**FIG. 2A**) present on the second surface **112** of the pattern adapter **102**. In another aspect, the channels **116** of the pattern adapter **102** may comprise conductive regions joining the first surface **110** and second surface **112** and wherein the first plurality of contacts **118** are formed along the second surface **112** of the pattern adapter **102** and further conductively joined to the first surface **110** through the channels **116**. In this embodiment, each wire **104** is preferably secured to the first surface **110** of the pattern adapter **102** and further secured to the conductive regions comprising channels **116** by suitable means such as adhesive bonding, solder or welding contacts. Thus, a path of conductivity is made to extend from the wire end **106** secured to the conductive channel **116** on the first surface **110** of the pattern adapter **102** , through the conductive channel **116** of the pattern adapter **102**, to a point where the conductive channel **116** is joined with the electrical contacts **118** which form a first contact pattern **124** present on the second surface **112** of the pattern adapter **102**.

[**0035**] The pattern adapter **102** may further comprise mechanisms for fixedly attaching the pattern adapter **102** on a receiving surface which desirably possesses a second pattern of receiving contacts corresponding to those present on the second surface **112** of the pattern adapter **102**. When the pattern adapter **102** is properly aligned, the mounting mechanisms are secured so as to retain the pattern adapter **102**, and the first contact pattern **124** therein, in a desirable orientation, conductively joining the wires **104** of the high-density electrical connector **100** to a second pattern of contacts of the receiving surface as will be shown in subsequent illustrations. The mounting mechanism for securing the pattern adapter **102** may further include openings or recesses **108** that, for example, may receive attachment devices **109** comprising screws, rods, tabs, latches, epoxy structures or other mounting structures designed to secure the pattern adapter **102** to the mounting location. In another aspect, the pattern adapter **102** may desirably remain unsecured so as to allow the pattern adapter to be continuously aligned, providing a "live" and active positioning method.

[**0036**] In the illustrated embodiment, a rectangularly shaped pattern adapter **102** is shown, however, the pattern adapter **102** can be readily adapted to other shapes and sizes to accommodate additional wiring/cable arrangements and attachment mechanisms which therefore represent additional embodiments and applications as should be appreciated by those of skill in the art.

[**0037**] An additional embodiment of the first connector member **93** is shown in **FIG. 1B**. The first connector member **93** forms a pattern adapter **102** from a packaged integrated circuit (PIC) housing, microchip, or other self-contained electronic device. The packaged integrated circuit adapter **91**, comprises similar structural features as the high-density electrical connector **90** (**FIG. 1A**). In one aspect, the pattern adapter **102** shown in **FIG. 1B** has a first surface **110** and second surface **112** with side surfaces **114**. Additionally, a first contact pattern **124** is formed along the second surface **112** to allow the electronic components of the PIC to be conductively joined to other components in a manner that will be described in greater detail hereinbelow. As shown in the illustrated embodiment, recesses or openings **108** may be present along the adapter sides **114** and are used to secure the adapter **102** following alignment using a suitable mounting method **111** such as, for example, latches, screws, pins, or epoxy structures.

[**0038**] A perspective view of the pattern adapter **102** further detailing the second surface **112** is illustrated in **FIGS. 2A**. A centrally disposed first contact pattern **124** is formed from numerous/discrete connections to individual wires **104** as previously illustrated. The first contact pattern **124** comprises a plurality of conductive surfaces or contacts **118**, which in one embodiment comprise solder platin or welding points, that are received by a plurality of corresponding receiving contacts as will be shown in detail in later Figures. The illustrated first contact pattern **124** may further comprise large and small contacts **118***a*, **118***b* corresponding to the different sizes and types of wiring **104**. It should be appreciated by those of skill in the art that the illustrated first contact pattern **124** is but one of many possible embodiments and, as such, the first contact pattern **124** can be modified to accommodate any high-density cable array arrangement or wiring scheme without detracting from the spirit of the invention. Furthermore, additional embodiments of the present invention may include other devices or components such as PIC adapters comprising a similar first pattern of contacts **124** to be desirably aligned with a second surface and corresponding contact pattern as shown in **FIG. 2B**.

[**0039**] In one aspect, the dimensions of the contact pattern and individual contacts are desirably formed in a high-density arrangement with a density of approximately 100 contacts per cm^2 and 1600 cm^2. It will be appreciated by those of skill in the art, however, that the pattern of contacts **124** can accommodate higher or lower contact densities and, as such, are considered to be additional embodiments of the present invention.

[**0040**] In both of the abovementioned pattern adapter embodiments, illustrated in **FIGS. 2A, 2B**, a sensor assembly **95** comprising a plurality of sensing contacts **130** are further arranged about the second surface **112** of the pattern adapter **102**. The sensing contacts **130** comprise conductive surfaces which are disposed within the first contact pattern **124** and are used by the sensor assembly **95** to determine the state of alignment of the pattern adapter **102** in a manner that will be described in greater detail hereinbelow. The size, number, and placement of the sensing contacts **130** on the second surface **112** of the pattern adapter **102** desirably does not occupy a large area increasing the available space for the high-density wiring contacts **118**. The arrangement of sensing contacts **130** further allows for detection of the orientation and position of the pattern adapter **102** when placed in an appropriate mounting location by forming a "bridge" and closing a sensor circuit when the pattern adapter is mounted in a manner that will be described in greater detail in subsequent figures.

