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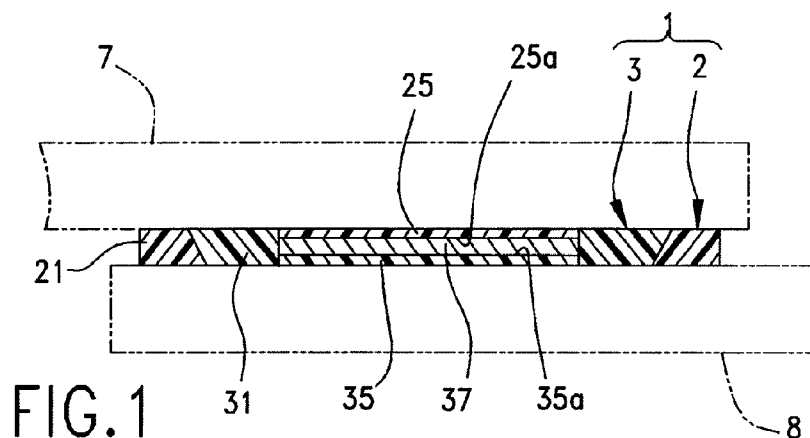
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(57) Abstract: A connector is characterized by a receptacle frame attached to a first circuit substrate, a first terminal formed in a plate-like shape and having one surface electrically connected to the first circuit substrate and another surface serving as a capacitive-coupling surface, and a plug frame that is attached to a second flat circuit substrate, with a second terminal formed in a plate-like shape and having one surface electrically connected to the second circuit substrate with another surface serving as a capacitive-coupling surface. A dielectric portion is formed on the capacitive-coupling surface of the second terminal so that when the receptacle and plug connector frames are fitted together, the capacitive-coupling surface of the first terminal and the capacitive-coupling surface of the second terminal oppose each other through intermediation of the dielectric portion.

CONNECTOR FOR CAPACITIVELY COUPLED INTERFACE

BACKGROUND OF THE INVENTION

The Present Invention relates to a connector and a terminal assembly, and more particularly, to connectors for use with capacitively-coupled interfaces.

In conventional capacitive-coupled connectors, as shown in Japanese Patent Application 2002-289309, the terminals of two connector parts are opposed to each other at a spatial interval. This connector has a dielectric body disposed between the terminals opposed to each other at the spatial interval.

However, in that conventional connector, there is a problem in that each of the plate-like terminals are raised upright toward a mating connector to allow the surfaces thereof to oppose each other, thereby causing increase in height of the connector.

Furthermore, the disclosure in JP 2002-289309 is unclear in that it is not explained whether the terminals can sandwich the dielectric body, or whether the terminals can be prevented from being damaged by the dielectric body, because the terminals are moved along a raised direction when the connectors are fitted to each other.

The Present Invention has been made in view of the above-mentioned problems, and it is an object of the Present Invention to provide a connector and a terminal holding member capable of achieving reduction in height thereof.

SUMMARY OF THE INVENTION

In order to solve the above-mentioned problem, according to the Present Invention, a connector includes at least one first planar terminal formed in a plate-like shape and having one surface electrically connected to a wiring circuit formed on a first flat circuit substrate in the form of a circuit board or flat flexible circuitry and another surface serving as a capacitive-coupling surface; at least one second planar terminal, also formed in a plate-like shape and having one surface electrically connected to a wiring circuit formed on a second flat circuit board or flexible circuitry and another surface serving as a capacitive-coupling surface; a dielectric portion formed between the capacitively-coupling surfaces of the first and the second terminals; and, means for coupling the first and second flat circuit substrates together so that the

capacitively-coupling surfaces of the first and second terminals are opposed to each other, with the dielectric portion interposed between them.

According to the Present Invention, each of the terminals is formed in a planar manner and has one surface thereof electrically connected to a respective wiring circuit formed on the flat circuit substrate and another surface serving as the capacitive-coupling surface for
5 sandwiching the dielectric portion, thereby making it possible to achieve a reduction in height of the connector.

According to one aspect of the Present Invention, the coupling means includes a press contact mechanism which is formed between the first and second circuit substrates which
10 generates a pressing contact force that retains the first and second circuit substrate together and which allows the first and second terminals to be brought into pressing contact with the dielectric portion. With this structure, it is possible to suppress entering of air or the like between the terminals and the intervening dielectric portion.

In the basic aspect of the Present Invention, a receptacle connector is provided with a
15 receptacle frame member attached to a first circuit substrate; at least one first planar terminal having one surface electrically connected to a wiring circuit formed on the first circuit substrate and another surface serving as a capacitive-coupling surface. The connector also includes a plug frame member attached to a second circuit substrate. The plug frame member engages the receptacle frame member in the manner of a plug and receptacle connector and it included at
20 least one second planar terminal that has one surface electrically connected to a wiring circuit formed on the second circuit substrate and another surface serving as a capacitive-coupling surface. The connector still further includes a dielectric portion formed on at least one of the capacitively-coupled surfaces of the first and second terminals, and is characterized in that, when the female and male frame members are fitted to each other, the capacitively-coupled surfaces of
25 the first and second terminals are opposed to each other through interposition of the dielectric portion.

Each of the terminals is preferably formed in a planar configuration and has one surface electrically connected to the wiring circuit formed on the circuit substrates, and another surface serving as the capacitive-coupling surface for sandwiching the dielectric portion, thereby making
30 it possible to achieve reduction in height of the connector.

The connector may includes a plurality of first terminals and second terminals corresponding in number to each other and aligned with each other so that when the two frame members are engaged with each other, the capacitively-coupled surfaces of the first and second terminals are opposed each other. With this structure, by the fitting of the frames together, a plurality of pairs of terminals can be capacitive-coupled together to electrically connect the two circuit substrates together without utilizing any galvanic connection.

According to an aspect of the Present Invention, the plug and receptacle frame members include a press contact mechanism for bringing the first terminals and the second terminals into pressing contact with the dielectric portion by exerting a force which attracts the female frame to a side of the second circuit substrate to which the male frame member is attached, and a force which attracts the male frame member to a side of the first circuit substrate to which the female frame member is attached, when the female and the male frame members are fitted to each other. With this structure, it is possible to suppress entering of air between the terminals and the dielectric portion.

According to this aspect, as a part of the press contact mechanism, a first tapered portion formed with an inclined surface is provided facing one side of the first circuit substrate to which the female frame member is attached, while the male frame member includes, as a part of the press contact mechanism, a second tapered portion formed with an inclined surface corresponding to the inclined surface of the female frame member first tapered portion and facing a side of the second flat circuit substrate to which the male frame member is attached; and at least one of the first tapered portion and the second tapered portion includes an elastic member. The first and second tapered portions are fitted in a state where the elastic member is deformed in a horizontal direction of the first and second terminals, and a restoring force of the elastic member is converted into the force for attracting the female frame member and the force for attracting the male frame member.

A pair of the first tapered portions and a pair of the second tapered portions may be provided to the first terminal and the second terminal, respectively, on both sides thereof in a horizontal direction. With this structure, it is possible to bring the first terminal and the second terminal into pressing contact with each other from the both sides thereof.

A plurality of the first terminals and the second terminals each may be provided in a predetermined arrangement direction, and the first tapered portions and the second tapered

portions may be extended in the predetermined arrangement direction. With this structure, it is possible to uniformize a force for holding the dielectric portions in press contact between the first terminals and the second terminals.

According to another aspect of the Present Invention, the receptacle frame includes first protruding portions which protrude, on sides thereof close to the second flat circuit substrate more than on sides thereof close to the first flat circuit substrate, toward the plug frame, the plug frame includes second protruding portions which protrude, correspondingly to the first protruding portions, on sides thereof close to the first circuit substrate more than on sides thereof close to the second circuit substrate, toward the receptacle frame, and the first protruding portions are inserted into gaps formed between the second protruding portions and the second circuit substrate, respectively, and the second protruding portions are inserted into gaps formed between the first protruding portions and the first circuit substrate, respectively. With this structure, the receptacle frame and the plug frame are fitted to each other by the protruding portions which protrude to the mating member, so it is possible to achieve reduction in height of the connector.

According to this aspect, the first protruding portions (212h, 214h) are formed to be thicker than the gaps formed between the second protruding portions (312h, 314h) and the second flat circuit substrate (8), and/or the second protruding portions (312h, 314h) are formed to be thicker than the gaps formed between the first protruding portions (212h, 214h) and the first flat circuit substrate (7). With this structure, the first terminal and the second terminal can be brought into pressing contact with the dielectric portion, so it is possible to suppress entering of air or the like between the terminals and the dielectric portion.

Furthermore, a connector according to the Present Invention includes: at least one terminal formed in a plate-like shape and having one surface electrically connected to a wiring circuit formed on a first flat circuit substrate and another surface serving as a first capacitive-coupling surface; a dielectric portion formed on the first capacitive-coupling surface of the terminal; and coupling means which couples the first flat circuit substrate and the second flat circuit substrate so that the first capacitive-coupling surface of the terminal and a second capacitive-coupling surface of a conductor portion conducted to a wiring circuit formed on a second flat circuit substrate are opposed to each other through intermediation of the dielectric

portion. With this structure, the dielectric portion is sandwiched between the plate-like terminals, so it is possible to achieve reduction in height of the connector.

Additionally, a terminal holding member according to the Present Invention is characterized by including: a plate-like substrate; and at least one terminal having, on a side of one surface of the plate-like substrate, a connection surface connected to a circuit provided on a first flat circuit substrate, and on a side of another surface of the plate-like substrate, a first capacitive-coupling surface opposed each other, through intermediation of a dielectric portion, to a second capacitive-coupling surface of a conductor portion, which is conducted to a circuit provided on a second flat circuit substrate, and is characterized in that the terminal holding member are arranged between the first flat circuit substrate and the second flat circuit substrate so that the dielectric portion is sandwiched between the first capacitive-coupling surface and the second capacitive-coupling surface. With this structure, the dielectric portion is sandwiched between the plate-like terminals, so it is possible to achieve a great reduction in height of the connector and utilize heights that are about 0.5mm.

