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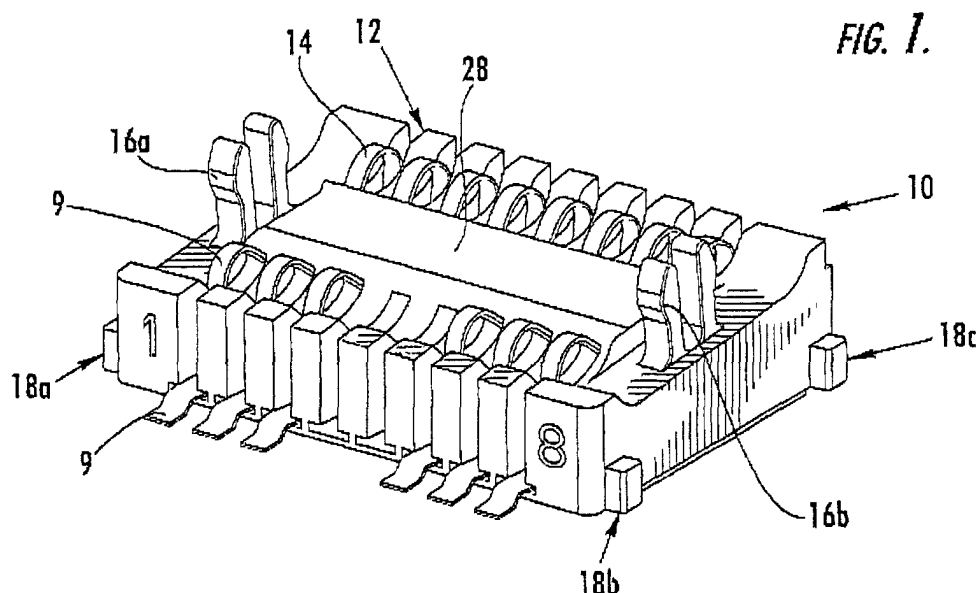
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(54) **Electrical connector**

(57) An electrical connector for mating at least two circuits having a first (10) and second (11) insulating body adapted to mate with each other in completing an electrical circuit. The first body having a bottom portion and a top portion to connect to a first circuit and the second body having a bottom portion adapted to connect to a second circuit and a top portion to connect to the

first body. The first and second bodies having a plurality of adjacently spaced recesses (12,13) on their mating surfaces and sides and further having contact elements (14,15) located within the adjacently spaced recesses. Contact elements are pressed against each other when the first body and second body are joined in forming a connector.



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Description

Field of the Invention

[0001] This invention generally relates to electrical connectors. More particularly, the present invention relates to a connector used to interconnect circuits, for example, printed circuit boards.

Background of the Invention

[0002] In the electronics industry, it is common to provide devices, such as consumer electronics, in a standard format that may be upgraded to a format with greater features at a later time. Upgrading an integrated consumer electronic device can be expensive, and the labor involved to actually hard wire or solder new printed circuit boards ("PCB's") into an existing consumer electronic device, such as a telephone, can easily be worth more than the telephone itself. Thus, it is a significant problem to provide a telephone or other electronic device in a format or mode that can be upgraded to a more advanced version later.

[0003] There are methods known in the art for interconnecting circuits, particularly circuit boards containing circuits, to each other. For example, it is well known to hard wire boards together, or to use edge connectors attached to the boards which engage corresponding fixed edge connectors carried within a frame in which the boards are mounted to provide the desired connections between circuits. Known methods of hard wiring boards or deploying edge connectors are costly and inconvenient. Some prior apparatus and methods require multiple interconnected parts that must be assembled to be correctly integrated into the system. In addition, when a circuit board needs to be added or removed from an electronic assembly, the cost incurred can be significant. Furthermore, there often is a significant loss of time when the system is down for repairs. Typically, electronic traces are soldered together, adding to the time and expense of replacing or removing the circuit. Thus, there is no convenient and inexpensive way to upgrade an electronic device by a quick and easy procedure for adding a circuit.

[0004] It would be convenient in the case of electronic products to be able to easily and quickly add a circuit board to a consumer product in a quick and easy manner, without the necessity of sending the product back to the manufacturer. For example, this is desirable when an electronic product such as a telephone is to be upgraded with additional calling or system features that require installation of an "add-on" circuit board to an existing telephone unit.

[0005] Using most existing telephone designs, this sort of simple upgrade is usually not possible. Adding a circuit board is very complex when the consumer product was not initially designed with the addition of further circuits being contemplated at the time the telephone is

designed and manufactured. That is, a better manner of providing for quick upgrades to a consumer electronics device is desired.