[0041] A second connector member comprising a mounting location or receptacle **200**, designed to receive and finely adjust the position of the pattern adapter **102**, is illustrated in **FIG. 3A**. In the illustrated embodiment, the receptacle **200** comprises a solid member, substantially rectangular in shape, with a rectangular recess **202** centrally disposed within the receptacle **200**. The recess **202** is configured to be sized and shaped to enclose the second surface **112** and sides **114** of the pattern adapter **102** (**FIG. 2**). Proper positioning of the pattern adapter **102** commences with the manual placement of the pattern adapter **102** into the recess **202** with the second surface **112** of the pattern adapter **102** resting on a first surface **204** of the receptacle **200**. The area of the recess **202**, defined in part by recess sidewalls **212**, is further configured to have a small amount of space residing between the recess sidewalls **212** and the pattern adapter sides **114** when the pattern adapter **102** is positioned on the receptacle **200**. Furthermore, it will be appreciated by those of skill in the art that the aforementioned recess **202** which houses the pattern adapter **102** may be fashioned using a shallow recess or indentation on the receptacle **200** to partially enclose the second surface **112** and adapter sides **114**.

[0042] The space residing between the recess sidewalls **212** and the pattern adapter sides **114** is the result of manufacturing tolerances and permits the pattern adaptor **102** to be positioned within the receptacle **200** in a non-friction manner. Positioning the pattern adaptor **102** within the recess **200** results in the contacts **118** on the adaptor **102** being grossly aligned with a corresponding second plurality of contacts **224** on the first surface **204** of the receptacle **200**. However, as the density of the contacts on the adaptor **102** and on the first surface **204** of the receptacle **200** increase, the spacing between the side walls **114** of the adaptor **102** and the side walls **212** of the receptacle **200** can result in misalignment of the contacts **118**, **224** even though the adaptor **102** is correctly positioned within the receptacle **200**. The alignment mechanism of the illustrated embodiment is, however, specifically adapted to achieve proper alignment of the contacts **118**, **224** following positioning of the adaptor **102** in the receptacle **200** in the manner that will be described in greater detail hereinbelow.

[0043] The receptacle **200** additionally contains a plurality of pushrod assemblies **210** positioned about the recess sidewalls **212** and provides a method to moveably position the pattern adapter **102** within the recess **202**. In the illustrated embodiment, the pushrod assemblies **210** are centrally disposed within the recess sidewalls **212** with two pushrod assemblies **210** present on each sidewall.

[0044] The first surface **204** of the receptacle **200**, upon which the pattern adapter **102** rests, additionally forms a second contact pattern **206** comprising a second plurality of electrical contacts **224**. The second contact pattern **206** and second electrical contacts **224** are formed to have substantially the same shape and number of contacts as the first contact pattern **124** present on the second surface **112** of pattern adapter **102**. The pattern adapter **102** is properly aligned within the recess **202** of receptacle **200** when the first contact pattern **124** and second contact pattern **206** are in direct and continuous contact and wherein each contact of both the pattern adapter **102** and receptacle **200** are aligned with the corresponding contact of the opposing surface. In one aspect, proper alignment in the aforementioned manner desirably creates discrete paths of conductivity which can be used to join the individual wires **104** of the high-density cable **90** with other electrical components or devices connected to the receptacle **200**.

[0045] The second contact pattern **206** additionally comprises a plurality of alignment sensors or probes **208** used to detect the position and orientation of the pattern adapter **102** when inserted into the receptacle **200**. In the illustrated embodiment, alignment sensors **208** are embedded within the second contact pattern **206** in areas unoccupied by the second plurality of electrical contacts **224**. The alignment sensors **208** provide signals to direct the activity of the pushrod assemblies **210** to reposition the pattern adapter **102**, as needed, and align the first contact pattern **124** and the second contact pattern **206** in a manner that will be discussed in subsequent illustrations.

[0046] Another embodiment of the second connector member comprising a mounting location or receptacle **200** is shown in **FIG. 3B**. In this embodiment, the receptacle **200** comprises a structure wherein the second contact pattern **206** and pushrod assemblies **210** are co-located along a substantially planar surface comprising the first surface **204** of the receptacle **200**. The pattern adapter **102** (**FIG. 2**) is further positioned with its second surface **112** resting on the first surface **204** of the receptacle **200**. As with the previously illustrated receptacle **200** (**FIG. 3A**), a recessed area may optionally be present in the receptacle **200**, into which the pattern adapter **102** is placed.