BRIEF DESCRIPTION OF THE FIGURES

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

Fig. 1 is a sectional view of a connector constructed in accordance with the principles of the Present Invention;

Fig. 2A is a perspective view of the female frame member, or receptacle connector, of the connector of Fig.1;

Fig. 2B is an exploded perspective view of the receptacle of Fig. 2A, with the terminal assembly thereof removed for clarity;

Fig. 2C is a top plan view of the receptacle connector of Fig. 2A;

Fig. 2D is a bottom plan view of the receptacle connector of Fig. 2A;

Fig. 2E is a sectional view of the receptacle connector of Fig. 2C; taken along Line E-E;

Fig. 2F is a side elevational view of the terminal assembly of the receptacle connector;

Fig. 2G is an enlarged sectional view of the terminal assembly of Fig. 2F, taken along Line G-G;

Fig. 3A is a perspective view illustrating the receptacle connector aligned for amounting to a flat circuit substrate;

5 Fig. 3B is the same view as Fig. 3A, but with the receptacle connector mounted to the circuit substrate;

Fig. 4A is a perspective view of a male, or plug, connector of the connector assembly of Fig. 1;

Fig. 4B is an exploded perspective view of the plug connector of Fig. 4A;

10 Fig. 4C is a top plan view of the plug connector of Fig. 4A;

Fig. 4D is a bottom plan view of the plug connector of Fig. 4A;

Fig. 4E is a sectional view of the plug connector of Fig. 4C, taken along Line 4E-4E;

Fig. 4F is a side elevational view of the terminal assembly of the plug connector;

15 Fig. 4G is an enlarged detail sectional view of the terminal assembly of Fig. 4F, taken along Line 4G-4G thereof;

Fig. 5A is a perspective view illustrating the plug connector aligned with a second flat circuit substrate;

Fig. 5B is the same view as Fig. 5A, but illustrating the plug connector mounted to the circuit substrate;

20 Fig. 6A is a diagram view illustrating a retaining effect by way of the forces applied to the receptacle of the connector of Fig. 1;

Fig. 6B is a diagram similar to Fig. 6A, but illustrating the retaining effect by way of the forces applied to the plug of the connector of Fig. 1;

25 Fig. 7 is a sectional view of a second embodiment of a connector assembly constructed in accordance with the Present Invention, in which only one terminal assembly is utilized;

Fig. 8A is a perspective view of the receptacle connector utilized in the connector assembly of Fig. 7;

Fig. 8B is a widthwise sectional view of the female connector of Fig. 8A;

30 Fig. 9A is a perspective view of the male connector utilized in the connector assembly of Fig. 7;

Fig. 9B is a widthwise sectional view of the male connector of Fig. 9A; and

Fig. 10 is a sectional view of a third embodiment of a connector constructed in accordance with the principles of the Present Invention in which the male and female frame members have stepped shoulder portions for engaging each other.

5 **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

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

10 Fig. 1 is a sectional view of a connector 1 according to an embodiment of the Present Invention. The connector 1 includes a female, or receptacle, connector 2 attached to a first extent of flexible printed circuit ("FPC") 7, and a male, or plug, connector 3 attached to a second extent of FPC 8. The receptacle connector 2 has a hollow frame member 21, and plate-like first planar terminals 25 are supported by the receptacle frame 21. On the other hand, the plug
15 connector 3 has a plug frame 31, and plate-like planar second terminals 35 that are supported by the plug frame 31. Furthermore, surfaces of the planar second terminals 35 are provided with dielectric portions 37.

When the receptacle frame 21 and the plug frame 31 are fitted to each other, the first terminals 25 and the second terminals 35 are opposed to each other through the intermediation of
20 the dielectric portions 37, and are capacitive-coupled with each other. As a result, the connector 1 can function as a high-pass filter, thereby making it possible to transmit high-frequency signals between the first FPC 7 and the second FPC 8.

Note that, in this embodiment, for an example of a flat circuit substrate, flexible printed circuitry is used. However, the flat circuit substrate is not limited to such a structure and can also
25 incorporate other circuit substrates, such as a printed circuit board.

The receptacle connector 2 and its receptacle frame 21 have a rectangular frame shape and made of a resin having appropriate elasticity. The receptacle frame 21 includes a receptacle opening 219 bored therethrough in a vertical direction, and the plug frame 31 is inserted therein from a top surface 2a thereof. On the bottom surface 2b side of the short transverse end portions
30 218 of the receptacle frame 21, there are formed recesses 216. The terminal assembly 23 is fitted into the recessed portions 216. The terminal assembly 23 is formed with the plurality of first

terminals 25 aligned in a lengthwise direction. The first terminals 25 are arranged in the receptacle 219. In this manner, the plurality of first terminals 25 are positioned with respect to the receptacle frame 21.

On inner peripheral edges of long side portions 217 of the receptacle frame 21, first tapered portions 212 and 214 are formed and extend into the opening 219. The first tapered portions 212, 214 inwardly protrude largely on the top surface 2a of the frame, and have inclined surfaces 212c and 214c that are inclined downwardly in the opening 219 toward the bottom surface 2b of the frame, respectively. The first tapered portions 212 and 214 are part of a press contact mechanism described later. In other words, the distance between the top inner edges of the tapered portions 212, 214 is D1 and is less than the distance D2 between the bottom inner edges. This is shown best in FIG. 2E.

In the structure of the terminal assembly 23, as illustrated in Figs. 2F and 2G, conductor films 252 may be formed so as to be wound around an insulative plate-like substrate 232 in a width direction, thereby defining the first terminals 25. Accordingly, the conductive film 252 is also formed on end portions in the width direction of the substrate 232, thereby achieving conduction between the top surface (capacitively-coupling surface) 25a and the bottom surface 25a for each of the first terminals 25. The top surfaces 25a face similar surfaces on the plug connector and may be aptly considered as mating portions of the terminals while the bottom surfaces 25b, namely those joined to the circuit substrates may be considered as mounting portions of the terminals.

In this case, the substrate 232 can be a low dielectric substrate made of an insulative material such as a BT (bismaleimide-triazine) resin. The conductive film 252 can be a copper foil. In a specific example, to a surface of a substrate 232 made of the BT resin, a nickel undercoating is applied, gold plating is further applied thereto, and the conductor film 252 made of the copper foil is disposed thereon. Note that, the terminal assembly 23 is not limited to this aspect and may be formed, for example, by integrally molding metal plates as the first terminals 25 on resin material. The terminals may also be formed as conductive plastics or plated plastics.

As shown in Fig. 3A, on a connecting surface of the first FPC 7, there are formed a plurality of wiring circuits 73. On end portions of the wiring circuits 73, terminals 732 are formed, respectively. Further, on the surface of the first FPC 7, there are also formed ground wires 77 for electrically protecting the wiring circuits 73. The receptacle connector 2 is mounted

to the surface of the first FPC 7 as shown in FIG. 3B. Specifically, the bottom surface 2b of the receptacle frame 21 is joined to the connecting surface of the first FPC 7. As a result, the bottom surfaces 25b of the plurality of first terminals 25 provided to the receptacle connector 2 and the plurality of terminals 732 formed on the surface of the first FPC 7 are allowed to abut each other, and thereby electrically connect with each other.

Note that, in this embodiment, the bottom surfaces 2b of the short side portions 218 of the receptacle frame 21 are joined to the connecting surface of the first FPC 7, and the bottom surfaces 2b of the long side portions 217 are not joined to the connecting surface of the first FPC 7. This structure permits elastic deformation of the long side portions and is employed for easily generating a restoring force when the long side portions 217 are pushed to be widened in the widthwise direction of the connector.

Turning to Figs. 4A-B, the plug connector 3 includes a flat plug frame 31 having a rectangular shape and made of an insulating resin. The plug frame 31 includes two frame portions 316 extending lengthwise and a plurality of connection portions 317 extending widthwise for connecting the frame portions 316 to each other, and is formed in a ladder-like shape. Further, between the adjacent connection portions 317, accommodation openings 318 are formed and extend vertically.

Further, a top surface 3a of the connection portions 317 is concave compared to the top surface 3a of the lengthwise frame portions 316. A space formed by a concave section on the top surface 3a of the connection portion 317 serves as an installation space for the terminal assembly 23 provided to the receptacle connector 2.

On the other hand, a bottom surface 3b of the connection portions 317 is also concave compared to the bottom surface 3b of the frame portions 316. In a space formed by a concave section on the bottom surface 3b side of the connection portion 317, the terminal assembly 33 is disposed. The terminal assembly 33 has the plurality of second planar terminals 35 formed thereon and aligned in the lengthwise direction. The connection portions 317 are aligned so as to form the opening 318 in positions corresponding to the second terminals 35.

Further, on the plurality of second terminals 35 formed on the terminal assembly 33, a like plurality of dielectric portions 37 are arranged, respectively. The dielectric portions 37 are accommodated in the openings 318. As described above, the plurality of second terminals 35 and the plurality of dielectric portions 37 are positioned with respect to the plug frame 31.

On outer edges of the frame portions 316 of the plug frame 31, second tapered portions 312 and 314 protruding outwardly are formed, respectively. The second tapered portions 312 and 314 protrude outwardly largely on the top surface 3a, and have inclined surfaces 312c and 314c facing the bottom surface 3b, respectively. The second tapered portions 312 and 314 are combined with the above-mentioned first tapered portions 212 and 214 to constitute the press contact mechanism. Both tapered portion take advantage of their wedge shape to apply the retention forces described in more detail below.