[0006] What is needed in the industry is a connector that facilitates a convenient and cost efficient method of interconnecting and disconnecting circuits reliably and without unintentional damage to the circuits. A connector that facilitates connection and disconnection of a circuit board from an electronic system with relative ease would be very desirable. A connector system that facilitates relatively quick and easy replacement of circuit boards with minimum down time would be very desirable. The ability to upgrade a consumer electronic item to an improved item having greater electronic and circuit capability, in a quick and easy procedure, is needed.

Summary of the Invention

[0007] It is a principal object of the present invention to provide an improved electrical connector particularly suited for mating circuit boards with one or more an electronic devices.

[0008] It is one object of the invention to provide an apparatus that will facilitate the addition of a circuit board to an existing electronic device, by way of upgrading the device, in an efficient and cost effective manner.

[0009] Further, it is an object of this invention to provide a method and apparatus for upgrading an electronic device without the necessity of shipping the device back to the manufacturer, or engaging in expensive soldering or complete electrical disassembly.

[0010] It is still another object of this invention to provide a connector in at least two parts, one part of which may be installed into a consumer product during initial manufacture of the product, and one part of which is capable of being installed at a later time, in the case of an upgrade of the electronic device. In some connectors, three or more parts may be provided.

[0011] Additional objects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention. In accordance with the objects and purposes of the invention, an electrical connector is provided for mating circuit boards, such as in a stacked configuration. The electrical connector has a first insulating body and a second insulating body that each are adapted to mate to each other in completing an electrical circuit. The first insulating body and second insulating body having a top portion and a bottom portion. The bottom portion of the first insulating body and the bottom portion of the second insulating body each are generally adapted to connect to a circuit, such as a printed circuit board or PCB. The top portion of the first insulating body is adapted to mate the first insulating body to the top portion of the second insulating body. The first and second insulating bodies may also include adjacently spaced recesses on their mating surfaces extending down the sides of these surfaces.

[0012] A plurality of such recesses are provided in the invention, and there may be electrical contact elements within one or more of such recesses. A plurality of separate, adjacently disposed contact elements may rise above the surface of the first or second body (i.e., above the mating surface) in some embodiments. It should be appreciated that in some embodiments, not all recesses contain a contact element. Contact elements are designed to flex against each other to form a secure electrical connection, but other means of securing a reliable electrical connection is possible.

[0013] The contact elements deployed in the invention may be generally elongated and flexible, made from a typical conducting material. The connector elements of the first body mate with the connector elements of the second body, thereby creating an electrical circuit between the first circuit and the second circuit. It should be appreciated that the contact elements may have a plurality of embodiments. Preferably, at least one contact element is a resilient arm disposed for pressing in mating contact with a respective contact element of the other insulating body. In one embodiment, the other contact element may comprise a generally rigid arm. Thus the rigid arm located on the first body is held within the recesses of the second body beneath the top surface of the body. Contact elements are spaced within recesses and provided laterally adjacent to each other to prevent objects from striking the contact elements, and to prevent inadvertent touching of contact elements by human hands, fingers, or foreign objects. In this embodiment, the resilient arm of the first body enters the recesses of the second body and presses against or contacts the rigid arm disposed in the recesses of the first body, forming a secure connection within the second body.

[0014] In an alternative preferred embodiment, both of the connector elements may comprise resilient arm members disposed for pressing in mating contact with a respective resilient arm member of the other insulating body. In this embodiment, the connector elements of one insulating body move into the recesses of another insulating body when they are mated together. The contact elements are pressed together to connect an electrical circuits. The electrical connector includes fasteners to mate the insulating bodies together and align the bodies to ensure proper mating.

[0015] In some embodiments, the elongated insulating fasteners comprise the male structure that is located on one insulating body, which firmly holds the insulating bodies together when mated. It includes as well a female corresponding recessed receptacle, or female structure, located on another insulating body. The fastener allows the insulating bodies to easily detach from each other to provide for added convenience to the electrical connector.

[0016] In some electronic devices, the insulating body having contacts that are held below the mating surface of the body is used as the first part of the connector, and mounted in the consumer device when it is manufac-

tured. This provides a device which has no exposed electrical contacts to inadvertently be damaged or shorted against other structures when manufactured and shipped to consumers. Then, later, when an upgrade is desired, the housing of the electronic device is opened (if necessary) and the second part of the two part connector (having an insulating body with contacts above the mating surface) is mated to the insulative body already within the electronic device, to secure the addition of a second circuit board to the device. This occurs without damage to the electrical circuit, in part because the electrical contacts of the insulative body within the electronic device are hidden below the upper mating surface of the body. Thus, a connector having two or more parts is very useful for such upgrades to occur efficiently and safely.

