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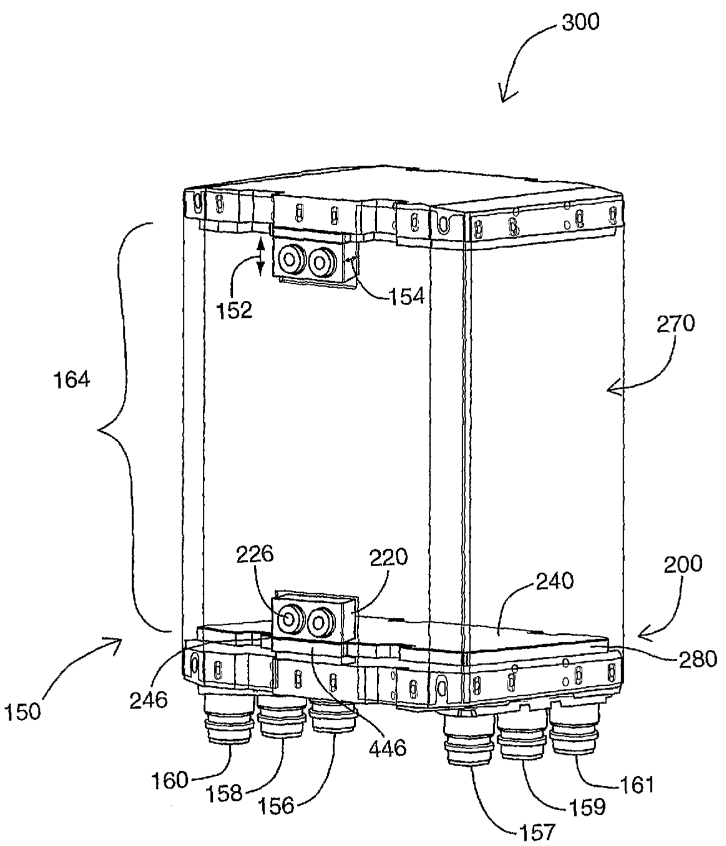

(57) Abstract: A system for drawing current in an electrochemical cell stack is described. The system includes an electrical connection assembly having a terminal plate for collecting current, and an electrical connector mounted on the terminal plate for connecting electrical leads thereto to draw current. The electrical connector has a longitudinal length along the stacking direction of the electrochemical cell stack and a lateral length perpendicular thereto, the longitudinal length being longer than the lateral length. The electrical connector is removably and replaceably mounted on the terminal plate.

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ELECTRICAL CONNECTION ASSEMBLY FOR AN ELECTROCHEMICAL CELL STACK

FIELD OF INVENTION

The present invention relates to an electrical connection assembly for an electrochemical cell stack.

BACKGROUND TECHNOLOGY

Electrochemical cell stacks include fuel cell stacks and electrolyzers. A fuel cell is an electrochemical device that produces an electromotive force by bringing a fuel (typically hydrogen gas) and an oxidant (typically air or oxygen gas) into contact with two suitable electrodes and an electrolyte. The fuel is introduced at a first electrode where it reacts electrochemically in the presence of the electrolyte to produce electrons and cations. The electrons are circulated from the first electrode to a second electrode via an electrical circuit. Cations pass through the electrolyte to the second electrode.

Simultaneously, the oxidant is introduced to the second electrode where the oxidant reacts electrochemically in presence of the electrolyte and catalyst, producing anions and consuming the electrons circulated through the electrical circuit; the cations are consumed at the second electrode. The anions formed at the second electrode or cathode react with the cations to form a reaction product.

The first electrode or anode may alternatively be referred to as a fuel or oxidizing electrode, and the second electrode may alternatively be referred to as an oxidant or reducing electrode.

The half-cell reactions at the two electrodes are, respectively, as follows:

$H_2 \rightarrow 2H+ + 2e-$

$1/2O_2 + 2H+ + 2e- \rightarrow H_2O$

The external electrical circuit withdraws electrical current and thus receives electrical power from the fuel cell. The overall fuel cell reaction produces electrical energy as shown by the sum of the separate half-cell reactions written above. Water and heat are typical by-products of the reaction.

In practice, fuel cells are not operated as single units. Rather, fuel cells are connected in series, stacked one on top of the other, or placed side by side, to form what is usually referred to as a fuel cell stack. As used herein, the term “cell stack” will include the special case where just one fuel cell is present, although typically a plurality of fuel cells are stacked together to form a cell stack. The fuel and oxidant are directed through manifolds to the electrodes, while cooling is provided either by the reactants or by a cooling medium. Also within the stack are current collectors, cell-to-cell seals and insulation, with required piping and instrumentation provided externally of the fuel cell stack. The stack and associated hardware make up a fuel cell module.

Conceptually, electrolyzers are fuel cells run in reverse. In particular, a current is supplied to the electrolyzer for the electrolysis of water into hydrogen and oxygen gases. Electrolyzers and fuel cell stacks share many of the same components.

Conventional designs of components for drawing current from a fuel cell have several shortcomings. The electrical connection between the fuel cell stack and the external circuit is provided by terminal plates, also known as current collectors or bus bars, which are located at either end of the fuel cell stack. Terminal plates collect the current from the electrodes of the fuel cell and convey it to the load, such as a motor or other energy-consuming device. Conventional terminal plates have tabs that protrude from the stack for connecting to external circuits. Because the tabs protrude, the effective volume of the fuel cell stack is larger than it would otherwise be, making packaging difficult in actual applications. Additionally, because the terminal plates and tabs are relatively thin, the tabs are also prone to breaking when electrical leads are attached thereto. When a tab breaks, or becomes inappropriate for a particular application, the entire cell stack must be rebuilt, repaired or wastefully discarded. Therefore, there is a need for a new cell stack design that overcomes these shortcomings.

SUMMARY OF THE INVENTION

Described herein is a system for drawing current in an electrochemical cell stack. The system includes an electrical connection assembly having a terminal plate for collecting current, and an electrical connector mounted on the terminal plate for connecting electrical leads thereto to draw current. The electrical connector has a longitudinal length along the stacking direction of the electrochemical cell stack and a lateral length perpendicular thereto, the longitudinal length being longer than the lateral length. The electrical connector is removably and replaceably mounted to the terminal plate.

In one embodiment, the terminal plate has a terminal plate protrusion on which the electrical connector is mounted, the terminal plate protrusion being substantially coplanar with the terminal plate.

The system further comprises an insulator plate having an insulator plate protrusion for providing support to the terminal plate protrusion, the electrical connector and the insulator plate protrusion sandwiching the terminal plate protrusion.

The insulator plate protrusion has one insulator plate hole, the terminal plate protrusion has one mounting hole, and the electrical connector has one through hole that are all aligned in assembly. A screw pierces the insulator plate hole, the mounting hole and the through hole along the stacking direction to secure the electrical connector, the terminal plate and the insulator plate together.

The insulator plate hole can be a blind hole with a nut disposed therein. The nut may be screwed on the screw to secure the electrical connector, the terminal plate and the insulator plate together. The electrical connector may be removed from the terminal plate by unscrewing the nut from the screw.