In the terminal assembly 33, as illustrated in Figs. 4F-G, the conductive film 352 is formed so as to be wound around an insulative substrate 332 widthwise, thereby forming the second terminals 35. In this manner, the conductive film 352 is also formed on end portions widthwise of the substrate 332, thereby achieving conduction between a top surface (capacitive-coupling surface) 35a side and a bottom surface 35a side of the second terminals 35. The terminal assembly 33 of the plug connector may be structured in the same manner as that of the terminal assembly 23 for the receptacle connector. The height of this substrate will affects the height of the terminal assembly, which, in turn affects the overall height of the connector.

The dielectric portion 37 preferably is made of a high dielectric ceramic material such as barium titanate, and may be joined to the top surface 35a of the second terminal 35 by an adhesive or the like. Specifically, a copper layer may be formed on the surface of the dielectric portion 37 through vapor deposition or the like, and the copper layer is joined to the top surface 35a of the second terminal 35 through soldering. As a result, without forming an air layer between the second terminal 35 and the dielectric portion 37, those are reliably joined to each other.

This is not required, and the dielectric portion 37 may be formed on the front surface 35a of the second terminal 35, by sputtering or printing. Note that, not limited to the top surfaces 35a of the second terminals 35, the dielectric portions 37 may be provided to the top surfaces 25a of the first terminals 25.

On a connecting surface of the second FPC 8, there are formed a plurality of wiring circuits 83, and terminals 832 are formed on end portions of the wiring circuits 83, respectively. Further, on the connecting surface of the second FPC 8, there are also formed ground wires 87 for electrically protecting the wiring circuits 83.

The plug connector 3 is mounted to the connecting surface of the second FPC 8. Specifically, the bottom surface 3b side of the plug frame 31 is joined to the connecting surface of the second FPC 8. As a result, bottom surfaces 35b of the plurality of second terminals 35 are provided to the plug connector 3 and the plurality of terminals 832 formed on the connecting surface of the second FPC 8 abut on each other, to thereby be electrically connected to each other.

The receptacle connector 2 attached to the first FPC 7 and the plug connector 3 attached to the second FPC 8 as described above are fitted to each other as illustrated in Fig. 1. Specifically, the plug frame 31 before hardening is inserted into the receptacle frame 21 before hardening so as to outwardly push and widen the long side portions 217. The plug and receptacle frames are preferably made from an elastically deformable material as described below, so that an assembler may squeeze, or pinch, the plug frame together in order to insert it into the receptacle frame. Likewise, the plug frame may be pushed into the receptacle frame in a manner so that it forces one or both sidewalls of the receptacle frame outwardly until the plug frame enters the receptacle opening and then due to the elasticity of the receptacle frame, it rebounds, or returns to its original shape and engages the plug frame.

As a result, the front surfaces 25a of the first terminals 25 are positioned with respect to the receptacle frame 21 and the front surfaces 35a of the second terminals 35 positioned with respect to the plug frame 31 are opposed to each other with the dielectric portions 37 interposed therebetween.

In this manner, the first terminals 25 and the second terminals 35, each of which is formed in a planar configuration, are arranged in parallel to the first and second extents of FPC 7, 8, respectively. The plate-like dielectric portions 37 are sandwiched between the top surfaces 25a of the first terminals 25 and the top surfaces 35a of the second terminals 35, thereby realizing reduction in height of the connector 1.

Further, when the plug frame 31 is inserted into the receptacle frame 21, the dielectric portions 37 provided to the plug frame 31 are pressured so as to be closer to the first terminals 25 while being kept opposing the first terminals 25 provided to the receptacle frame 21. Accordingly, the dielectric portions 37 can be appropriately brought into contact with the top surfaces 25a of the first terminals, and it is possible to prevent the dielectric portions 37 from damaging the top surfaces 25a of the first terminal 25.

Note that, in this embodiment, the combination of the receptacle frame 21 and the plug frame 31 is taken as an example of coupling means. However, the coupling means is not limited to this aspect as long as it is capable of coupling the first FPC 7 and the second FPC 8 to each other such that the top surfaces 25a of the first terminals 25 and the top surfaces 35a of the second terminals 35 are opposed to each other through the interposing of the dielectric portions 37.

Further, in this embodiment, by the press contact mechanism obtained by combining the first tapered portions 212 and 214 and the second tapered portions 312 and 314, the first terminals 25 and the second terminals 35 are brought into pressure contact with the dielectric portions 37, so it is possible to suppress entering of air or the like therebetween. In other words, the combination of the elastic deformation of one of the two frame members and the inclined surfaces serves to press the two connector frames into close and reliable contact with each other. Further, it is possible to prevent change in dielectric constant between the first terminals 25 and the second terminals 35 due to the pressure and the elimination of air. Although each of the individual members that make up the connection has an individual dielectric constant, the connector as a whole has an effective dielectric constant. Introducing air into the gap between the contacts and the dielectric portion can affect the overall dielectric constant.

That is, as illustrated in Figs. 6A-B, when the receptacle frame 21 and the plug frame 31 are fitted to each other, inclined surface 214c of the first tapered portion 214 and the inclined surface 314c of the second tapered portion 314 abut on each other. In this case, the receptacle frame 21 is formed of an elastic resin material, and the plug frame 31 is inserted therein while being outwardly pushed and widened, so there is generated an inward restoring force, while maintaining a significant reduction in height.

Thus, as illustrated in Fig. 6A, the first tapered portion 214 of the receptacle connector frame transmits a restoring force f_2 to the second tapered portion 314 of the plug connector frame in a direction perpendicular to the inclined surface 214c. The restoring force f_2 can be divided into a horizontal component f_{2h} and a vertical component f_{2v} . The vertical component f_{2v} serves as a force for pulling the plug frame 31 to the side of the first FPC 7 to which the receptacle frame 21 is attached. Accordingly, the second terminals 35 provided to the plug frame 31 are brought into pressing with the dielectric portion 37. Further, the dielectric portions 37 are also brought into pressing contact with the first terminals 25.

Further, as illustrated in Fig. 6B, the second tapered portion 314 of the plug connector frame generates a reaction force against the restoring force, so it transmits a reaction force f_3 to the first tapered portion 214 in a direction perpendicular to the inclined surface 314c. The reaction force f_3 can be divided into a horizontal component f_{3h} and a vertical component f_{3v} .

5 The vertical component f_{3v} serves as a force for pulling the receptacle frame 21 to the side of the second FPC 8 to which the plug frame 31 is attached. Accordingly, the first terminals 25 provided to the receptacle frame 21 are brought into pressing contact with the dielectric portion 37. Further, the dielectric portions 37 are also brought into pressing with the second terminals 35. In other words, the wedge-shapes of the plug and receptacle frames apply a downward
10 pressure on both frames, *i.e.*, toward the circuit substrates.

Note that, in this embodiment, there is provided an example of the pressing contact mechanism obtained by combining the first tapered portions 212 and 214 and the second tapered portions 312 and 314. However, the press contact mechanism is not limited to this aspect as long as it is a mechanism in which the first terminals 25 and the second terminals 35 can be brought
15 into pressing contact with the dielectric portions 37.

As illustrated in another embodiment that is illustrated in Figs. 8A-9C, the receptacle connector 2B is defined by the receptacle frame 21. That is, the receptacle connector 2B does not include a terminal assembly 23 of the above embodiment, on which the first terminals 25 are formed. As illustrated in Figs. 9A-B, the plug connector terminal assembly 33 is attached to the
20 plug frame 31, and on the second terminals 35 formed on this terminal assembly 33, the dielectric portions 37 are disposed. In this modification, the total thicknesses of the second terminals 35 and dielectric portions 37 are set substantially equal to the thickness of the plug frame 31.

The receptacle connector 2B and the plug connector 3B structured as described above are
25 fitted to each other as illustrated in Fig. 7. In this case, the second terminals 35 and the terminals 832 (refer to Fig. 5A described above) on the wiring circuits 83 provided to the surface of the first FPC 7 are opposed to each other through the intermediation of the dielectric portions 37. With this structure, the height of the connector 1B can be set substantially equal to the total thicknesses of the second terminals 35 and dielectric portions 37, whereby it is possible to
30 achieve further reduction in height thereof. With connectors of the invention, it is possible to obtain connectors heights of less than about 1.0 mm and heights of about 0.5 mm are obtainable.

On an inner peripheral edge of a receptacle frame 21C of a receptacle connector 2C, first protruding portions 212h and 214h are formed which inwardly protrude on the top surface 2a with respect to the bottom surface 2b. Meanwhile, on an outer edge of a plug frame 31C of a plug connector 3C, second protruding portions 312h and 314h are formed which outwardly protrude on the front surface 3a side with respect to the bottom surface 3b.

Those receptacle frame 21C and plug frame 31C are fitted with each other by inserting the first protruding portions 212h and 214h into gaps between the second protruding portions 312h and 314h and the second FPC 8, respectively, and by inserting the second protruding portions 312h and 314h into gaps between the first protruding portions 212h and 214h and the first FPC 7, respectively.

Further, the first protruding portions 212h and 214h formed on the receptacle frame 21C are formed to be thicker than the respective gaps between the second protruding portions 312h and 314h and the second FPC 8. The receptacle frame 21C is formed of an elastic resin material, and the first protruding portions 212h and 214h are inserted into the gaps between the second protruding portions 312h and 314h and the second FPC 8, respectively, while being pushed and retracted. With restoring forces thus generated, the second protruding portions 312h and 314h are pressed to the first FPC 7 side. That is, the restoring forces of the first protruding portions 212h and 214h are forces which attract the plug frame 31C to the first FPC 7 side. As a result, the second terminals 35 and the terminals 832 (refer to Fig. 3A described above) provided on the surface of the first FPC 7 are brought into press contact with the dielectric portions 37.