[0017] Support lugs may optionally be located on the sides of the connector. These support lugs secure the connector within the phone housing to eliminate or reduce strain on the printed circuit board.

[0018] The electrical connectors may, in one embodiment, comprise a thick portion of an insulating body and a thin portion of an Insulating body. The thick portions of the bodies mate together along one edge, and then thin portions of the insulating body mate along another edge, in one embodiment. This provides the connector with an angled configuration. Other configurations are available to mate the thin portion of one body with the thick portion of another body.

Brief Description of the Drawings

[0019] The present invention will be more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, and in which:

Figure 1 is a perspective view of one embodiment of the first body of an electrical connector according to the invention;

Figure 2 is a perspective view of one embodiment of the second body of an electrical connector according to the invention;

Figure 2A shows a perspective view of the mated connector with the first body and the second body fastened together in electrical communication;

Figure 3 is a side view of the second body of an electrical connector which is shown in Figure 2;

Figure 4 is a side view of the first body of an electrical connector shown in Figure 1;

Figure 5 is a side operational view of the first body and second body prepared for interconnection between two circuit boards;

Figure 6 is an end view of the first body and second body in the mated configuration between two circuit boards;

Figure 7 is a cross-sectional view of the first body and second body in mating configuration, showing

a cross-sectional view of the assembly taken along lines 7-7 of Figure 2A; and

Figure 8 is a cross-sectional view along the lines 8-8 of the connector assembly of Figure 2 showing the contact elements in electrical communication when the first body and second body are mated together, such as after an upgrade of the consumer electronic device by adding a second body with a second circuit board to an existing electronic device.

Detailed Description of the Invention

[0020] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope and spirit of the invention. It is intended that the present invention include such modifications and variations as come within the scope of the appended claims and their equivalents.

[0021] Several embodiments of the invention are shown. Turning to Figure 1, a first body 10 of a connector assembly is shown. First body 10 is particularly useful when mating with second body 11 to form electrical communication between two or more circuits. The first body includes a flat plate 28 in its middle, which can assist in providing a surface for engagement and grasping ("pick and place") during manufacturing of connectors.

[0022] The first body 10 has paired stab fasteners 16a and 16b on each end of the connector that are adapted to fit into corresponding recessed receptacles 17a and 17b of second body 11 shown in Figure 2. The recessed receptacles are located on the second body 11, and the stab fasteners snap into place when the first body 10 and the second body 11 are mated together, as shown in Figures 2A and 7, for example. The first body 10 and second body 11 are removed from the mating configuration with relative ease by pulling the connectors apart, if necessary.

[0023] Although the invention will be described generally in terms of interconnecting circuit boards, and with reference to structures sufficient for connecting the boards, it should be understood that the boards and the first body 10 and the second body 11 according to the invention may further be retained or secured in other types of circuit arrangements. There may be other circuit arrangements that do not utilize boards that are useful applications of the invention.

[0024] First body 10 includes a plurality of adjacently spaced recesses 12 and located on the top portion of the connector and extending along the sides of the first body 10. Positioned inside the adjacently spaced recesses 12 are a plurality of contact elements, designated 14 as a group. Along the other side of the first body 10 is a second row of contact elements designated 9, which also reside in recesses on the opposite side of the first body 10,

[0025] Support lugs 18a-d are provided on the four

corners of the embodiment shown in Figure 1, which secure the connector within the telephone housing to eliminate strain on the printed circuit board (18d is not visible in Figure 1).

[0026] Second body 11 includes a plurality of adjacently spaced recesses 13 located on the top portion of the connector and extending down both of the sides of the second body 11. Positioned inside the adjacently spaced recesses 13 are a plurality of contact elements 15. It should be appreciated that Figure 2 shows only one embodiment of the second insulating body 11. Flat plate 29 is seen in the center of the second body 11. Recesses 17a-b provide an aperture for the stab fasteners 16a-b to secure one part of the connector (first body 10) to the second part of the connector (second body 11).

[0027] The contact elements 14 of the first insulating body 10, as shown in Figure 1, are held within the recesses 12 and emerge above the mating surface. The contact elements 15 and 15a of the second insulating body 11 as shown in Figure 2 are contained within the recesses 13 (which extend all the way across the width of the connector) and beneath the mating surface. One purpose of this configuration is to allow the contact elements 14 of the first insulating body 10 to enter the recesses 13 of the second insulating body 11 to form an electrical circuit when the two-part connector is provided in the mated position as shown in Figure 8 and in Figure 2A. Recesses or grooves are merely one method of securing the interconnection between the contact elements in a secure manner, and other means of shielding the contact elements and yet making them available for electrical communication, are within the scope of this invention. For example, it might be possible to provide pores, rather than recesses, or apertures of various shapes or configurations. Spring loaded pins could also be used in the practice of the invention.