[0047] In both of the above-illustrated embodiments shown in **FIGS. 3A, 3B** the pushrod assemblies **210** located within the mounting location or receptacle **200** moveably position the pattern adapter **102** to desirably achieve an aligned state where the first contact pattern **124** of the pattern adapter **102** is conductively joined and aligned with the second contact pattern **206** of the receptacle in a manner that will be described in greater detail in subsequent Figures and discussion.

[0048] **FIG. 4A, 4B** illustrate the placement of the high-density electrical connector **90** and packaged integrated circuit adapter **91** respectively within the receptacle **200**. The following discussion is directed towards both **FIG. 4A** and **FIG. 4B** wherein like numerals refer to like parts throughout.

[0049] As previously described, the pattern adapter **102** (corresponding to either the pattern adapter **102** of the high-density electrical connector **90** or the packaged integrated circuit connector **91**) is desirably placed within the recess **202** with an open area **225** surrounding the adapter **102** to allow for adjustments in its position and orientation. When inserted into the receptacle **200**, the pattern adapter **102** is engaged by each pushrod **220** which exert a bias on the adapter **102**. When the adapter **102** is in a resting position, the bias **223** exerted by each pushrod **220** against the adapter sides **114** is in a state of equilibrium.

[0050] In one aspect, during positioning and alignment of the adapter **102**, pushrods **220** are selectively retracted into or extended from the recess sidewalls **212**. Using selectively controlled pushrod movements, the bias on the adapter sides **114** is altered to reposition the adapter **102** within the receptacle **200** using lateral and rotational movements. In the illustrated embodiment, each pushrod **220** is independently controllable and extends to engage the adapter sides

114, positioning the adapter **102** so as to insure the first contact pattern **124** of the adapter **102** remains properly aligned with the second contact pattern **206** of the receptacle **200**.

[0051] **FIG. 5** further illustrates a cross-sectional view of the mechanism for aligning the pattern adapter **102** (corresponding to either the pattern adapter **102** of the high-density electrical connector **90** or the packaged integrated circuit connector **91**) using pushrod assemblies **210**. Each pushrod assembly **210** comprises a pushrod housing **230** that defines a cavity **231** which contains the pushrod **220** and further contains a shaped metal alloy (SMA) spring **240**. In the illustrated embodiment, the pushrod **220** is substantially cylindrical in shape and is desirably formed from a durable material such as plastic, metal, ceramic, or carbon fiber which is resistant to deformation. The spring **240** is desirably positioned behind the pushrod **220** and wholly contained within the pushrod housing **210**. In one aspect, the spring **240** comprises a shaped metal alloy (SMA) coiled wire spring designed to exert an electrically controllable bias on the rear portion of the pushrod **220** as will be discussed in greater detail hereinbelow.

[0052] In one aspect, spring leads **246**, comprising wires or conductive traces, are attached to the spring **240** and extend through the receptacle **200** where they are further connected to a control unit **249**. The shape metal alloy forming the spring **240** is responsive to current passed through the spring **240**. In one aspect, the control unit **249** selectively directs the flow of current **253** through the spring leads **246** to the spring **240** altering its physical state. When sufficient electrical current **253** is passed through the spring **240**, the internal resistance of the shaped metal alloy results in the heating of the spring **240**. The spring **240** is desirably heated in this manner to produce a controllable contraction **264** of the spring **240** as the alloy composition changes crystalline state from a low temperature martensite form to a high temperature austenite form as is known in the art of thermally responsive metal composition and manufacture. The temperature-dependent change in crystalline state of the spring **240** results in contraction of the spring **240** and reduces the bias exerted by the spring **240** along the bottom of the pushrod **220**. The reduced spring bias further reduces the bias **223** (**FIGS. 4A, 4B**) exerted by the pushrod **220** on the adapter side **114** and results in a shift in position of the pattern adapter **102** as the bias of other pushrods **220** against other adapter sides **114** exceeds the bias of the contracted spring **240** and pushrod **220**. Thus, with each pushrod contraction, a new state of equilibrium between the pushrods **220** and the adapter sides **114** is attained and results in the controllable positioning of the pattern adapter **102** within the receptacle **200**.

[0053] In one aspect, the pattern adapter **102** is dimensioned to have sides of approximately 1 cm to 10 cm in length. Additionally the magnitude of the force or bias generated by the springs **240** which is exerted and the pushrod **220** and further exerted on the adapter side **114** is in the range of 10 Newtons and 140 Newtons.

[0054] In one aspect, coordination of the forces exerted by various pushrod combinations desirably directs the movement and orientation of the pattern adapter **102** with a fine level of precision. **FIGS. 6A, B** illustrate exemplary pushrod engagement combinations which result in different repositionings of the pattern adapter **102**. As shown in **FIG. 6**A, lateral movement **300** is achieved by directing current through springs **240** of two pushrod assemblies **210** present along one side **114** of the adapter **102**. The resulting retraction **304** of the pushrods **320** reduces the bias on the adapter side **114** and is accompanied by a concomitant repositioning of the adapter **102** resulting from the bias directed by pushrods **310** present along the opposing side of the adapter **102**, which extend **302** and reposition the adapter **102** in the lateral direction **300** as shown.