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

CLAIMS**WHAT IS CLAIMED IS:**

- 5 1. A connector comprising:
 at least one first planar terminal and having a first surface electrically connected
to a wiring circuit formed on a first circuit substrate and a second surface serving as a capacitive-
coupling surface;
 at least one second planar terminal having a first surface electrically connected to
10 a wiring circuit formed on a second circuit substrate and a second surface serving as a capacitive-
coupling surface;
 a dielectric portion formed on at least one of the second surfaces of the first and
second terminals; and
 means for coupling the first and second circuit substrates together so that said first
15 and second terminal second surfaces are disposed in opposition with the dielectric portion
interposed therebetween.
2. The connector according to Claim 1, wherein the coupling means includes a
pressing contact mechanism which is formed between said first circuit substrate and said second
20 circuit substrate, the pressing contact mechanism generating a force for attracting said first
circuit substrate and said second circuit substrate together and thereby allowing said first and
second terminals to be brought into pressing contact with the dielectric portion.
3. A connector comprising:
25 a receptacle frame attached to a first flat circuit substrate, the receptacle frame
including a center opening, and at least one conductive first terminal supported in the receptacle
opening, the first terminal including a mounting surface electrically connected to a circuit
disposed on the first circuit substrate and a mating surface, opposite said mounting surface, the
mating surface serving as a capacitive-coupling surface of said receptacle frame;
30 a plug frame attached to a second flat circuit substrate and adapted to mate with
said receptacle frame, and at least one conductive second terminal supported by the plug frame,

the second terminal having a mounting surface electrically connected to a circuit disposed on the second circuit substrate and a mating surface, opposite said second terminal mounting first surface, that serves as a capacitive-coupling surface; and

a dielectric portion formed on at least one of the capacitive-coupling surfaces of said first and second terminals;

characterized in that, when said receptacle and plug frames are fitted to each other, said capacitive-coupling surfaces of said first and second terminals are opposed to each other with the dielectric portion interposed therebetween, and said first and second terminals exert a pressing force on said dielectric portion.

4. The connector according to Claim 3, wherein:
said receptacle frame includes a plurality of first terminals, and said plug frame includes a plurality of second terminals corresponding in number to the said first terminals; and
when said receptacle and plug frames are fitted to each other, said capacitive-coupling surfaces of each of said second terminals are opposed to said capacitive-coupling surface of each of said first terminals corresponding thereto.

5. The connector according to Claim 3, wherein said receptacle and plug frames cooperatively define a pressing contact mechanism for bringing said first and second terminals into pressing contact with said dielectric portion by exerting a force which attracts said receptacle frame to a surface of said second circuit substrate to which said plug frame is attached, and a force which attracts said plug frame to a surface of said first circuit substrate to which said receptacle frame is attached when said receptacle frame plug frame are fitted together.

6. The connector according to Claim 5, wherein
said receptacle frame includes a pair of first inclined surfaces disposed on opposite sides of said center opening, the first inclined surfaces extending downwardly toward said first circuit substrate in an outwardly direction;
said plug frame includes a pair of second inclined surfaces disposed on opposite sides of said plug frame, the second inclined surfaces being complementary in configuration to

said first inclined surfaces, said second inclined surfaces extending downwardly toward said second circuit substrate in an outwardly direction; and

at least one of said first and second inclined surfaces being elastically deformable whereby it deforms outwardly in a horizontal direction during mating of said plug and receptacle frames together and rebounds inwardly after said receptacle and plug frames are mated together.

7. The connector according to Claim 3, wherein:

said receptacle frame comprises first protruding portions which protrude, on sides thereof close to the second flat circuit substrate more than on sides thereof close to the first flat circuit substrate, toward the plug frame;

the plug frame comprises second protruding portions which protrude, correspondingly to the first protruding portions, on sides thereof close to the first flat circuit substrate more than on sides thereof close to the second flat circuit substrate, toward the receptacle frame;

the first protruding portions are inserted into gaps formed between the second protruding portions and the second flat circuit substrate, respectively; and

the second protruding portions are inserted into gaps formed between the first protruding portions and the first flat circuit substrate, respectively.

8. The connector according to Claim 7, wherein the first protruding portions are formed to be thicker than the gaps formed between the second protruding portions and the second flat circuit substrate, and/or the second protruding portions are formed to be thicker than the gaps formed between the first protruding portions and the first flat circuit substrate.

9. A connector for connecting circuit substrates together, through a capacitively coupled mating interface, comprising:

a receptacle connector housing, the receptacle connector housing including a frame having a pair of sidewalls joined together by a pair of end walls, said receptacle connector housing further including a receptacle opening disposed therein, the sidewalls and endwalls defining a perimeter of the receptacle opening, said receptacle connector housing further including a terminal assembly supported thereon which supports a plurality of conductive

terminals therein, the receptacle terminals including respective mounting portions and mating portions disposed on opposite surfaces thereof, the terminal assembly being disposed within said receptacle and extending between two of said four walls of said receptacle connector housing and being located along a bottom surface of said receptacle opening;

5 a plug connector housing, the plug connector housing including a frame having a pair of sidewalls joined together by a pair of endwalls, said plug connector housing further including a terminal assembly supported thereon, the plug connector terminal assembly including a plurality of conductive second terminals, each of the second terminals including respective mounting and mating portions disposed on opposite surfaces thereof;

10 the plug connector housing sidewalls including exterior sides with inclined surfaces that extend at an angle toward a centerline of said second circuit substrate and the receptacle connector housing sidewalls including exterior sides with inclined surfaces, the plug and receptacle connector housing sidewall inclined surfaces being complementary configured to each other, whereby said plug connector housing is received and firmly held within said
15 receptacle; and

 a dielectric portion is interposed, under pressure, between the mating surfaces of said receptacle and plug connector terminals.

10. The connector of Claim 9, wherein said receptacle connector housing sidewall
20 inclined surfaces are angled toward said terminal mounting portions such that a distance separating said receptacle connector sidewalls from each other is greater at the bottom of said receptacle connector sidewalls than at the top of said receptacle connector sidewalls.

11. The connector of Claim 10, where one of said receptacle connector housing
25 sidewall inclined surfaces is longer than the other receptacle connector housing sidewall inclined surface.

12. The connector of Claim 9, wherein said dielectric portion includes a ceramic coating applied to at least one of said plug and receptacle connector terminal mating portions.

30

13. The connector of Claim 12, wherein said dielectric portion ceramic coating is disposed on both of said plug and receptacle connector terminal mating portions.

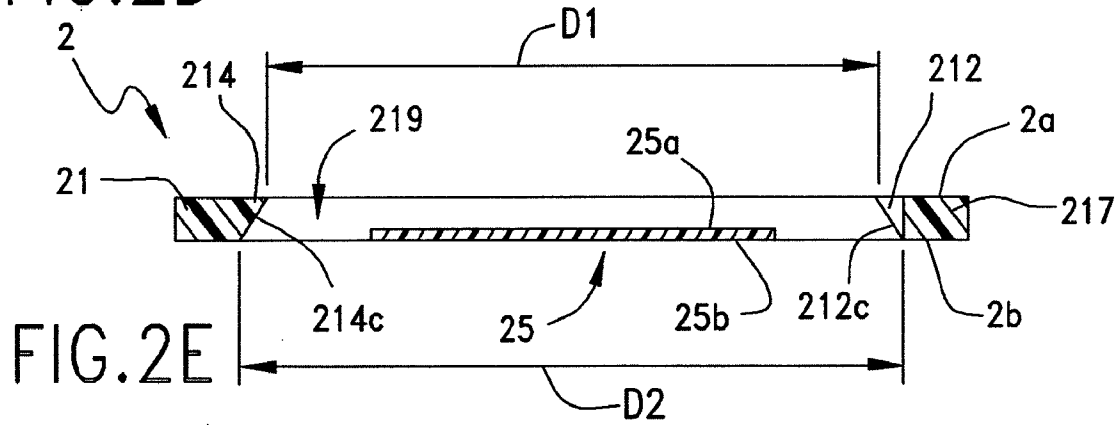
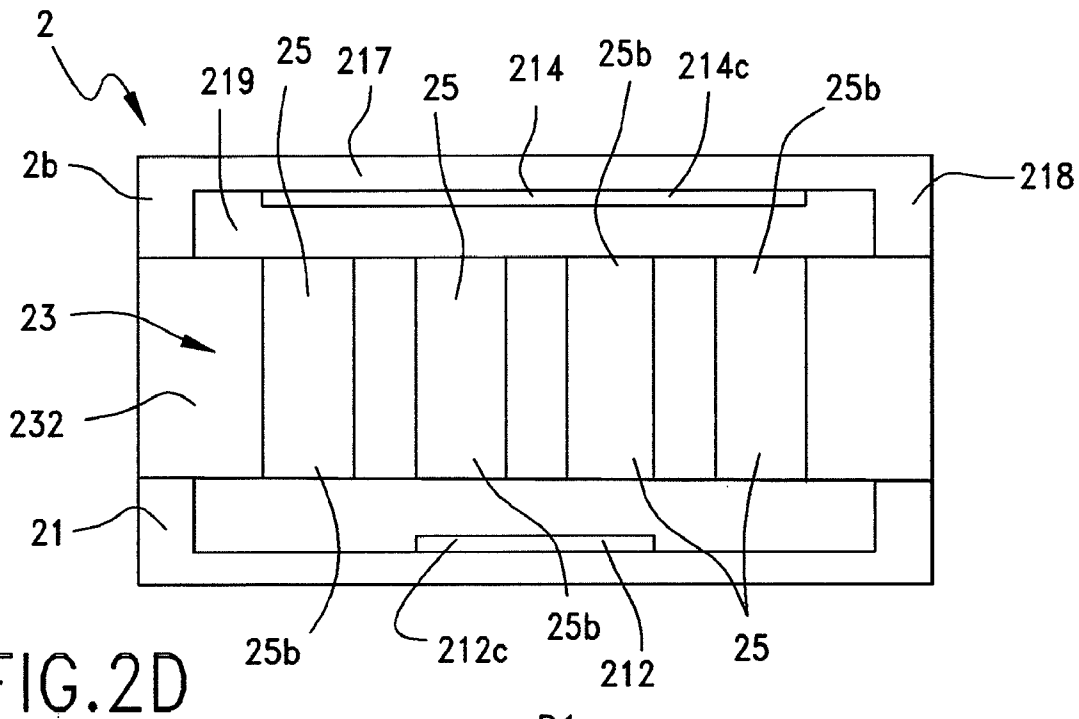
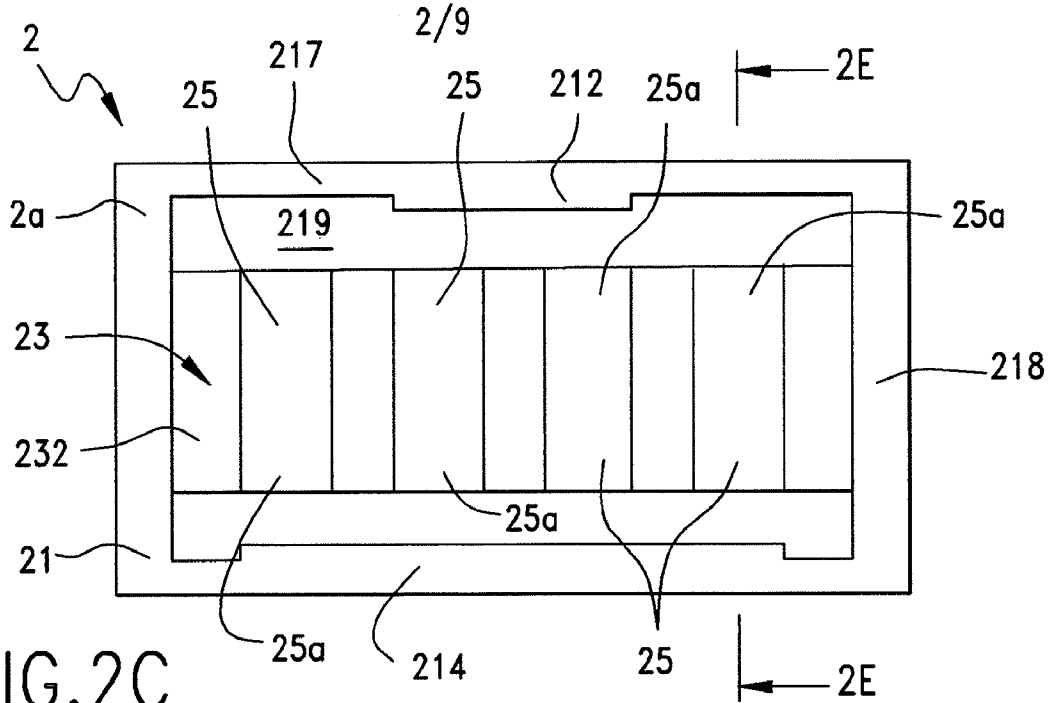
14. The connector of Claim 9, where said dielectric portion includes a dielectric film
5 disposed on at least one of said plug and receptacle connector terminal mating portions.