[0028] Furthermore, the second body includes one or more support lugs for securing the connector to the housing, shown as reference numerals 19a-d in Figure 2. Contact elements 15 and 15a are provided in two rows along the connector, which match or mate with the elements 14 and 9 shown in first body 10.

[0029] In one embodiment, the insulating bodies are mated together using elongated fasteners 16a-b which are located on the top portion of the first insulating body 10 as illustrated in Figure 1. In the mated configuration as illustrated in Figures 2A and 7, the elongated fasteners 16a-b fit into corresponding recessed receptacles 17a-b located on the top portion of the second insulating body as illustrated in Figure 2. The fasteners provide a firm fit that is easily achievable by applying minimal pressure to the contact elements resulting in the mated configuration.

[0030] Figure 2A shows the two-part connector in the mated configuration as when two circuit boards are connected. In Figure 2A, first circuit board 41 is shown mated with the first body 10. The second body 11 is mated

to second circuit board 40. The second body 11 (second part of the two part connector) is added to an existing electronic device by engaging it to the first body 10 using stab fasteners 16a and 16b which are inserted into recesses 17a and 17b respectively (hidden from view in Figure 2A). The invention could also include more than two bodies, or parts, and could therefore apply to more than two circuit boards, in other embodiments. There is no practical limit to the number of stackable connectors that could be added to increase the capability of an existing circuit within an electronic device. The invention is not limited to any particular electronic device, although it finds remarkable utility in cellular telephones, as one example.

[0031] In one embodiment of the invention, the electrical connector is provided having a thick portion or side 31, and a thin portion or side 30, as shown in Figure 3. The second body 11 is shown mounted upon first circuit board 40 in Figure 3, and likewise the first body is shown mounted on the second circuit board 41 in Figure 4.

[0032] The second insulating body is illustrated by a side view in Figure 3 showing a thick portion 31 and a thin portion 30. The first insulating body is illustrated by a side view in Figure 4 showing a thick portion 32 and a thin portion 33. The two bodies are mated together resulting in an angled configuration as illustrated in Figure 6, in which the thin portions line up on the same side, and the thick portions line up on the same side, in one aspect of the invention. For various reasons related to the geometry of the connectors and the housing of the electronic device into which the connector is placed, a thick/thick and thin/thin mating configuration is sometimes very desirable. In this configuration, the circuit boards are not provided in parallel, but instead are provided at an angle due to the thickness of the connectors themselves.

[0033] Contact elements 14 of the first insulating body 10 can be pressed in mating configuration to the contact elements 15 of the second insulating body 11. Further, the contact elements 9 are pressed into mating configuration to the contact elements 15a.

[0034] Figure 3 shows the mating surface of the second body 11 at the upper portion of the Figure. Likewise, the contact elements 14 and the contact elements 15, and also 9 and 15a, can have various configurations when pressing or mating with each other, including having two elongated flexible contact elements extending beyond the insulating bodies. In other configurations, there may be other mechanical means or structures used to hold the first body and second body together tightly to enable a secure electrical connection between the electrical connectors of the first body 10 and the second body 11. Sometimes, the connectors may be electrical contact pads, or merely flexible metal contacts, and there is no limit to the various configurations that the electrical contacts may take in this invention.

[0035] Figure 4 shows an end view of the first body 10 of Figure 1 with contact elements 9 and 14 shown

raised above the mating surface of the first body and prepared for engagement with contacts of the second body 11 (which are recessed and therefore not visible in the side view of Figure 5). The contact elements are configured to be resting above (i.e., outside of) the mating surface 38 of the second body 10. Thick portion 32 and thin portion 33 of the first body 10 are seen, and they align in Figure 5 with thick portion 31 and thin portion 30, respectively.

[0036] Figure 6 shows the first body 10 and the second body 11 in a mated configuration, with the mating surface 37 indicating contact of the connectors to each other at their mating surfaces. In this position, electrical contact is made between first circuit board 40 and second circuit board 41.

[0037] Figure 7 shows a side cross-sectional view of the two-part connector taken along lines 7-7 of Figure 2A. In this Figure, one can see the stab fastener 16b that is lodged into the receptacle 17b where it holds tightly the first body 10 and the second body 11 together, providing for a secure electrical connection.

[0038] Figure 8 shows a cross-sectional view of the two-part connector of Figure 7 taken along lines 8-8 of Figure 2A. Curved tips of the contact elements are shown as 51a-b and 52a-b in the Figure 7. In this particular embodiment, electrical contact is made by flexible engagement of elements 14 with elements 15a, and between elements 9 and 15. It is not necessary that the electrical contacts meet each other in each and every recess, and in fact some recesses may be "blanks", with no contacts within them at all. Further, the contacts could be electrical "pads" or contact points, and need not always be flexible elongate elements. Pins, cords, snaps, serrated edges or other geometries or fastening systems all could be employed, if they provide a secure electrical connection. The invention is not limited to the shape or variety of electrical contact elements that are deployed.