[0055] Rotational movements of the pattern adapter **102** are likewise achieved by engaging other pushrod **220** combinations. As shown in **FIG. 6**B, retraction **304** of pushrods **320** positioned along opposite sides **114** of the adapter **102** results in a counterclockwise repositioning of the adapter **102**. The rotational movement is achieved through the coordinated bias exerted by extension **302** of the selected pushrods **310** following the retraction **304** of other selected pushrods **320**.

[0056] While the previous examples demonstrate two possible methods by which the adapter position is altered, it will be appreciated by those of skill in the art that through the use of selective pushrod engagement, other positional variations can be achieved using other combinations of pushrod motion to achieve desirable results in moving the pattern adapter **102** along other vectors. In one aspect, the electrically directed retraction of selected pushrods may be replaced with an electrically directed extension of selected pushrods. In this embodiment, the spring material is selected to expand following current passage through the spring and may be alternatively used to exert controllable bias against the adapter sides to result in the repositioning of the adapter **102** as needed.

[0057] Using the aforementioned methods of electrically induced spring contraction/expansion, the plurality of pushrods **220** present along the adapter sides **114** are directed to exert positioning bias on the high-density electrical connector **90** which may be repositioned within the recess **202** of the receptacle **200** as necessary. Thus, proper contact between the second surface of the adapter **112** and the first surface **204** of the receptacle **200** is maintained in a finely controlled manner with superior precision over existing methods of alignment.

[0058] **FIGS. 7A, B** further illustrate the method by which the pattern adapter **102** position is detected and altered to align the first contact pattern **124** of the pattern adapter **102** with the second contact pattern **206** of the receptacle **200**. In the illustrated embodiment, the second contact pattern **206** is shown with a plurality of alignment sensors or probes **208** located substantially adjacent to each corner of the second contact pattern **206**. Each sensor **208** comprises a region **226** wherein a conductively isolated lead pair **229** is positioned. In one aspect, the lead pair **229** is connected to the control unit **249** which further detects current flow through the lead pair **229** when conductively joined. The exposed portion of each lead pair **229** comprises an electrically-conductive material which is present on the surface of the second contact pattern **206**.

[0059] The sensing contacts **130** on the second surface **112** of the pattern adapter **102** comprise conductive surfaces formed to be of substantially the same size as the alignment sensors **208**. The sensing contacts **130** are further positioned about the alignment sensors **208** so as to conductively join the lead pair **229** of the alignment sensors **208** when the pattern adapter **102** is misaligned. In one aspect, conductive joining of the lead pair **229** issues a signal to the control unit **249** in a manner that will be discussed in greater detail in subsequent Figures and discussion.

[0060] As shown in **FIG.** 7A, an exemplary misaligned pattern adapter **245** is positioned over the second contact pattern **206** of the receptacle **200**. In the illustrated embodiment, the misaligned pattern adapter **245** results in the positioning of sensing contacts **130** over the region of the alignment sensor **208** and further conductively joins the lead pair **229** of two alignment sensors **231**. While in this position, a signal **234** is issued to the control unit **249** corresponding to each alignment sensor **208** which is triggered by conductive joining of the lead pair **229** by the sensing contact **130**. In one aspect, the control unit **249** responds to the triggering of an alignment sensor **208** by engaging selective pushrods **220** (**FIG.** 5) to reposition the adapter **102** in the alignment direction **255** indicated until the signal **234** received from the alignment sensor **208** has ceased.

[0061] **FIG. 7B** illustrates a properly aligned first contact pattern **124** and second contact pattern **206**. In the illustrated embodiment, selective pushrod engagement results in the repositioning of the pattern adapter **102** wherein each sensing contact **130** rests in a position where the lead pair **229** of the alignment sensor **208** is not conductively joined by the sensing contact **130**. In this position, the pattern adapter **102** and its corresponding first contact pattern **124** are aligned with the second contact pattern **206** of the receptacle **200**. Furthermore, in the aligned position, the alignment sensors **208** remain untriggered. Thus, the current position of the pattern adapter **102** is maintained and the pattern adapter **102** can be subsequently secured using the aforementioned methods of mounting for securing the pattern adapter **102** to the first surface.

[0062] **FIGS. 8A, B,** C illustrate one embodiment of the method by which the sensor information is processed by the control unit to position the adapter within the receptacle. As shown in **FIG.** 8A, the sensing contacts **130** are located in pairs substantially adjacent to each corner of the first contact pattern **124**. When the adapter **102** is placed within the receptacle **200** (**FIG.** 3), the sensing contacts **130** of the positioning adapter **102** are positioned substantially over the regions where the alignment sensors **208** of the second contact pattern **206** are located (**FIG.** 3). When the adapter **102** is properly positioned within the receptacle **200** the first contact pattern **124** on the adapter **102** and the second contact pattern **206** in the receptacle **200** are aligned such that both patterns **124, 206** are joined, providing the desired connectivity and conductivity characteristics. While in this position, the sensing contacts **130** on the adapter **102** desirably do not conductively join with the alignment sensors **208** by remaining slightly offset so as to prevent current flow between the sensing contacts **130** and the alignment sensors **208**.