The electrical connection assembly of the present invention is compact, helping to reduce the effective volume of the fuel cell stack. In addition, the electrical connector is removable and replaceable, allowing a fuel cell stack to be adapted to different current ranges and different external electrical connections, such as cables and lugs, by just replacing the electrical connector. In addition, the electrical connection is isolated from the endplate and thus prevents the stack from electrically shorting.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, which show a preferred embodiment of the present invention and in which:

Figure 1 shows an exploded perspective view of a fuel cell unit located within a conventional fuel cell stack;

Figure 2 shows an electrical connection assembly in accordance with the present invention;

Figure 3 shows an exploded perspective view of a fuel cell stack having an electrical connection assembly of Figure 2;

Figure 4A shows a first perspective view of the electrical connection assembly of Figure 2;

Figure 4B shows a second perspective view of the electrical connection assembly of Figure 2;

Figure 5A shows a first perspective view of the electrical connector of Figure 2;

Figure 5B shows a second perspective view of electrical connector of Figure 2;

Figure 5C shows a front elevational view of the electrical connector of Figure 2;

Figure 5D shows a side elevational view of the electrical connector of Figure 2;

Figures 6A and 6B show a contact lead connected to the electrical connector of Figure 2;

Figure 7 shows a perspective view of a terminal plate of Figure 2;

Figure 8A shows a perspective view of an insulator plate of Figure 2;

Figure 8B shows a front elevational view of the insulator plate;

Figure 8C is a partial section view of the insulator plate along line A-A of Figure 8A; and

Figure 9 shows a terminal plate having two terminal connectors according to the principles of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows an exploded perspective view of a conventional fuel cell unit 100. The fuel cell unit 100 includes an anode flow field plate 120, a cathode flow field plate 130 that sandwich a membrane electrode assembly (MEA).

Various sizes are possible for the plated 120 and 130. In one embodiment, the short edge of the flow field plates 120, 130 is about 12 cm. Each plate 120 and 130 has an inlet region, an outlet region, and open-faced channels (not shown). The channels fluidly connect the inlet region to the outlet region, and provide a way for distributing the reactant gases to the outer surfaces of the MEA 124.

The MEA 124 comprises a solid electrolyte (i.e. a proton exchange membrane or PEM) 125 disposed between an anode catalyst layer (not shown) and a cathode catalyst layer (not shown). A first gas diffusion layer (GDL) 122 is disposed between the anode catalyst layer and the anode flow field plate 120, and a second GDL 126 is disposed between the cathode catalyst layer and the cathode flow field plate 130. The GDLs 122, 126 facilitate the diffusion of the reactant gas, either the fuel or oxidant, to the catalyst surfaces of the MEA 124. Furthermore, the GDLs enhance the electrical conductivity between each of the anode and cathode flow field plates 120, 130 and the membrane 125.

A first current collector plate 116 abuts against the rear face of the anode flow field plate 120, where the term "rear" indicates the side facing away from the MEA 124. Likewise, the term "front" refers to the side facing the MEA. A second current collector plate 118 abuts against the rear face of the cathode flow field plate 130. Each of the first and second current collector plates 116 and 118 respectively has a tab 146 and 148 protruding from the side of the fuel cell stack. A first insulator plate and second insulator plates 112, 114 are located immediately adjacent the first and second current collector plates 116, 118, respectively. First and second end plates 102, 104 are located immediately adjacent the first and second insulator plates 112, 114, respectively. Pressure may be applied on the end plates 102, 104 to press the unit 100 together. Moreover, sealing means are usually provided between each pair of adjacent plates. Preferably, a plurality of tie rods 131 may also be provided. The tie rods 131 are screwed into threaded bores in the anode endplate 102, and pass through corresponding plain bores in the cathode endplate 104. Fastening means, such as nuts, bolts, washers and the like are provided for clamping together the fuel cell unit 100.

The endplate 104 is provided with a plurality of connection ports for the supply of various fluids. Specifically, the second endplate 104 has first and a second air connection ports 106, 107, first and second coolant connection ports 108, 109, and first and second hydrogen connection ports 110, 111. The MEA 124, the anode and cathode flow field plates 120, 130, the first and second current collector plates 116, 118, the first and second insulator plates 112, 114, and the first and/or second end plates 102, 104 have three inlets near one end and three outlets near the opposite end, which are in alignment to form fluid ducts for air as an oxidant, a coolant, and hydrogen as a fuel. Also, it is not essential that all the outlets be located at one end, i.e., pairs of flows could be counter current as opposed to flowing in the same direction. The inlet and outlet regions of each plate are also referred to as manifold areas. Although not shown, it will be understood that the various ports 106 - 111 are fluidly connected to ducts that extend along the length of the fuel cell unit 100.

In the fuel cell stack shown in Figure 1, the fuel cell stack runs in "closed-end" mode, which means process fluids and coolant are supplied to and discharged from same end of the fuel cell stack. It should be understood that in other versions, the fuel cell may run in "flow-through" mode where process fluids and coolant enter the fuel cell stack from one end and leave the stack from the opposite end thereof. This requires the first end plate 102 be provided with corresponding connection ports for process fluids. It should also be understood that in practice it is useful to stack the several plates 130, 120 and MEAs 124 to form a fuel cell stack to produce a greater voltage output. Cell stacks of more than one hundred MEAs 124 are known.

The tabs 146 and 148 connect to electrical leads (not shown) for drawing current from the fuel cell unit 100. The use of such tabs 146 and 148 has several shortcomings. First, they are thin and subject to breaking. Second, problems can arise with the tab that might require replacing the tab, plate, or, worse, the entire fuel cell unit or stack. Finally, because the tabs jut out, they increase the effective size of the fuel cell unit or stack. To address these shortcomings, a new design for a fuel cell unit or stack is now described.

Figure 2 shows a system 150 for drawing current in a fuel cell stack 300. The system 150 includes an electrical connection assembly 200 having an electrical connector 220 mounted on a terminal plate protrusion 246 of a terminal plate 240. The electrical connector 220 possesses connection ports 226, and is box shaped, although in other embodiments the electrical connector 220 can be other shapes.

The terminal plate 240 collects current, which is then transferred to an external load (not shown) via the electrical connector 220. For this purpose, electrical leads (not shown) from the external load are connected to the electrical connector 220 to draw current from the fuel cell stack 300. The system 150 further includes an insulator plate 280 having an insulator plate protrusion 446 that abuts the terminal plate protrusion 246. Ports 156-161 corresponding to ports 106-111 are also shown. The body 164 of the fuel cell stack 300 includes anode and cathode flow field plates, and MEAs (not shown) corresponding to anode and cathode flow field plates 120, 130 and MEA 124 shown in Figure 1.

The electrical connector 220 has a longitudinal length 152 along the stacking direction of the fuel cell stack 300 and a lateral length 154 perpendicular thereto, the longitudinal length 152 being longer than the lateral length 154 to provide strength. In contrast, the tabs 146 and 148 in the conventional design shown in Figure 1 have a longitudinal length that is the same thickness as the terminal plates 116, 118 and which is much smaller than their lateral length. Because conventional tabs are so thin, they are much more likely to break than the electrical connectors 220 of the present invention.