[0039] It is understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present invention, which broader aspects are embodied in the exemplary constructions. The invention is shown by example in the appended claims.

Claims

1. An electrical connector for interconnecting a first circuit to a second circuit, comprising:

(a) a first insulating body and a second Insulating body, the bodies adapted to mate to each other in completing an electrical circuit, wherein the first body has a mating surface on its top portion and the second body has a mating surface on its top portion, such that the mating sur-

faces of the first and second bodies are capable of articulating together;

b) a plurality of contact elements within the first and second bodies, the first and second bodies further comprising a plurality of spaced recesses on their mating surfaces, wherein contact elements are located within said recesses;

c) wherein contact elements of the first body are held within the recesses of the first body, and contact elements of the second body are held within the recesses of the second body, the contact elements of the first body being held at an elevated position above the mating surface of the first body, such that upon mating the first body with the second body at least one contact element of the first body enters recesses of the second body, thereby causing electrical communication between the first and second bodies.

2. The electrical connector as in claim 1, wherein the first circuit comprises a circuit board.

3. The electrical connector as in claim 1, wherein first circuit and second circuit both comprise circuit boards.

4. The electrical connector as in any preceding claim, wherein, in the unmated configuration, contact elements of the second body are held within recesses in the second body beneath the mating surface of said body so as to be adapted to withstand foreign objects striking the mating surface of the second body.

5. The electrical connector as in any preceding claim, wherein the contact elements are elongated and flexible.

6. The electrical connector as in claim 5, wherein the contact elements of the first body flexibly engage contact elements of the second body.

7. The electrical connector as in any preceding claim wherein the first body further comprises elongated fasteners adapted to fit into corresponding recessed receptacles located on the second body.

8. The electrical connector as in any preceding claim wherein the first body further comprises mounting brackets for connection to the first circuit board.

9. The electrical connector as in any preceding claim wherein the first body and the second body each have a thickened side portion, the thickened side portion of the first body being aligned in registration with the thickened side portion of the second body when the first body and the second body are mated

together.

10. An electrical connector adapted for interconnecting a first circuit board to a second circuit board, comprising:

(a) a first and a second insulating body, the first and second bodies adapted to mate to each other in completing an electrical circuit, the first and second bodies having mating surfaces that are adapted to interlock together, wherein the first body electrically connects to said first circuit board and the second body electrically connects to said second circuit board,

b) at least one flexible elongated contact element being fixed within the first body, and at least one contact element being fixed within the second body, wherein the first and second bodies further provide a plurality of spaced recesses on their respective mating surfaces, at least one contact element being located within said recesses of each body,

c) wherein at least one elongated contact element of the first body projects from recesses on the mating surface of said first body to a location below the mating surface of the second body,

d) further wherein the first body and second body are configured such that upon mating with each other, at least one contact element of the first body makes electrical contact with at least one contact element of the second body.

11. The electrical connector of claim 10 wherein the location at which the contact element of the first body contacts the contact element of the second body is below the mating surface of the second body.

12. The electrical connector of claim 10, wherein the location at which the elongated contact element of the first body contacts the contact element of the second body is not within the interior of either the first or second body, but is above the mating surface of both the first and second body.

13. An electrical connector as in any of claims 10 to 12 wherein at least one contact element of the first body is flexible, wherein a first end of said electrical contact element is secured within the first body, and a second end of said contact element forms a curved tip adapted for flexible frictional contact with contact elements of the second body.

14. An electrical connector as in claim 13, wherein at least one contact element of the first body is provided on a mating surface in a paired configuration.

15. An electrical connector as in any of claims 10 to 14

wherein the first and second circuit boards are brought into mating electrical contact with each other using an elongated stab fastener, wherein the stab fastener comprises a projection and a receptacle.

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- 16.** An electrical connector as in any of claims 10 to 15, wherein the insulating bodies comprise at least two series of contacts.

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- 17.** An electrical connector as in any of claims 10 to 16, wherein the first body comprises a thick portion and a thin portion, and the second body comprises a thick portion and a thin portion, further wherein the thick portion of the first body is mated to the thick portion of the second body and the thin portion of first body is mated with the thin portion of second body, thereby facilitating an angled configuration of the overall connector.

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- 18.** An electrical connector as in any of claims 10 to 17 in which the first body further comprises a flat plate on its mating surface that is adapted as a reference grasping point for automated manufacturing.