[0063] While the adapter position **102** within the receptacle **200** has not reached a desired contact pattern aligned position, sensing contacts **130** conductively join with the alignment sensors **208** resulting in the control unit **249** issuing pushrod responses in a manner that will be described in greater detail hereinbelow. The conductive joining of the sensing contacts **130** with the alignment sensors **208** results in the issuance of electronic signals to the control unit **249** which interprets the signals to determine the corrections to the position of the adapter **102** required to achieve the desired contact pattern alignment. The control unit **249** directs the activity of the pushrod assemblies based on a series of state table information which define pushrod retraction combinations used to reposition the adapter **102**.

[0064] In one aspect, the pushrod retraction combinations may result in repositioning of the adapter **102** in four lateral directions **400** (Top, Down, Right, Left) and two rotational directions **402** (Clockwise, Counterclockwise). The trigger state table **410** shown in **FIG. 8B** illustrates one embodiment showing the direction **400, 402** of desired adapter movement and resulting conductive triggering of alignment sensors **208** by the sensing contacts **130**. In the trigger state table **410**, each position **400, 402** (Top, Down, Right, Left, Clockwise, Counterclockwise) is defined by a set of eight trigger states **420** corresponding to the conductive triggering of the alignment sensors **208** necessary to achieve the desired positioning. The state of triggering of the alignment sensors **208** is designated by a "1" when the alignment sensor **208** is triggered by the sensing contact **130**, or as untriggered and designated by a "0" in the state table. For example, should the sensing contacts **130** corresponding to the first surface of the adapter **102** trigger the upper alignment sensors (**10, 20**), the state table determines the response which will be issued by the control unit **249** to the pushrod assemblies **210**. Thus, various combinations of alignment sensor triggering are designated by the trigger state table **410** and correspond to desired directional re-positionings which must be made by the control unit **249** and pushrod assemblies **210** to properly align the first contact pattern **124** of the pattern adapter **102** with that of the second contact pattern **206** of the receptacle **200**.

[0065] It will be appreciated by those of skill in the art that other combinations of sensor triggering, defining additional state table entries, may be used to achieve the required re-positioning of the pattern adapter **102**. Furthermore, the placement of the sensing contacts **130** and alignment sensors **208** may be changed to accommodate other contact patterns **124** and may define still other state tables used by the control unit **249** for adapter re-positioning movements. Thus, each of the aforementioned possible combinations represent additional embodiments of the present invention.

[0066] As previously described, the pushrods **220** positioned along each side of the adapter **102** generate a variable bias which result in adapter movements **400, 402** in the directions indicated (Top, Down, Right, Left, Clockwise, Counterclockwise). The position control state table **430**, shown in **FIG.** 8C, illustrates each positional movement **400, 402** (Top, Down, Right, Left, Clockwise, Counterclockwise) and a corresponding set of eight motion states **403** which represent pushrod activations appropriate to achieve the desired positioning. Each set of motion states **403** is associated with a set of trigger states **420** corresponding to the desired movement necessary to align the first contact pattern **124** of the pattern adapter **102** and the second contact pattern **206** of the receptacle **200**. The control unit **248** issues appropriate electrical current selectively directed to the pushrod assemblies **210** whose activity is desirably altered to re-position the pattern adapter **102**. The activity of each pushrod **220** is shown as retracted (resulting from current flow **253** through the SMA spring **240**) and designated by a "1", or as engaged (no current flow **253** through the SMA spring **240**) and designated by a "0".

[**0067**] For example, to achieve a clockwise rotation **404**, **406** of the position adapter **102**, two combinations of pushrod activity may be used. A first combination for clockwise rotation **404** directs pushrod assemblies **210** corresponding to the locations at the upper left **10** (state **1**) and lower right **50** (state **5**) sides of the adapter **102** to be desirably retracted by electrical current flow **253** determined by the control unit **249**. During this time other pushrods assemblies **210** are not altered by electrical current flow **253**. The retraction of the pushrods **10**, **50** along the two sides **114** results in a shifting of the adapter **102** in a clockwise direction **404** as a new state of equilibrium is reached within the receptacle **200**. A second combination for clockwise rotation **406** is achievable in a similar manner using the control unit **249** which directs the selective retraction of the pushrod assemblies **210** corresponding to the locations at the upper right **30** (state **3**) and lower left **70** (state **7**) sides of the adapter **102**. The other combinations of selective pushrod retraction operate in a like manner, wherein the control unit **249** directs the retraction of pushrods **220** as determined by the state table to achieve the desired movement of the adapter **102**. It will be appreciated by those of skill in the art, that other combinations of control unit **249** directed pushrod activity exist which may perform desirable movements of the position adapter **102** and thus represent additional embodiments of the present invention. One example of another such movement comprises diagonal movement of the position adapter **102** within the receptacle **200**.