15. The connector of Claim 9, wherein said receptacle connector housing is capable of elastic deformation such that it applies a retaining force to said plug connector housing.

10 16. The connector of Claim 15, wherein said plug connector housing has a width that is greater than a corresponding width of said receptacle connector housing so that said receptacle connector housing elastically deforms when said plug connector housing is inserted into said receptacle.

15 17. The connector of Claim 15, wherein said receptacle connector housing sidewalls deform horizontally when said plug frame is mated to said receptacle frame.





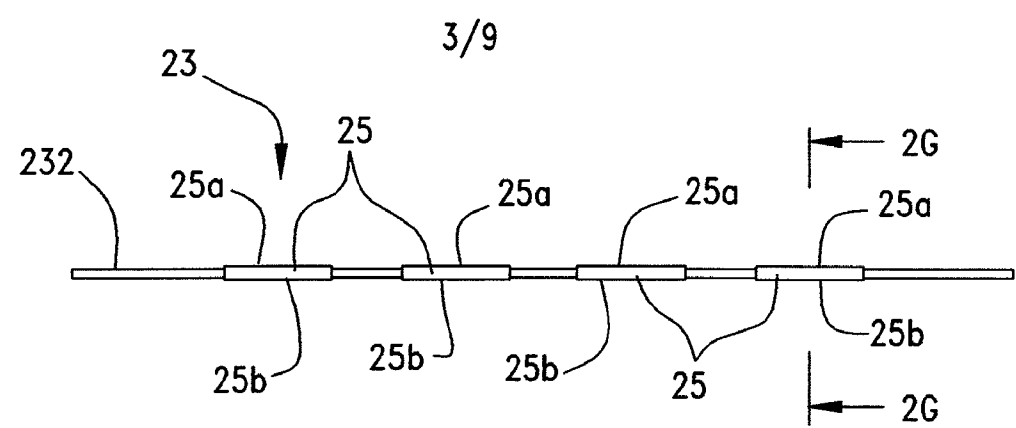


FIG. 2F

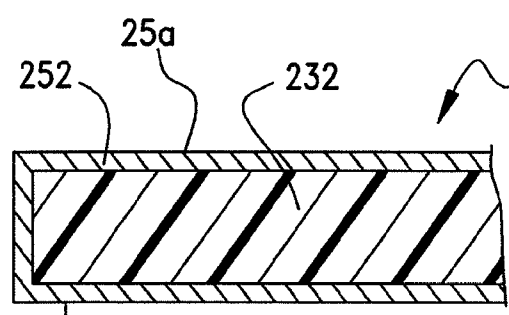


FIG. 2G

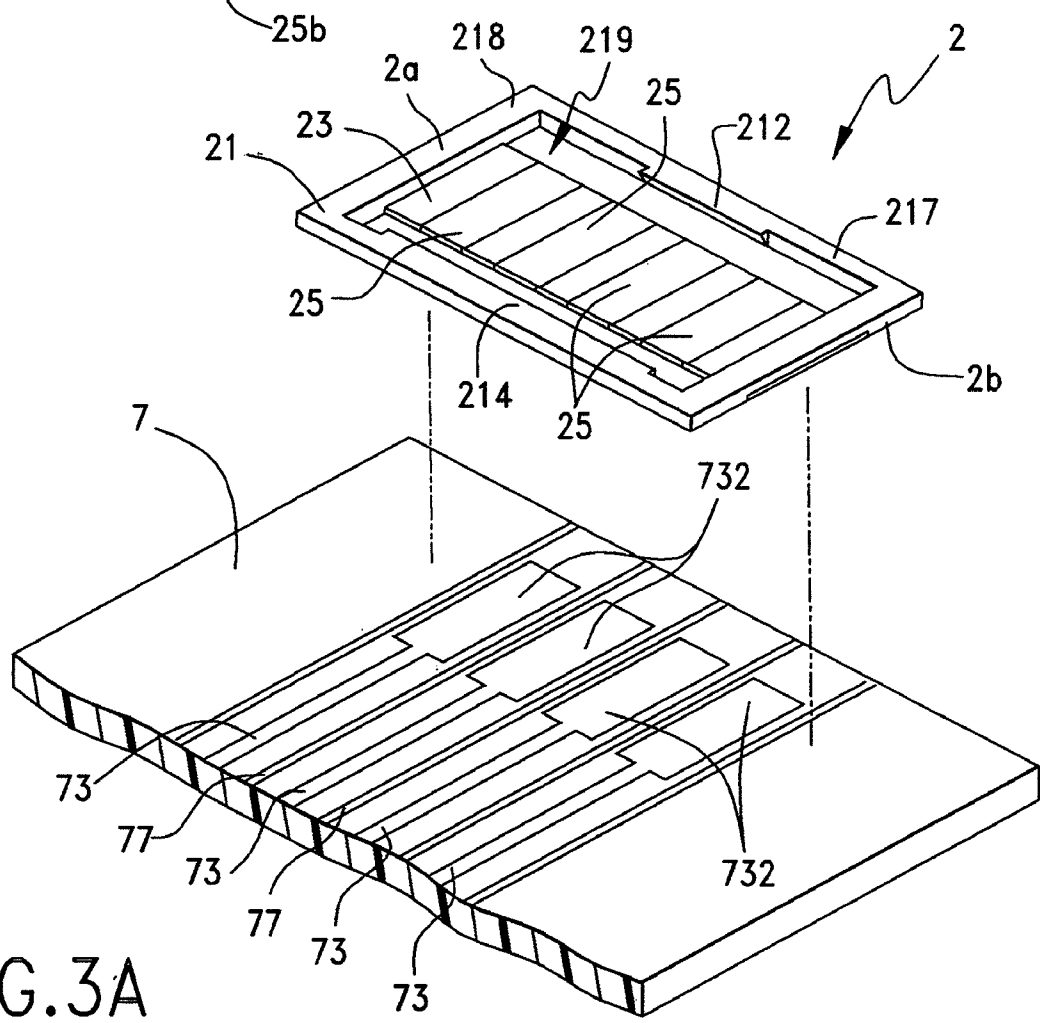


FIG. 3A

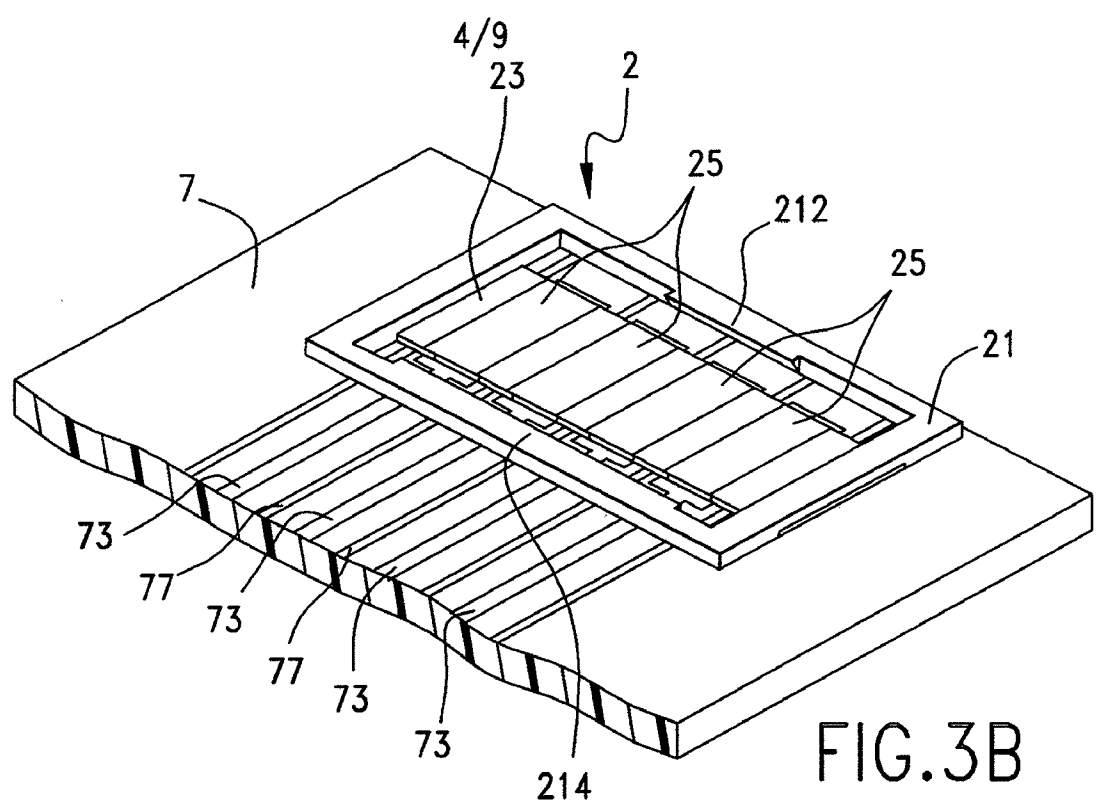


FIG. 3B

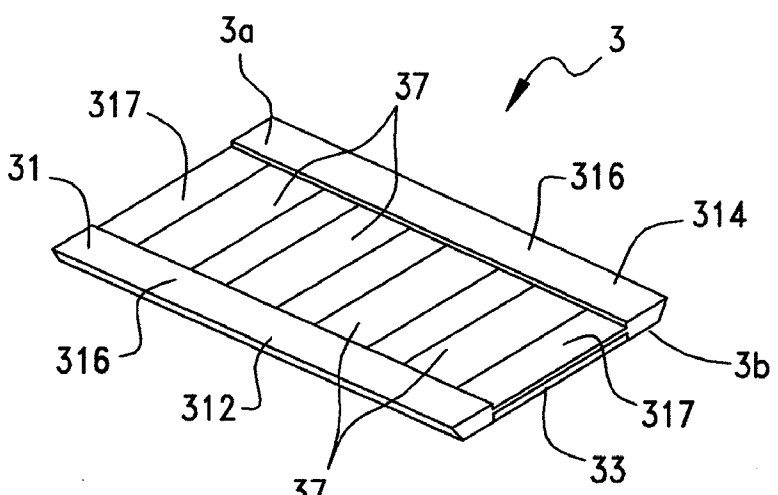


FIG. 4A

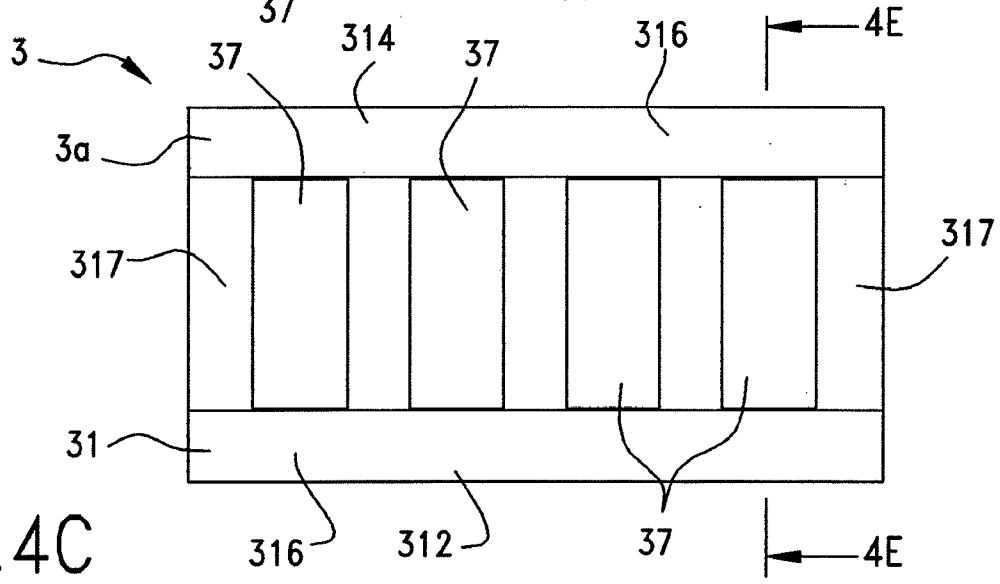