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- 19.** The connector of claim 10 wherein at least one elongated contact element of the first body projects from recesses on the mating surface of said first body to a location within the interior of the second body.

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- 20.** The connector of any of claims 10 to 19 in which the first body provides elongated flexible contact elements and the second body provides contact pads within recesses for articulation with the contact elements of said first body.

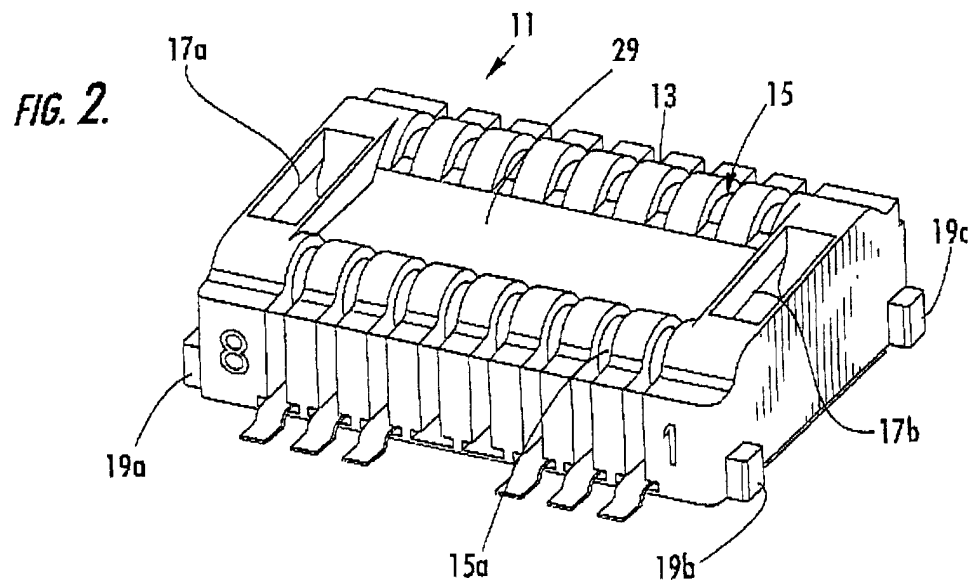
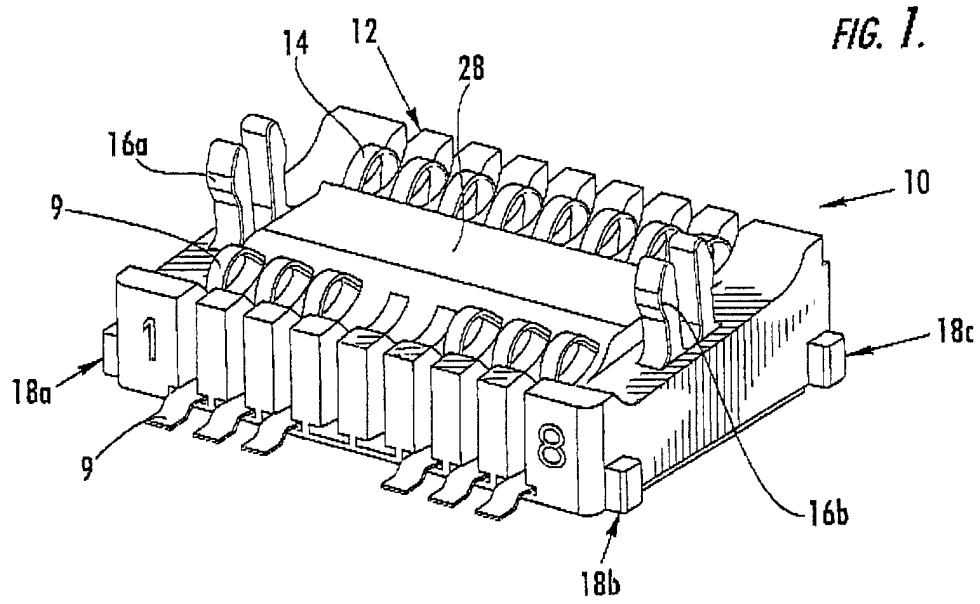
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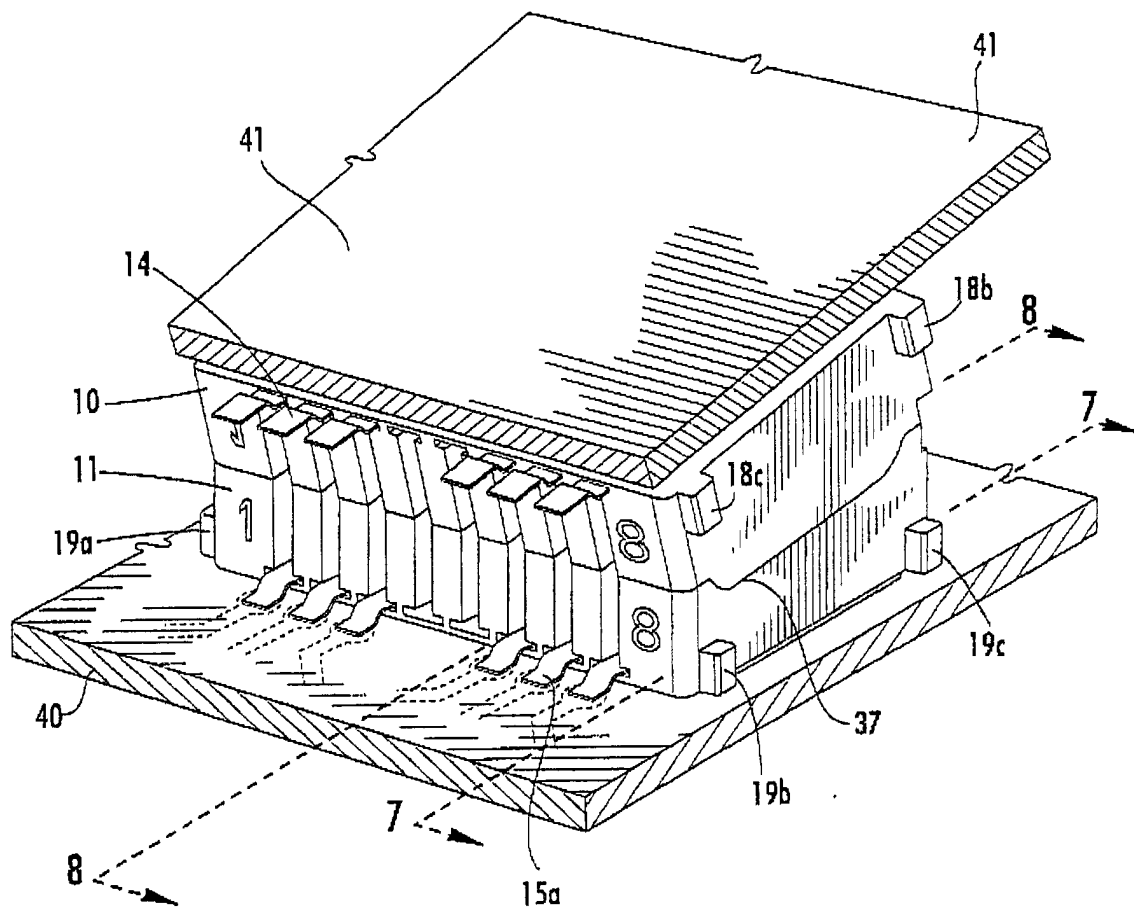