As used herein, the term "lateral" refers to a direction that lies on the plane perpendicular to the longitudinal direction. In Figure 2, the connector 220 possesses four long lateral edges that are parallel to the long edge of the flow field plates 270, and four short lateral edges that are perpendicular thereto. The length of the short lateral edge, for example, is termed the short lateral length. In the embodiments shown, only the four short lateral lengths are shorter than the longitudinal lengths. In other embodiments, for example in an embodiment in which the connector 220 possesses exactly one connection port 226, all eight lateral lengths may be shorter than the longitudinal length. In addition, the orientation of the electrical connector 220 can assume various orientations not shown by the Figures. For example, the connector 220 can be mounted in other embodiments in a position corresponding to rotating the connector 220 in Figure 2 by 90°, or by any other angle. Moreover, in some embodiments, the connector 220 can be translated towards the center of the fuel cell stack 300. Additionally, the upper assembly of Figure 3 can be rotated 180° about an axis parallel to the stacking direction. In such an orientation, one electrical connector 220 is on one side of the fuel cell stack 300, while the other electrical connector 220 is on the other side.

Besides being less likely to break, the electrical connectors 220 possess another advantage. In a preferred embodiment to be described below, the electrical connector 220 is *removably* and *replaceably* mounted to the terminal plate 240. Thus, after the fuel cell stack 300 has been assembled and used, it is possible to remove the electrical connector 220. The connector 220 may then be modified and remounted or a new connector may be mounted on the terminal plate 240. There are many reasons why the electrical connector 220 might be removed and replaced. First, the connector 220 could wear out or break before the end of the service life of the fuel cell stack 300. Instead of discarding the entire plate or fuel stack cell 300, the present invention allows the electrical connector 220 alone to be replaced. Second, if size constraints change for the intended use of the fuel cell stack 300, it may be possible to accommodate those changes by replacing the electrical connector 220 with a different sized one. Finally, if the current requirements of the fuel cell stack 300 change, then the electrical connector 220 can be replaced with a new connector capable of handling the new current. Being able to replace the electrical connector 220 instead of discarding the entire fuel cell stack 300 leads to a savings in operational cost.

The insulator plate 280 functions to insulate the terminal plate 240 to prevent shorting. The insulator plate 280 includes the protrusion 446 that abuts one side of the terminal plate protrusion 246 while the electrical connector 220 abuts the opposite side of the terminal plate protrusion 246. The insulator plate protrusion 446, being considerably thicker than the terminal plate protrusion 246 onto which it abuts, provides support to the terminal plate protrusion 246 and also provides indirect support to the electrical connector 220 thereby reducing the risk of breakage of the electrical connector 220.

Figure 3 shows the system 150 of Figure 2 with the ports 156-161 omitted. Also omitted in Figure 3 is part of the body 164 of the fuel cell stack 300 that contains anode and cathode flow field plates and MEAs. However, some flow field plates 270, which can be either cathode or anode flow field plates, are shown.

The end plates 290 are located at either end of the fuel cell stack 300. An insulator plate 280 is disposed immediately inside of the end plate 290 and a terminal plate 240 is disposed immediately inside of the insulator plate 280.

Two electrical connectors 220 are shown each having two electrical connection ports 226, and three through holes 224. Each terminal plate 240 includes one terminal plate protrusion 246 having three mounting holes 243. Positioning notches 292 are present in the end plates 290, terminal plates 240 and insulator plates 280. As mentioned above, the longitudinal length of the electrical connector 220 is greater than a lateral length parallel to the short edge of the end plate 290, which design provides more strength to the electrical connector 220. The mounting holes 243 help to removably and replaceably mount the electrical connectors 220, as is described below.

Figures 4A and 4B show two views of part of the electrical connection assembly 200 of Figure 2. Each terminal plate 240 is shaped in accordance with the shape of the end plate 290. Specifically, the end plate 290 has a plurality of positioning notches 292 around the edges thereof and the terminal plate 240 also has a plurality of positioning notches 242 around its edges. When assembled together, the positioning notches 242 align with the positioning notches 292 so that the terminal plate 240 and the end plate 290 are properly positioned. A plurality of through holes 244 is provided on the terminal plate 240 near its edges. The through holes 244 are adapted to allow tie rods (not shown) to pass through, compressing components of the fuel cell stack 300 together, in the same manner as shown in Figure 1. The terminal plate 240 preferably has a terminal plate protrusion 246 protruding from the side of the fuel cell stack 300 and at least one mounting hole 243 (not shown) is provided in the protrusion 246. The mounting hole 243 can be a through hole or blind hole, either plain or threaded.

An electrical connector 220 is mounted on the protrusion 246 of the terminal plate 240. The electrical connector 220 can be generally in the shape of a rectangular block, having a longitudinal extent substantially parallel to the longitudinal direction of the fuel cell stack 300 and a lateral extent substantially parallel to the short edge of the end plate 290. At least one through hole 224 is provided in the electrical connector 220, extending along the longitudinal extent of the electrical connector 220. The at least one through hole 224 is adapted to align with the at least one mounting hole 243 of the protrusion 246 such that the electrical connector 220 can be mounted onto the protrusion 246 using screws or bolts. In this particular example, three such mounting holes 243 and three corresponding through holes 224 are present. Where the through holes 224 are plain, then the mounting holes 243 are threaded; alternatively, in known manner, the through holes 22 can be threaded and the mounting holes would then be plain through holes. In either case, the plain holes are preferably countersunk to accommodate the heads of screws.

Figures 5A-5D show the electrical connector 220 of Figure 2. At least one electrical connection port 226 is provided in the electrical connector 220, extending along the direction of the short lateral edge of the electrical connector 220. The at least one electrical connection port 226 has a threaded blind hole 225 for connecting plugs (not shown) of external circuits. In this particular embodiment, two such electrical connection ports 226 are shown. Preferably, the electrical connection ports 226 are offset from the through holes 224. More preferably, each of the connection ports 226 is surrounded by a convex portion 228 on the end face 227.

Figures 6A and 6B show an electrical lead 302 connected to the electrical connector 220 of Figure 2 (here shown with four electrical connection ports 226). A contact lead 302 is connected to the connector 220 with a lug 304. The lug 304 secures the contact lead by being screwed into the blind hole 225. A contact lead cover 306 can cover the contact lead 302.

Such a connection between the electrical connector 220 and the contact lead 302 allows for a more compact fuel cell stack 300. In particular, the contact lead 302 can remain flush against the end face 227 of the connector 220 instead of jutting out perpendicular to the end face 227. Moreover, the robust design of the present invention allows larger lugs 304 to be attached to the electrical connector 220. The connector 220 can be designed to interface with the size and number of terminal lugs 304 that are used in the system application so that smaller cross sectional area lugs 304 may be used and the connector 220 can be designed to accommodate these changes.