[**0068**] Additionally, as shown in **FIG.** 9A, the sensing contacts **130** and corresponding alignment sensors **208** may be located in alternative positions along the adapter **102** and have a corresponding state table which defines a set of states to determine the selective retraction of the pushrods **220** by the control unit **249**. In the illustrated embodiment, shown in **FIG.** 9A, the alignment sensors **208** are positioned in pairs substantially equidistantly from each side of the adapter **102**. The resulting sensor configuration alters the trigger state table **450** (shown in **FIG. 9B**) for directing selective pushrod retraction as shown. In one aspect, the trigger state table **450** may include states which are designated as "don't care" states **465** (designated by an "x"), where the triggering of an alignment sensor **208** in a particular trigger state set **460** does not affect the positional decoding and resulting control unit re-positioning of the pattern adapter **102**. The position control state table **470** (shown in **FIG. 9C**) is used by the control unit **249** to selectively retract pushrods **220** as previously described and desirably results in the repositioning of the pattern adapter **102** in lateral and rotational directions.

[**0069**] The high-density electrical connector assembly of the present invention thus addresses the need for an improved electrical connector and overcomes the limitations of prior art connectors in a number of ways. The pattern adapter size, shape, and construction provides a flexible method to join electrically conductive components which have a high-density of contacts and must be reliably and securely joined to other structures. The pattern adapter can additionally be scaled up or down to accommodate both large and small applications and is particularly useful in joining large collections of wire or cable which may be of different sizes. Thus, many individual contacts can be made by the use of one connector, saving time and effort compared to connecting each wire or cable individually.

[**0070**] Furthermore, the aforementioned high-density electrical connector assembly possesses a near zero insertion force quality when joining the contact patterns. This is important to help preserve each electrical contact's structural and conductive integrity and prevent breakage of connector during coupling and decoupling of the connector components.

[**0071**] In the case of high-density electrical connector applications, proper alignment and positioning of the connector can be cumbersome and difficult to achieve. The use of the shaped memory metal spring and pushrod assemblies improve the ease and precision with which the connector can be operated. Additionally, the alignment process occurs quickly and with minimal operator intervention to insure that the connector is aligned in a desired manner and continuous conductive contact is maintained.

[**0072**] Although the foregoing description has described the invention in context for use with an adapter present in a high density electrical connector, it will be appreciated by those of skill in the art that the other applications of the present invention exist which represent other embodiments of the present invention. In one aspect the repositioning assembly can be fashioned to be used in conjunction with, for example, an electronics module, a hybrid electronic component, an integrated circuit or other device requiring a fine level control over the positioning of the interface between adjoining surfaces.

What is claimed is:

1. A high density electrical connector assembly comprising:

a first connector member with a first and second side wherein the first connector member comprises a plurality of electrical conductors on the first side and defines a first contact pattern on the second side comprising a first plurality of electrical contacts that are connected to corresponding electrical conductors;

a second connector member that defines a first surface adapted to receive the second side of the first connector wherein the second connector member has a second contact pattern comprising a second plurality of electrical contacts formed on the first surface that correspond to the first contact pattern on the second side of the first connector member, wherein the first contact pattern in substantially aligned with the second contact pattern when the first connector member is engaged with the second connector member; and

an alignment mechanism that engages with the first connector member and the second connector member wherein the alignment mechanism has a sensor assembly that determines whether the first contact pattern and the second contact pattern are precisely aligned such that there is electrical interconnection between the first and second plurality of electrical contacts and the alignment mechanism includes positioning assemblies which move the first and second connector members with respect to each other to precisely align the first and second contact patterns.

2. The assembly of claim 1, wherein the sensor assembly is formed on both the first and second connector members for sensing the alignment between the first and second contact patterns.

3. The assembly of claim 2, wherein the sensor assembly includes at least one probe formed on the second connector member and a plurality of sensing contacts formed on the first connector member wherein the probe and the plurality of sensing contacts are positioned such that the at least one probe sends signals indicative of the relative position between the first and second connector members based upon whether the at least one probe is electrically contacting one or more of the plurality of sensing contacts.

4. The assembly of claim 3, wherein the alignment mechanism further comprises an electrically activated spring that receives electrical current when the probe engages with the sensing contacts in a manner that indicates that the first and second electrical connectors are not precisely aligned.

5. The assembly of claim 4, wherein the at least one alignment mechanism comprises a shaped memory metal spring that retracts when it receives an electrical current.