FIG. 2A.

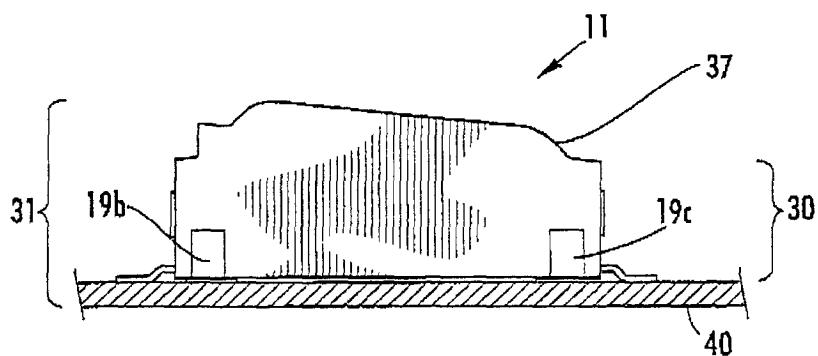


FIG. 3.

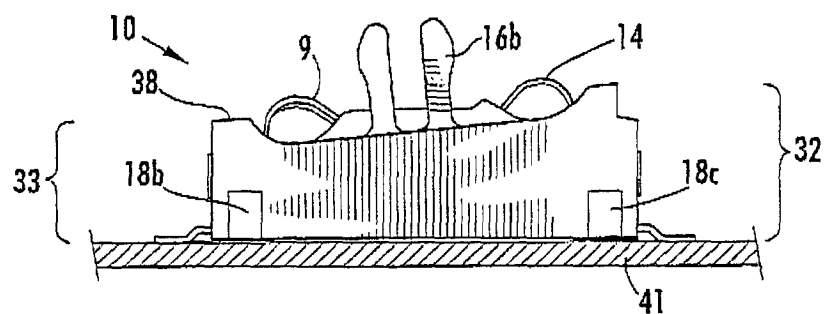


FIG. 4.