Figure 7 shows the terminal plate 240 and Figures 8A-C show the insulator plate 280 of Figure 2. The terminal plate protrusion 246 includes three mounting holes 243, while the terminal plate 240 includes four position notches 242. The positioning notches are provided to facilitate assembly of the fuel cell stack, by aligning the various elements against alignment bars fitting into the positioning notches. The insulator plate 280 has three blind holes 420 that in assembly are aligned with the three mounting holes 243 of the terminal plate protrusion 246. Preferably, the insulator plate 280 also has a protrusion 446 corresponding to the protrusion 246 of the terminal plate 240. Nuts (not shown) can be disposed in the blind holes 420. When the fuel cell is assembled, the terminal plate 240 is place on top of the insulator plate 400 and the nuts are then enclosed in the blind holes 420. Screws can be inserted in the mounting holes 243 of the terminal plate protrusion 246, through holes 224 of the electrical connector 220 and the blind hole 420 to engage with the nuts, thereby securing the electrical connector 220, the terminal plate 240 and the insulator plate 400 together.

The number of electrical connection ports 226 in an electrical connector 220 is dictated by the amount of current drawn from the fuel cell stack 300, the greater the current, the greater the number of connection ports 226. With conventional fuel cell stacks, if the amperage required for a particular application increases, the fuel cell is discarded and replaced with a one that has a greater number of connection ports 226. The present invention advantageously allows the replacement of just the electrical connector 220 in such case. Thus, when different current ranges are desired or different external electrical connections are used, the electrical connector 220 can be easily replaced.

To facilitate disassembly, mounting holes 422 can be further provided on the face of the insulator plate 280 not in contact with the terminal plate 240. The mounting holes 422 are in communication with the blind holes 420 to facilitate the removal of nuts from the blind holes 420. The easy replacement of the electrical connector 220 allows the electrical connection of the fuel cell stack 300 to be optimized for different current ranges, different external electrical connections, such as cables, lugs, etc. Further, since the electrical connector 220 is totally separated from the end plate 290, this effectively prevents shorting of the stack.

It should be understood that various modifications of the foregoing embodiments are possible while still falling within the scope of the present invention. For example, the protrusion 246 of the terminal plate 240 is not essential and the electrical connector 220 can be simply mounted on the edge of the terminal plate 240. Further, the electrical connector 220 is not necessarily mounted onto the terminal plate via screw or bolt connection. Rather, it could be removably mounted onto the terminal plate using any other means, such as glue.

Moreover, it is possible to mount more than one electrical connector on the terminal plate. For example, Figure 9 shows a terminal plate 640 having two terminal connectors 620. For this purpose, two terminal plate protrusions 546 can be provided for the terminal plate 640. Having two such electrical connectors 620 allows for more accessibility, more wiring design freedom, and the ability to flip the stack for maintenance purposes, etc.

Moreover, while emphasis has been placed on PEM fuel cell stacks, the principles of the present invention can be applied to other fuel cell types. In addition to fuel cells, other electrochemical cell stacks, such as electrolyzers, can be manufactured according to the principles of the present invention.

Claims

What is claimed is:

1. A system for drawing current in an electrochemical cell stack, the system comprising an electrical connection assembly having

a terminal plate for collecting current; and

an electrical connector mounted on the terminal plate for connecting electrical leads thereto to draw current, wherein the electrical connector has a longitudinal length along the stacking direction of the electrochemical cell stack and a lateral length perpendicular thereto, the longitudinal length being longer than the lateral length.

2. The system of claim 1, wherein the electrical connector is removably and replaceably mounted to the terminal plate.

3. The system of claim 1, wherein the terminal plate has a terminal plate protrusion on which the electrical connector is mounted.

4. The system of claim 3, wherein the terminal plate protrusion is substantially coplanar with the terminal plate.

5. The system of claim 3, further comprising an insulator plate having an insulator plate protrusion for providing support to the terminal plate protrusion,

the electrical connector and the insulator plate protrusion sandwiching the terminal plate protrusion.

6. The system of claim 5, wherein the insulator plate protrusion has at least one insulator plate hole, the terminal plate protrusion has at least one mounting hole, and the electrical connector has at least one through hole that are all aligned in assembly, the system further comprising at least one screw that pierces the at least one insulator plate hole, mounting hole and through hole along the stacking direction to secure the electrical connector, the terminal plate and the insulator plate together.

7. The system of claim 6, wherein the at least one insulator plate hole is a blind hole.

8. The system of claim 7, the system further comprising at least one nut disposed in the at least one blind hole and screwed on the at least one screw to secure the electrical connector, the terminal plate and the insulator plate together.

9. The system of claim 8, wherein the electrical connector may be removed from the terminal plate by unscrewing the at least one nut from the at least one screw.

10. The system of claim 1, wherein the electrical connector is box shaped.

11. The system of claim 1, further comprising a second electrical connector mounted on the terminal plate for connecting second electrical leads thereto to draw current, wherein the second electrical connector has a second longitudinal length along the stacking direction of the electrochemical cell stack and a second lateral length perpendicular thereto, the second longitudinal length being longer than the second lateral length.

12. A system for drawing current in an electrochemical cell stack, the system comprising an electrical connection assembly having

a terminal plate for collecting current; and

an electrical connector removably and replaceably mounted on the terminal plate for connecting electrical leads thereto to draw current.

13. The system of claim 12, wherein the electrical connector has a longitudinal length along the stacking direction of the electrochemical cell stack and a lateral length perpendicular thereto, the longitudinal length being longer than the lateral length.

14. The system of claim 12, wherein the terminal plate has a terminal plate protrusion on which the electrical connector is mounted.

15. The system of claim 14, wherein the terminal plate protrusion is substantially coplanar with the terminal plate.

16. The system of claim 14, further comprising an insulator plate having an insulator plate protrusion for providing support to the terminal plate protrusion, the electrical connector and the insulator plate protrusion sandwiching the terminal plate protrusion.

17. The system of claim 16, wherein the insulator plate protrusion has at least one insulator plate hole, the terminal plate protrusion has at least one mounting hole, and the electrical connector has at least one through hole that are all aligned in assembly, the system further comprising at least one screw that pierces the at least one insulator plate hole, mounting hole and through hole along the stacking direction to secure the electrical connector, the terminal plate and the insulator plate together.

18. The system of claim 17, wherein the at least one insulator plate hole is a blind hole.

19. The system of claim 18, wherein the rod is threaded, the system further comprising at least one nut disposed in the at least one blind hole and screwed on the at least one screw to secure the electrical connector, the terminal plate and the insulator plate together.

20. The system of claim 19, wherein the electrical connector may be removed from the terminal plate by unscrewing the at least one nut from the at least one screw.

21. The system of claim 20, wherein the electrical connector is box shaped.

22. A system for drawing current in an electrochemical cell stack, the system comprising

an electrical connection assembly having

a terminal plate for collecting current, the terminal plate having a terminal plate protrusion; and

an electrical connector mounted on the terminal plate protrusion for connecting electrical leads thereto to draw current; and

an insulator plate having an insulator plate protrusion for providing support to the terminal plate protrusion, the electrical connector and the insulator plate protrusion sandwiching the terminal plate protrusion.