6. The electrical connector according to claim 5 wherein said shape-memory metal comprises a nickel-titanium alloy.

7. The assembly of claim 4, wherein the at least one probe comprises a plurality of probes that are geometrically distributed about the first surface of the second connector member and the plurality of sensing contacts are geometrically distributed about the second surface of the first connector member and the at least one alignment mechanism comprises a plurality of alignment mechanisms spaced about the second connector member so as to be able to engage a surface of the first connector member to thereby move the first connector member with respect to the second connector member in both lateral and rotational directions.

8. The assembly of claim 7, wherein the plurality of probes and the plurality of sensing contacts are geometrically distributed such that at least some of the plurality of probes engage with the plurality of contacts when the first connector member is substantially aligned with second connector member and thereby provide an electrical signal to the corresponding alignment mechanisms to thereby precisely align the first and second contact patterns.

9. The assembly of claim 8, wherein the first connector member comprises a pattern adapter having a first geometric configuration and a first and a second side and the second connector member defines a mounting location having the first geometric configuration.

10. The assembly of claim 9, wherein the mounting location further comprises a receptacle having a recess for receiving the pattern adapter.

11. The assembly of claim 9, further comprising a control unit which receives the signals sent by the at least one probe and selectively sends electrical current to the alignment mechanism and further directs the activity of the positioning assemblies.

12. The assembly of claim 11, wherein the control unit selectively engages the positioning assemblies when one or more of the plurality of probes are engaged with one or more of the plurality of sensing contacts.

13. The assembly of claim 1, further comprising a mechanism for fixedly attaching the first and second electrical connectors in a fixed relationship wherein the first and second electrical connectors are precisely aligned.

14. The assembly of claim 13, wherein the mechanism for fixedly attaching the first and second electrical connectors is selected from the group consisting of screws, bolts, rods, tabs, and latches.

15. A high-density electrical cable connector comprising:

a pattern adapter having a first side, a second side and side surfaces, the second side further comprising a first contact pattern formed from a first plurality of electrical contacts conductively joined to a plurality of wires extending from the first side, the second side further comprising a plurality of sensing contacts comprising conductive surfaces positioned about the second side;

a mounting location having a first surface wherein a second contact pattern is formed from a second plurality of electrical contacts and corresponds to the first contact pattern such that when the second side of the pattern adapter and the first surface of the mounting location are aligned and joined, the first and second contact patterns are conductively joined;

an alignment mechanism, comprising a sensor assembly which detects the alignment of the first and second contact patterns and issues signals based on the alignment, and further comprising at least one electronically actuated pushrod assembly that generates a bias against the pattern adapter to align the position of the first contact pattern with the second contact pattern;

a control unit, that receives the signals generated by the sensor assembly and induces the alignment of the first and second contact patterns by actuating the plurality of pushrods to result in lateral and rotational movements of the pattern adapter.

16. The high density electrical cable connector according to claim 15, wherein the mounting location further comprises a receptacle having a recess for receiving the pattern adapter.

17. The high-density electrical cable connector according to claim 15, wherein the plurality of pushrod assemblies further comprise a plurality of shape memory metal springs which contract when electrical current passes through the springs.

18. The high-density electrical cable connector of claim 17 wherein the shape memory metal comprises a nickel-titanium alloy.

19. The high-density electrical cable connector according to claim 18, wherein each spring exerts a bias on the pattern adapter that corresponds to signals generated by the sensor assemblies.

20. The high-density electrical cable connector according to claim 19 wherein the control unit sends electrical current through the springs causing the springs to retract thereby reducing the bias exerted by selected pushrods on the pattern adapter and furthermore resulting in re-alignment of the pattern adapter.

21. The high-density electrical cable connector of claim 15, wherein the first contact pattern comprises a geometrically distributed plurality of sensing contacts and the sensor assembly comprises a corresponding, geometrically distributed plurality of sensors.

22. The high-density electrical cable connector of claim 21, wherein the sensors generate signals based on conductive engagement with one of more of the plurality of sensing contacts.

23. The high-density electrical cable connector of claim 15, wherein the control unit further comprises a trigger state table which defines the position of the pattern adapter based on the conductive joining of the sensing contacts with the sensors.

24. The high-density electrical cable connector of claim 23, wherein the trigger state table is linked to a control state table to direct electrical current through the a least one pushrod assemblies.

25. The high-density electrical cable connector of claim 15, further comprising a mechanism for fixedly attaching the pattern adapter and mounting location in a fixed relationship wherein the first and second contact patterns are precisely aligned.

26. The assembly of claim 25, wherein the mechanism for fixedly attaching the pattern adapter and mounting location comprises is selected from the group consisting of screws, bolts, rods, tabs, and latches.