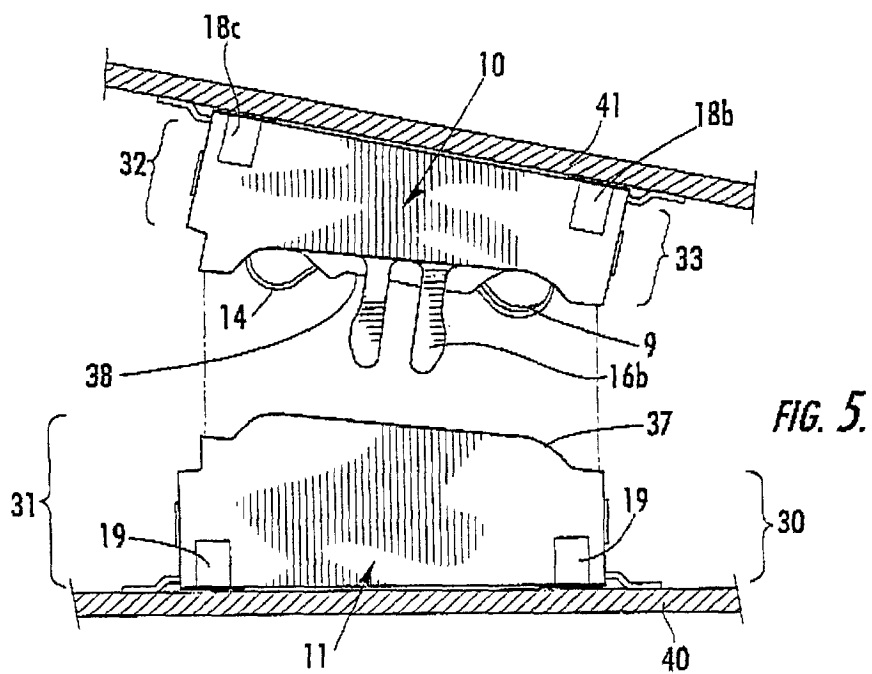


FIG. 5.

FIG. 6.

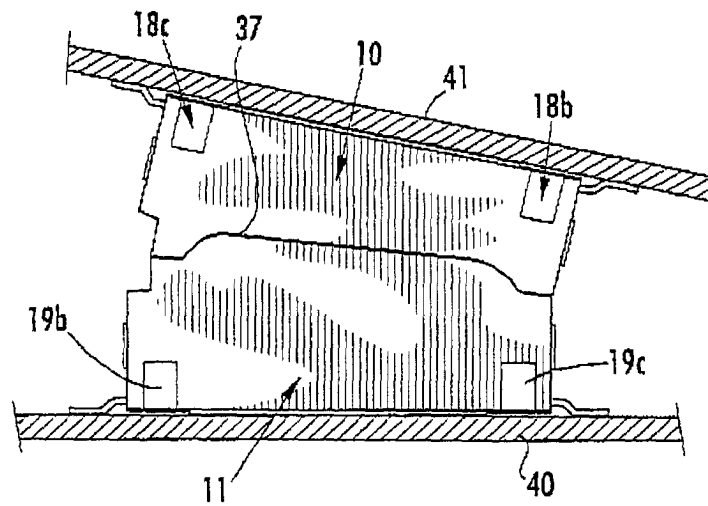


FIG. 7.

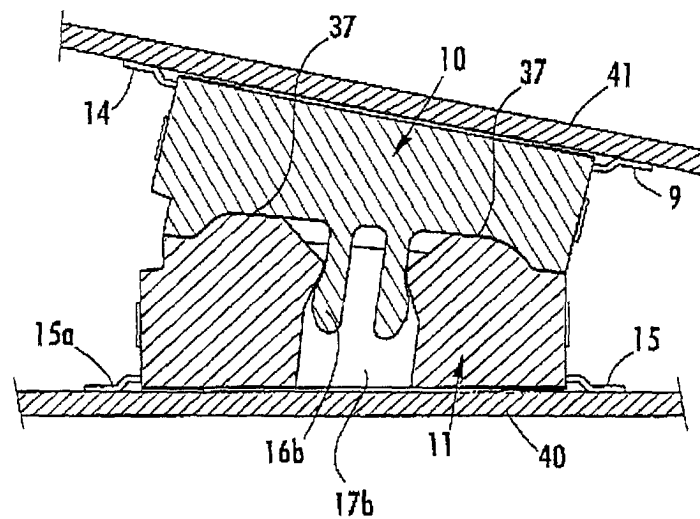


FIG. 8.