23. The system of claim 22, wherein the electrical connector is removably and replaceably mounted on the terminal plate protrusion.

24. The system of claim 22, wherein the terminal plate protrusion is substantially coplanar with the terminal plate.

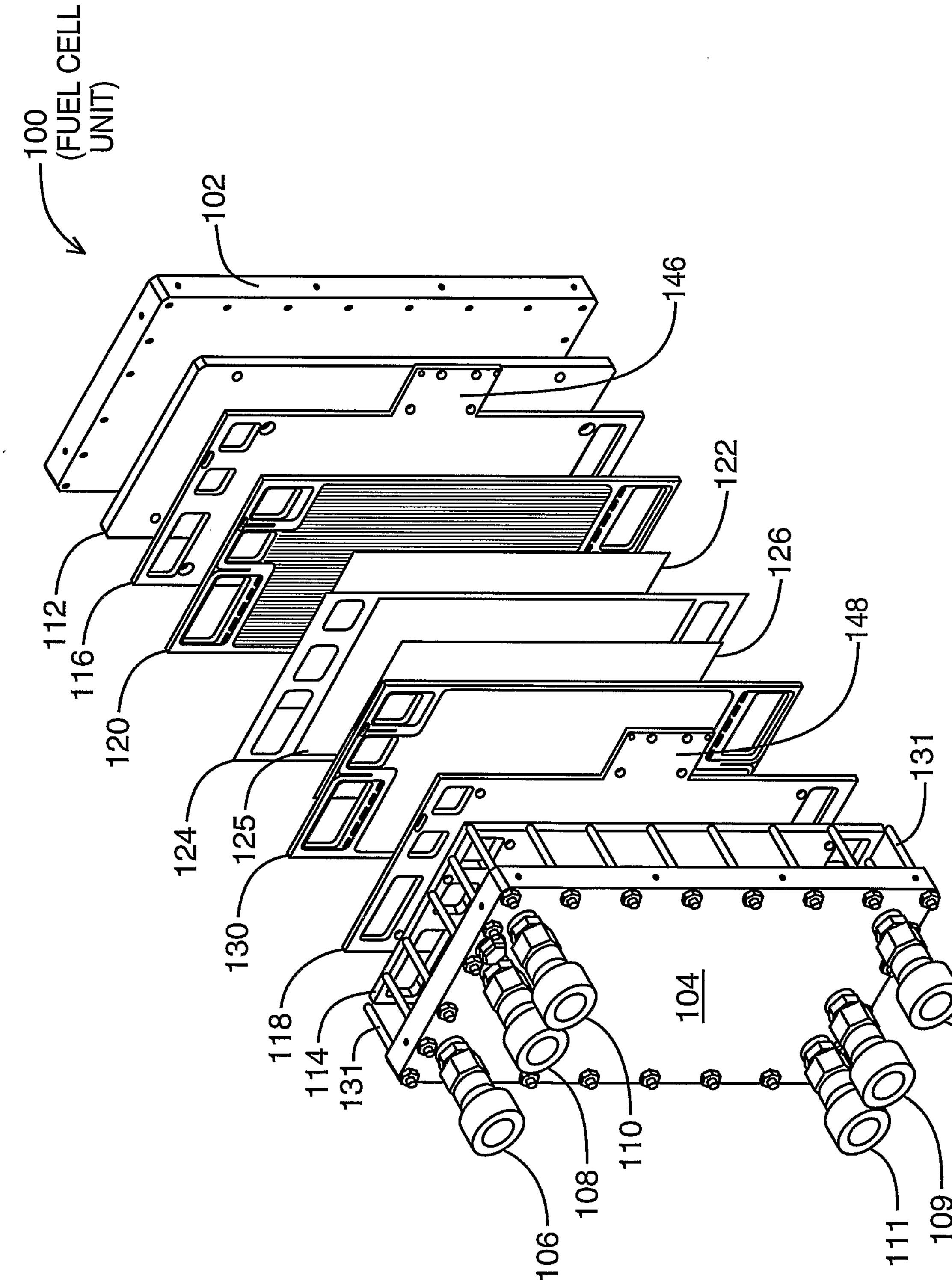
25. The system of claim 22, wherein the insulator plate protrusion has at least one insulator plate hole, the terminal plate protrusion has at least one mounting hole, and the electrical connector has at least one through hole that are all aligned in assembly, the system further comprising at least one screw that pierces the at least one insulator plate hole, mounting hole and through hole along the stacking direction of the electrochemical cell stack to secure the electrical connector, the terminal plate and the insulator plate together.

26. The system of claim 25, wherein the at least one insulator plate hole is a blind hole.

27. The system of claim 26, the system further comprising at least one nut disposed in the at least one blind hole and screwed on the at least one screw to secure the electrical connector, the terminal plate and the insulator plate together.

28. The system of claim 27, wherein the electrical connector may be removed from the terminal plate by unscrewing the at least one nut from the at least one screw.

29. The system of claim 22, wherein the electrical connector is box shaped.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102
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112
116
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131
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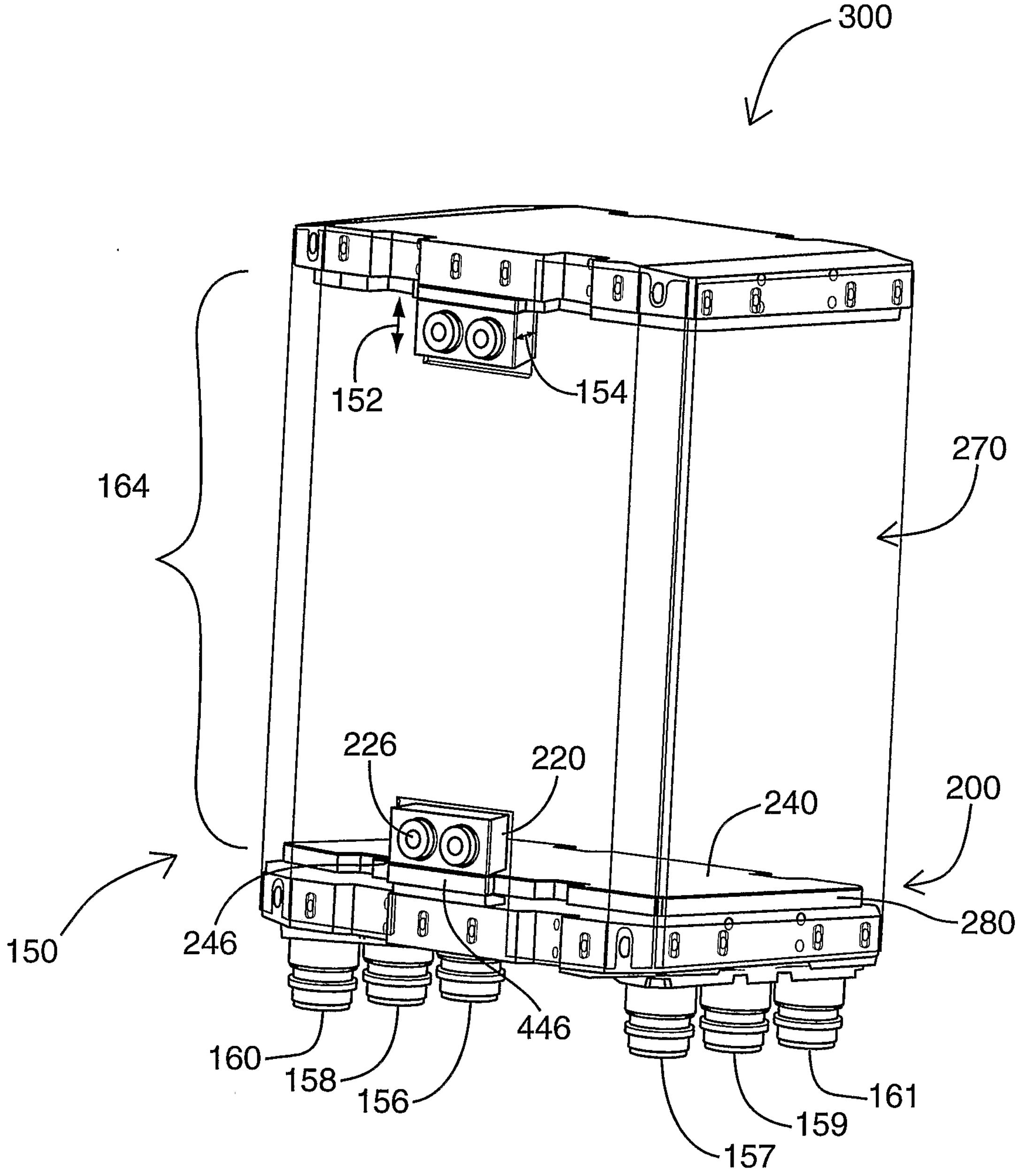
111