27. A device for aligning packaged integrated circuits comprising:

a packaged integrated circuit assembly having a first side, a second side and side surfaces, the second side further comprising a first contact pattern formed from a first plurality of electrical contacts conductively joined to electronic components of the packaged integrated circuit assembly, the second side further comprising a plurality of sensing contacts comprising conductive surfaces positioned about the second side;

a mounting location having a first surface wherein a second contact pattern is formed from a second plurality of electrical contacts and corresponds to the first contact pattern;

an alignment mechanism, comprising a sensor assembly which detects the alignment of the first and second contact patterns and issues signals based on the alignment, and further comprising a plurality of electronically actuated pushrod assemblies which generate a bias against the packaged integrated circuit assembly to align the packaged integrated circuit and join the contacts of the first plurality of electrical contacts with the second plurality of electrical contacts;

a control unit that receives the signals generated by the sensor assemblies and aligns the first and second contact patterns by actuating the plurality of pushrods to result in lateral and rotational movements of the packaged integrated circuit assembly.

28. The device for aligning packaged integrated circuits according to claim 27, wherein the mounting location further comprises a receptacle having a recess for receiving the a packaged integrated circuit assembly.

29. The device for aligning packaged integrated circuits according to claim 28, wherein the plurality of pushrod assemblies further comprise a plurality of shape memory metal springs that are altered by passage of electrical current through the springs to change the bias exerted by the pushrods.

30. The device for aligning packaged integrated circuits according to claim 29 wherein the shape-memory metal comprises a nickel-titanium alloy.

31. The device for aligning packaged integrated circuits according to claim 27, wherein the first contact pattern comprises a geometrically distributed plurality of sensing contacts and the sensor assembly comprises a corresponding, geometrically distributed plurality of sensors.

32. The device for aligning packaged integrated circuits according to claim 31, wherein the sensors generate signals based on conductive engagement with one of more of the plurality of sensing contacts.

33. The device for aligning packaged integrated circuits according to claim 29, wherein each spring exerts a bias on the position adapter.

34. The device for aligning packaged integrated circuits according to claim 33, wherein the control unit directs current through the plurality of springs.

35. The device for aligning packaged integrated circuits according to claim 34, wherein the control unit selectively directs the retraction of selected springs thereby reducing the bias exerted on the packaged integrated circuit assembly.

36. The device for aligning packaged integrated circuits according to claim 35, wherein the control unit further comprises a trigger state table which defines the position of the packaged integrated circuit assembly based on the conductive joining of the sensing contacts with the sensors.

37. The device for aligning packaged integrated circuits according to claim 36, wherein the trigger state table is linked to a control state table to direct electrical current through the plurality of pushrod assemblies.

38. The device for aligning packaged integrated circuits according to claim 27, further comprising a mechanism for fixedly attaching the packaged integrated circuit assembly and mounting location in a fixed relationship.

39. The device for aligning packaged integrated circuits according to claim 38, wherein the mechanism for fixedly attaching the packaged integrated circuit assembly and mounting location is selected from the group consisting of screws, bolts, rods, tabs, and latches.

40. A method of precisely aligning a first electrical connector member to a second electrical connector member such that the plurality of contacts on a first contact pattern of the first connector member is electrically connected to a corresponding plurality of contacts on a second contact pattern of the second connector member, the method comprising:

positioning the first connector member in proximity to the second connector member, such that the first and second contact patterns are grossly aligned;

electrically sensing whether the first and second connector members are precisely aligned such that first and second plurality of contacts are electrically connected to each other; and

electrically inducing movement between the first and second connector members so as to precisely align the connector members in response to electrically sensing whether the first and second connector members are precisely aligned.

41. The method of claim 40, further comprising securing the first and second connector members in the precisely aligned state.

42. The method of claim 41, wherein positioning the first connector member in proximity to the second connector member comprising positioning the first connector member into a receptacle defined by the second connector member that is sized to within a manufacturing tolerance to correspond to the first connector member such that the first

contact pattern and the second contact pattern are aligned to within the manufacturing tolerance of the first connector member and the receptacle.

43. The method of claim 42, wherein electrically inducing movement between the first and second connector members comprises inducing a mechanical apparatus that is engaged with the first and second connector member to move the first connector member within the receptacle such that the first connector member is precisely aligned with the second connector member.

44. The method of claim 43, wherein inducing a mechanical apparatus to move the first connector member within the receptacle comprises providing current to a shape memory alloy spring that causes a member to move thereby resulting in a bias being applied between the first and second connector members.

45. The method of claim 44, wherein electrically sensing whether the first and second connector members are precisely aligned comprises determining the relative location between at least one probe formed on the second connector member to at least one sensing contact formed on the first connector member.

46. The method of claim 45, wherein determining the relative location between the least one probe and the at least one sensing contact comprises generating a electrical signal when the probe is conductively joined to the sensing contact.

47. The method of claim 46, wherein the electrical signal is further detected by a control unit.

48. The method of claim 47, wherein the control unit decodes the signal using a trigger state table to determine the first and second connector member alignment.

49. The method of claim 48, wherein the control unit induces the mechanical apparatus following decoding of the first and second connector member alignment.

50. The method of claim 49, wherein the control unit induces the mechanical apparatus by sending an electrical current to the mechanical apparatus.

51. The method of claim 50, wherein the control unit further uses a control state table to determine when to send the electric current to the mechanical apparatus.

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