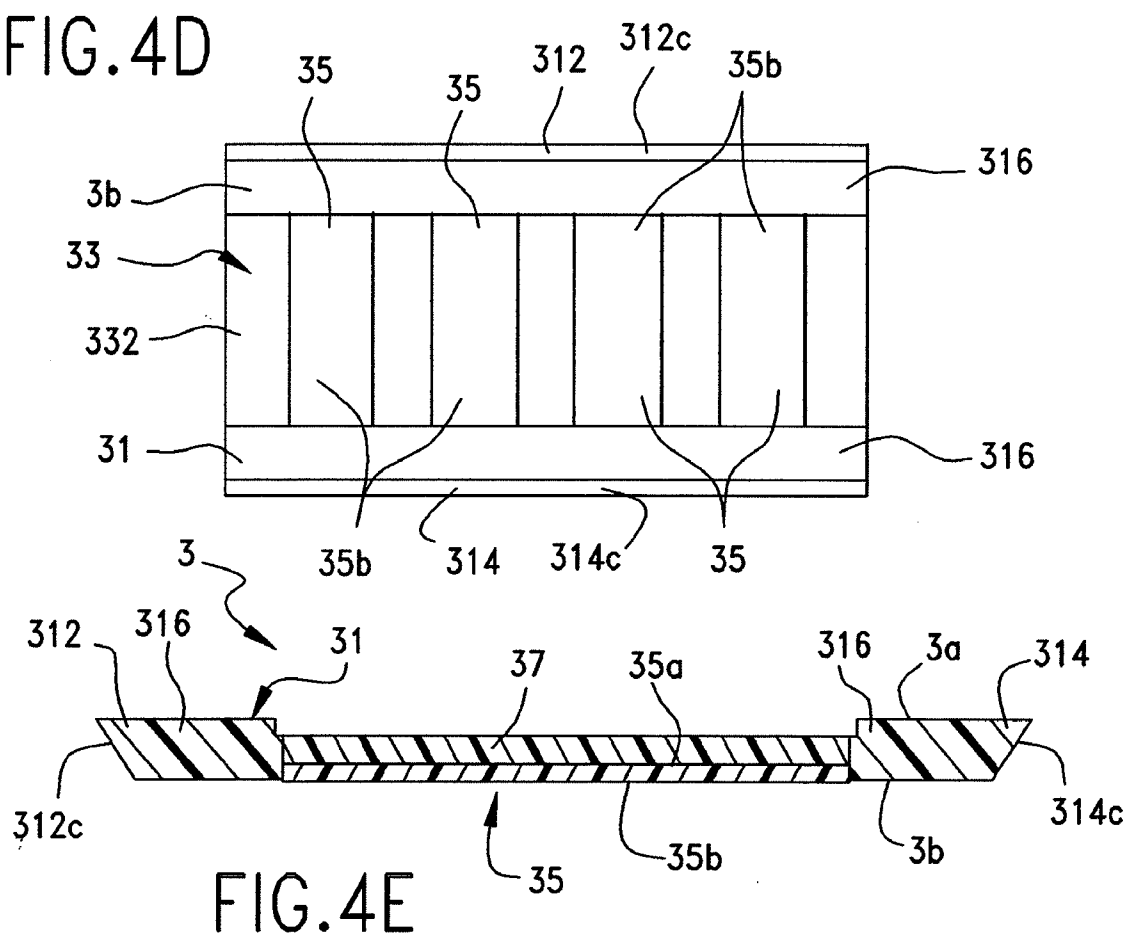
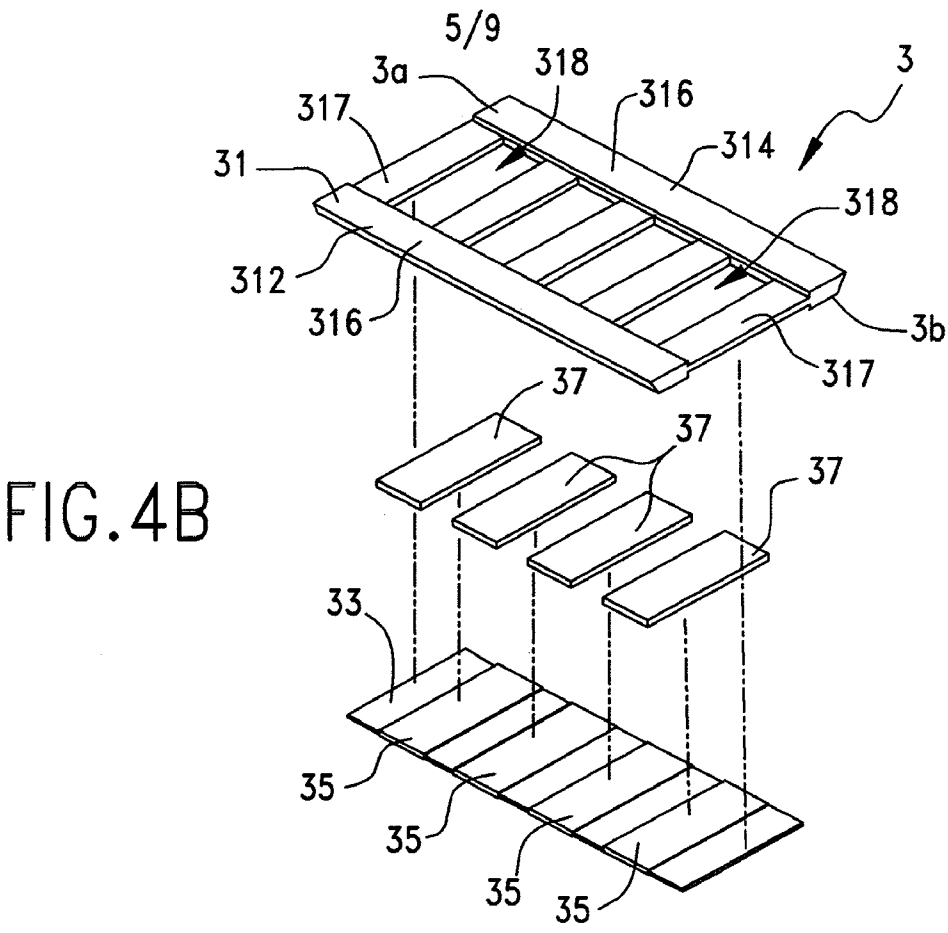
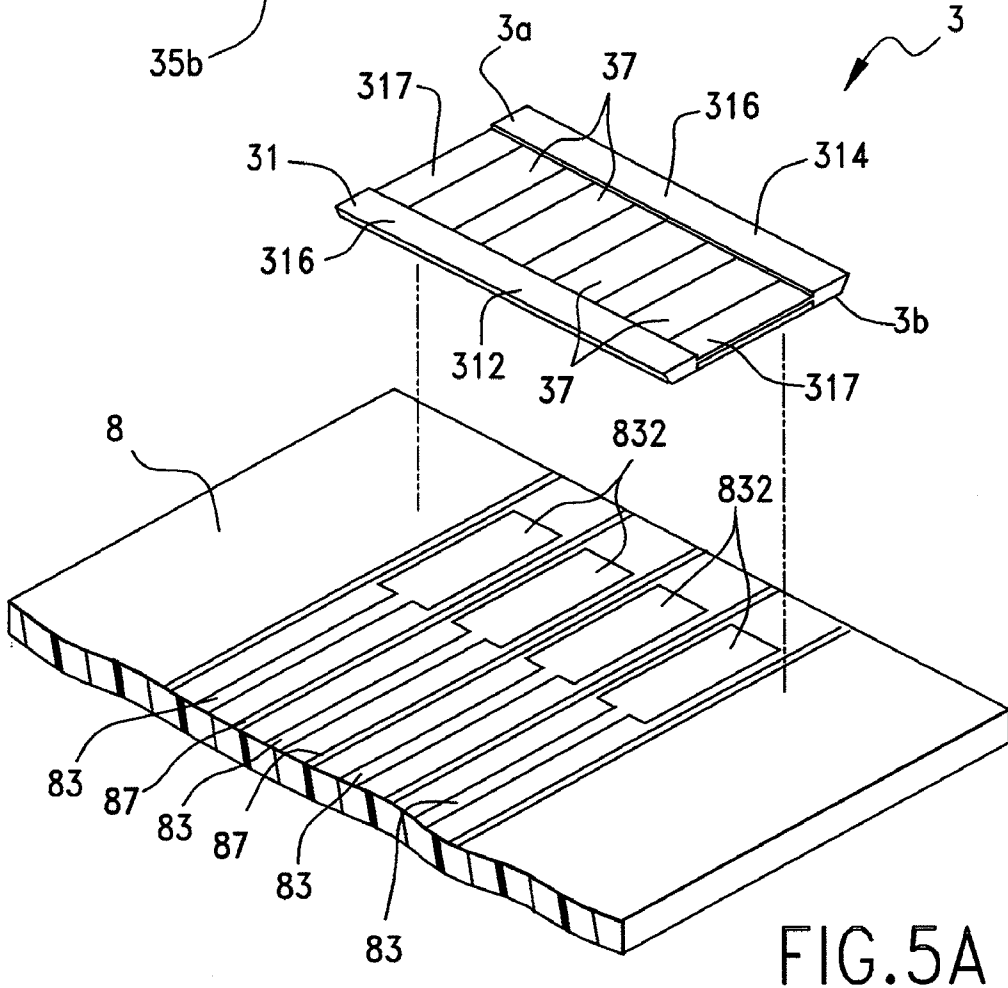
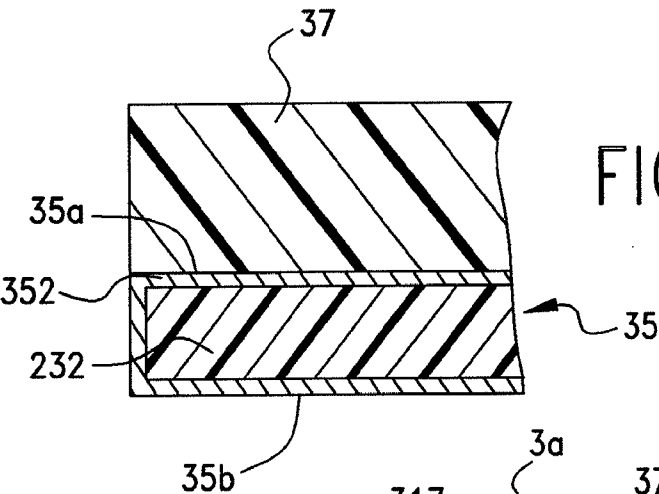
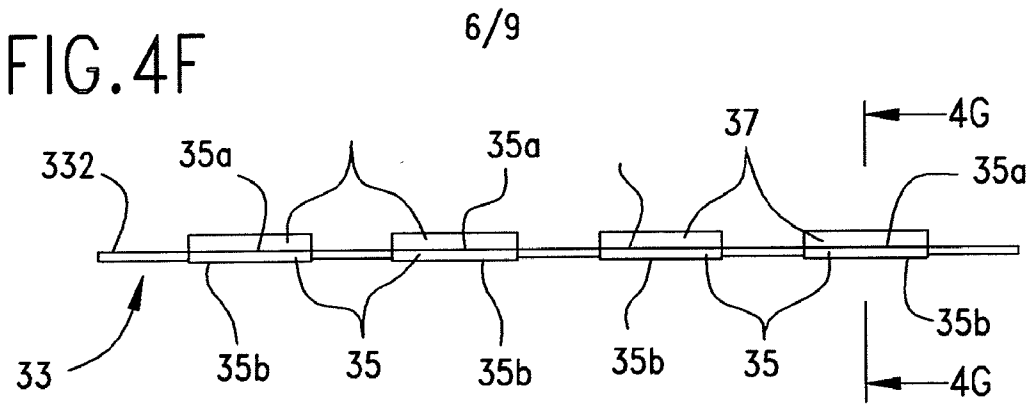
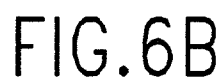
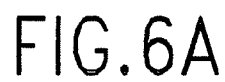
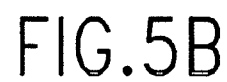
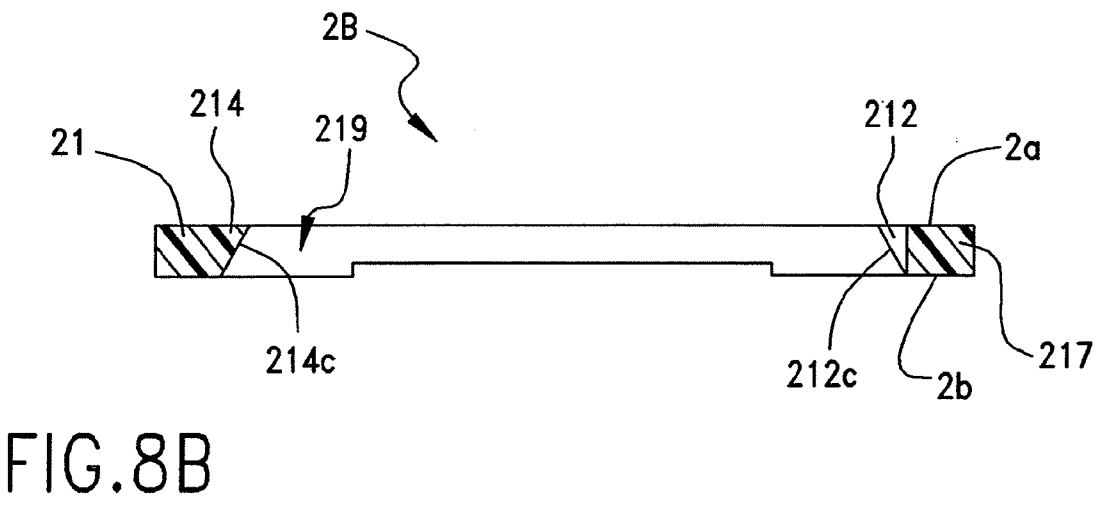
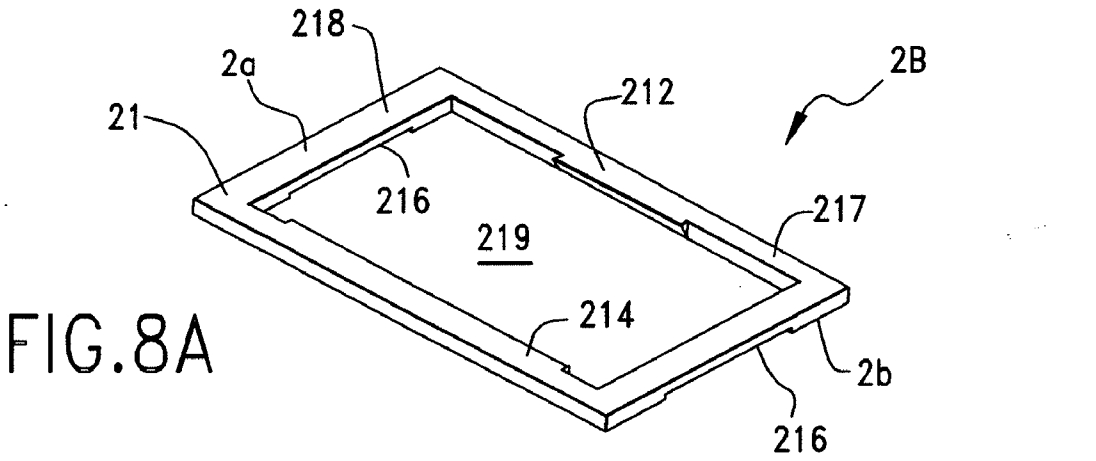
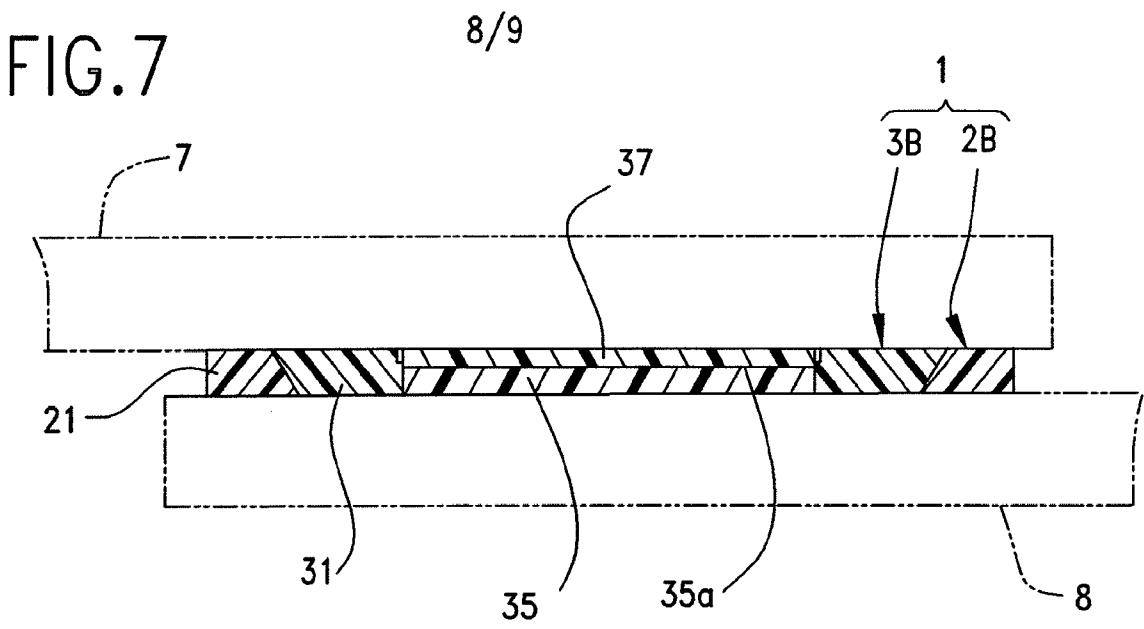