FIG. 1


300
152
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446
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159
161

FIG. 2

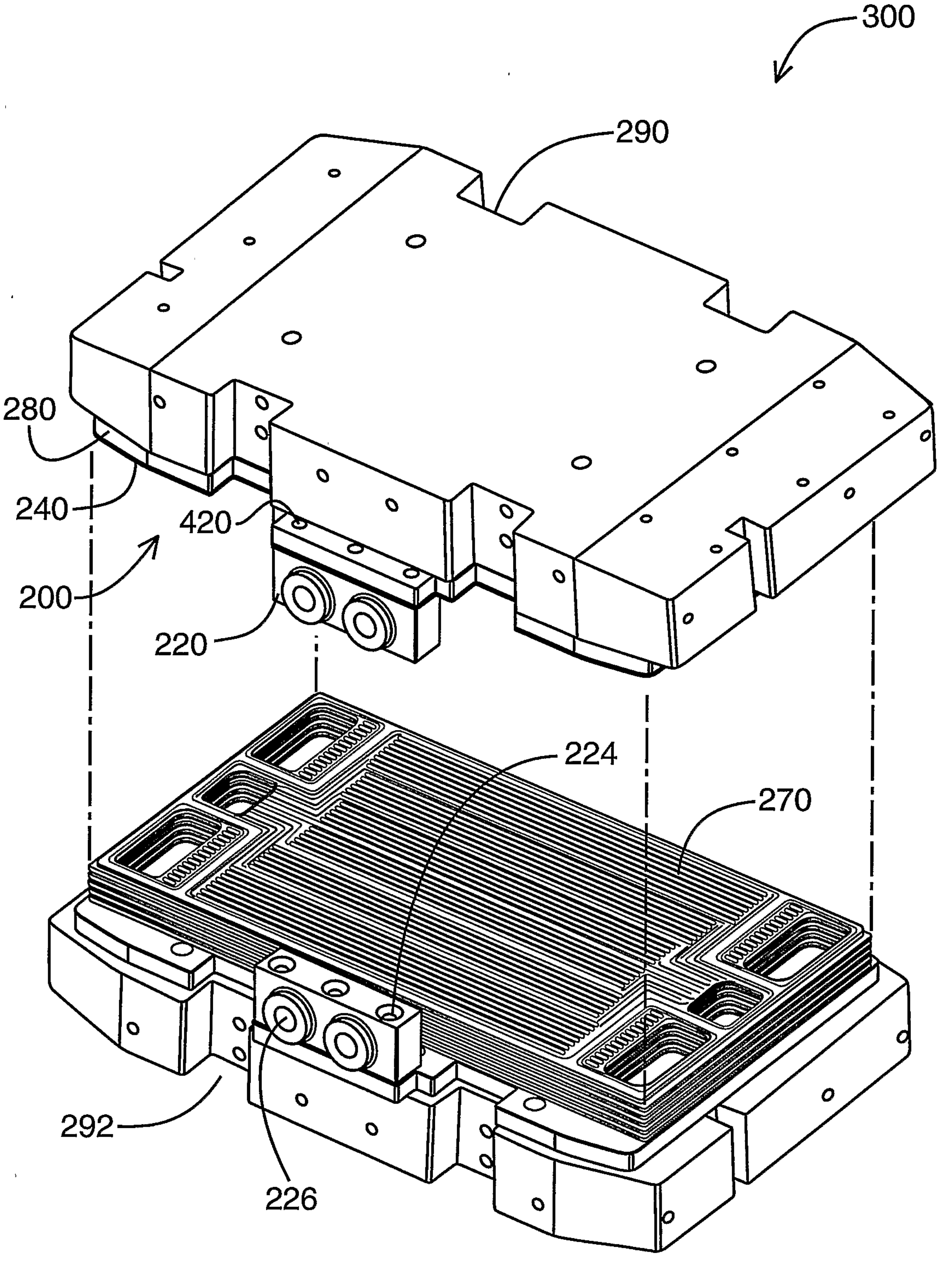

FIG. 3

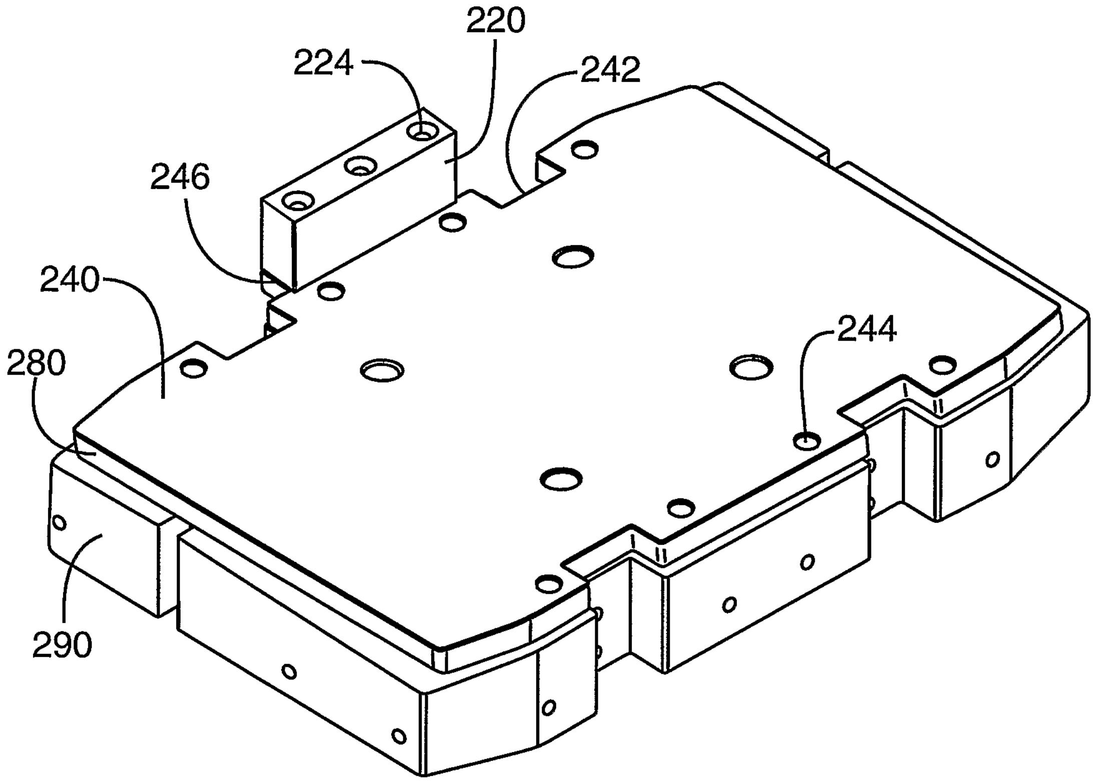

FIG. 4A

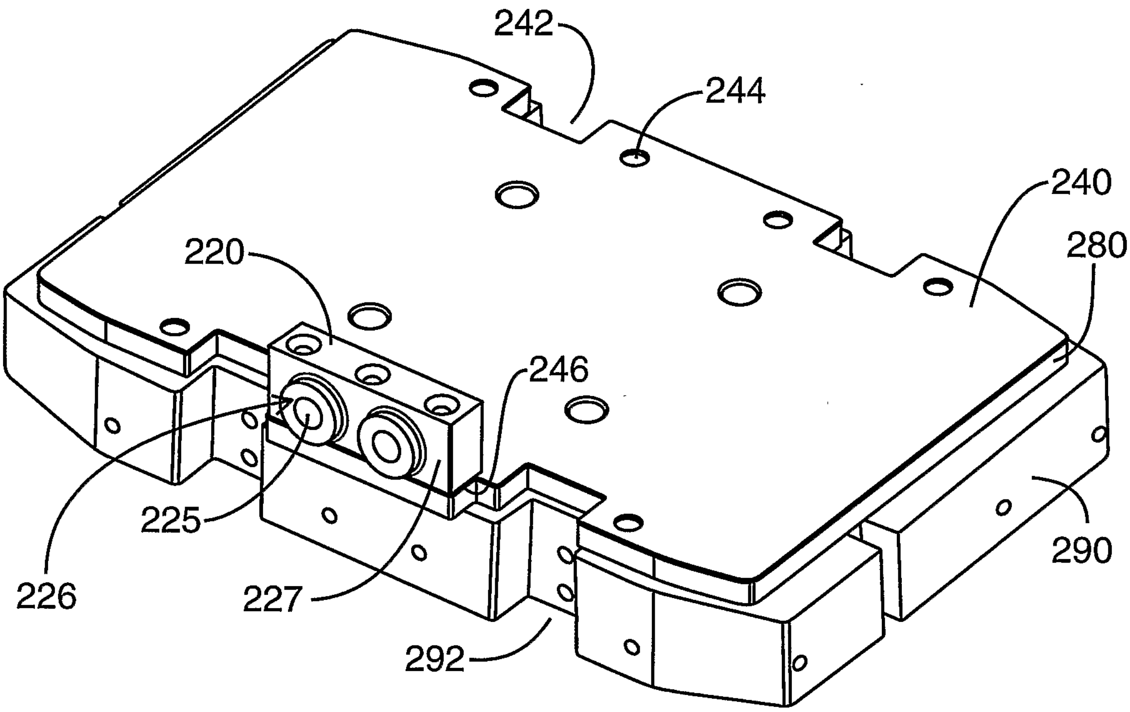

FIG. 4B

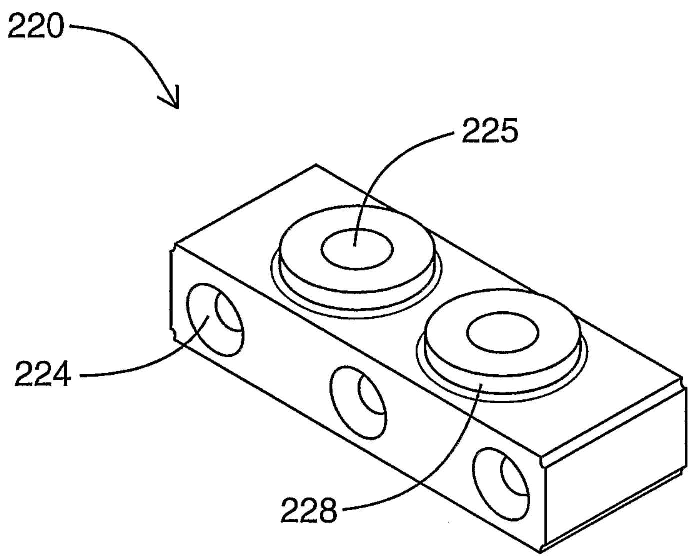

FIG. 5A

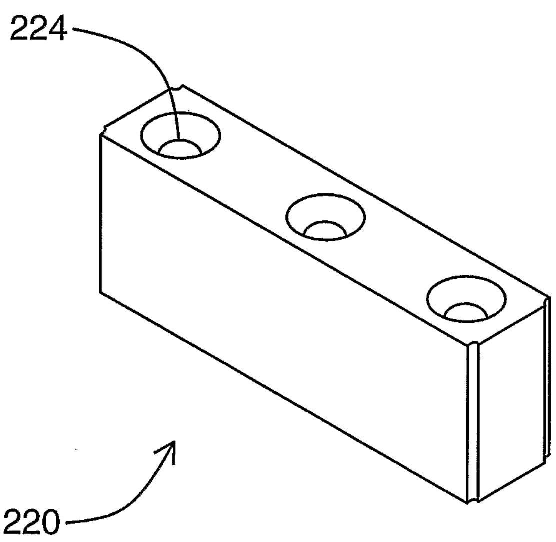

FIG. 5B

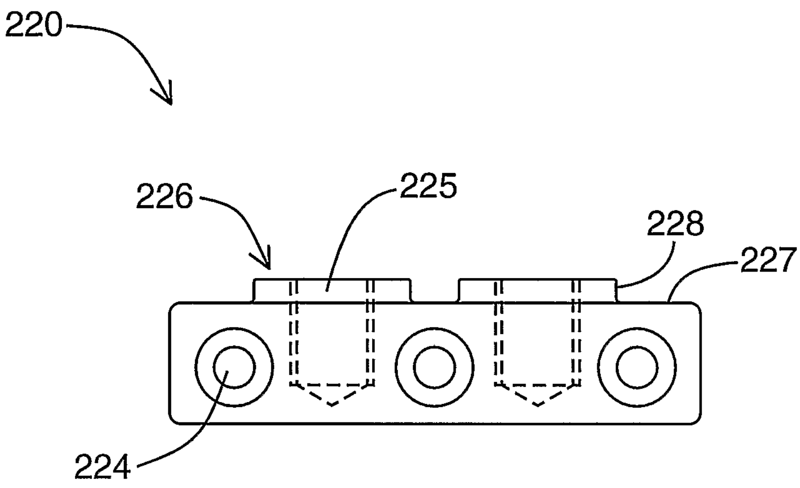

FIG. 5C