FIG. 4C









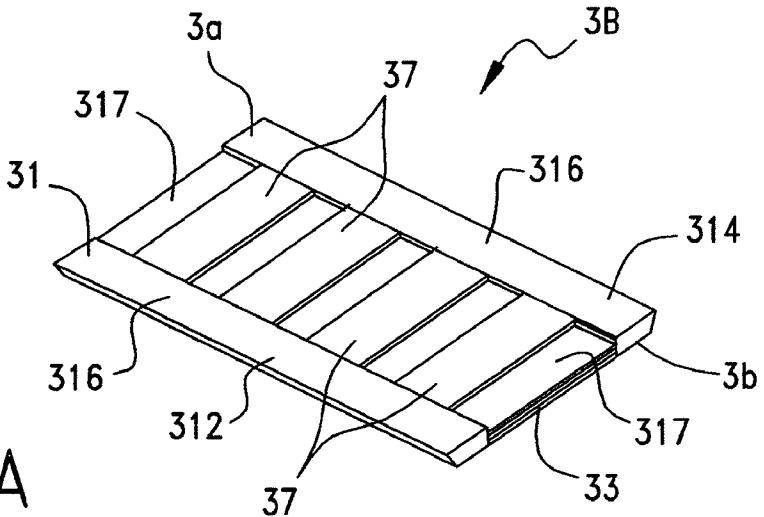


FIG. 9A

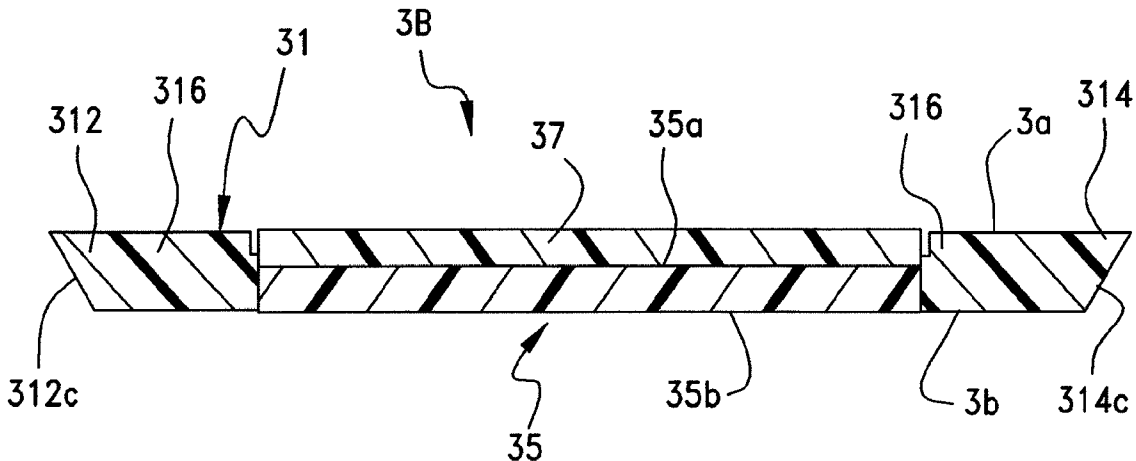


FIG. 9B

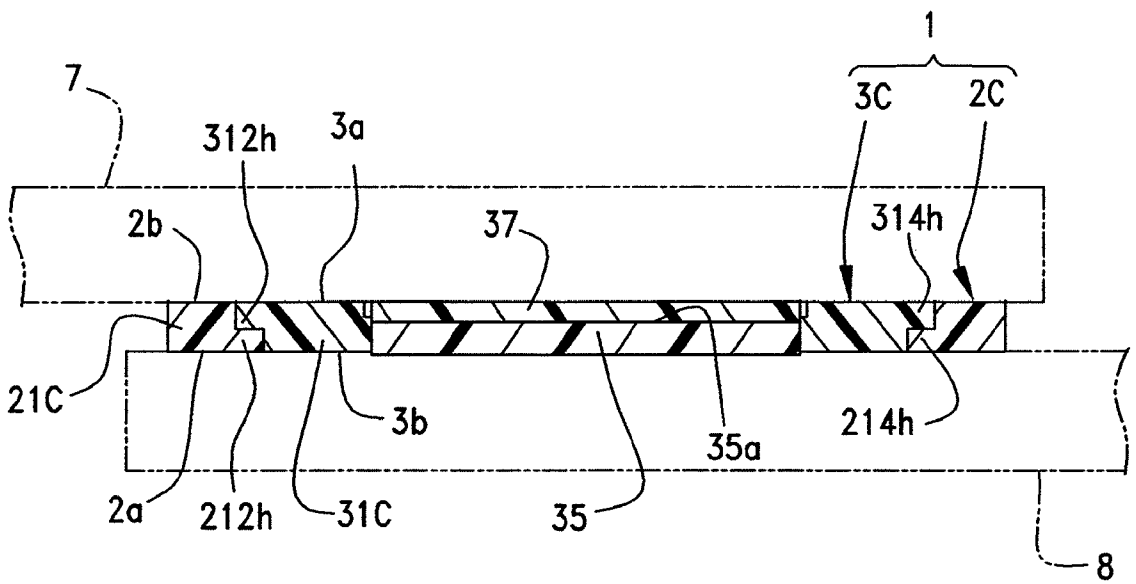


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/041964

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R12/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/101164 A1 (RATHBURN JAMES J [US]) 12 May 2005 (2005-05-12) paragraph [0136]	1,2
A	WO 2008/041433 A (HOKURIKU ELECT IND [JP]; TADA MORIO; UENO SATOSHI; TAKASAKI SATORU) 10 April 2008 (2008-04-10) abstract	3
A	US 2006/281341 A1 (SOETA KAORU [JP]) 14 December 2006 (2006-12-14)	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

24 June 2009

Date of mailing of the international search report

07/07/2009

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Bertin, Michel

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/041964

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2005101164	A1	12-05-2005	NONE	
WO 2008041433	A	10-04-2008	GB 2455689 A JP 2008091164 A	24-06-2009 17-04-2008
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