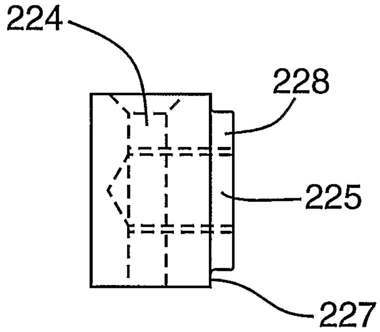

FIG. 5D

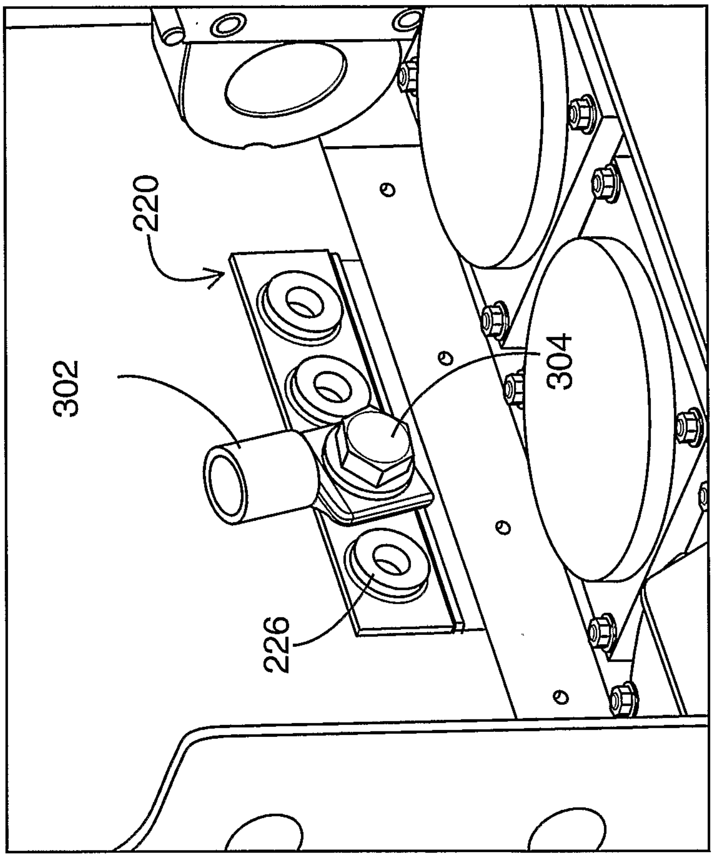

FIG. 6A

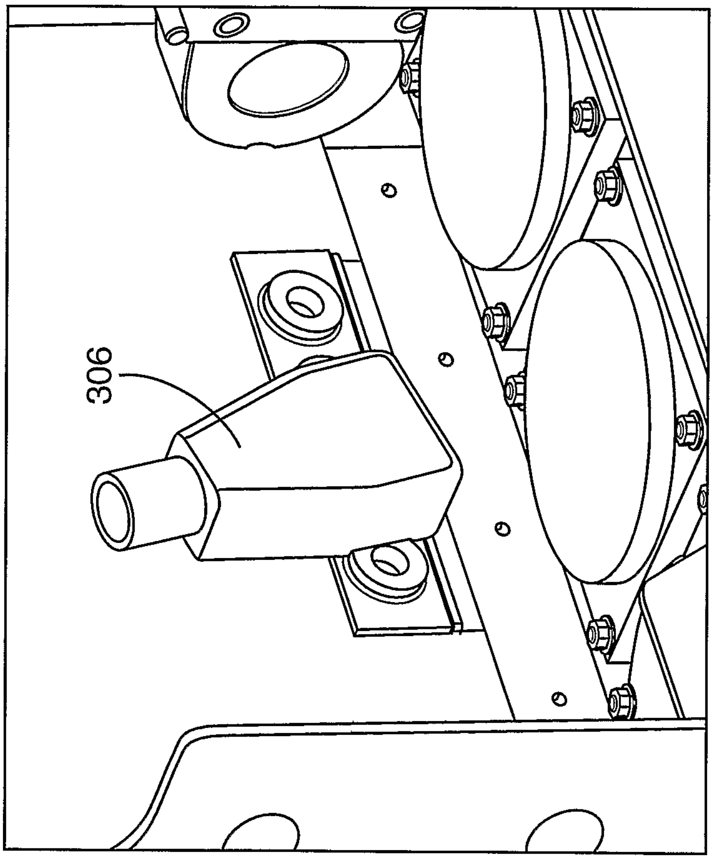

FIG. 6B

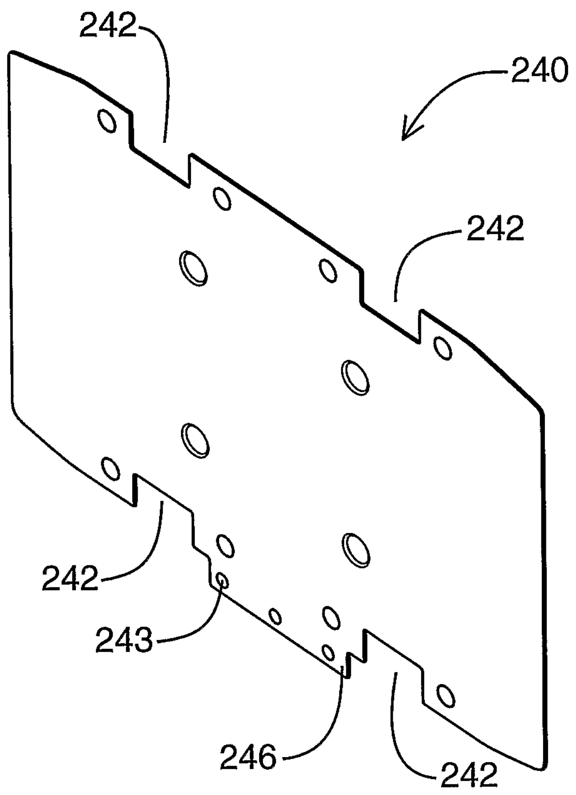

FIG. 7

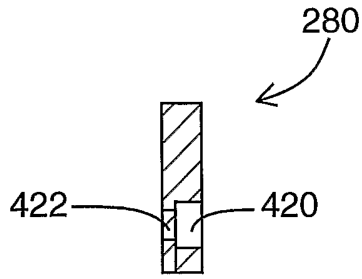

FIG. 8C

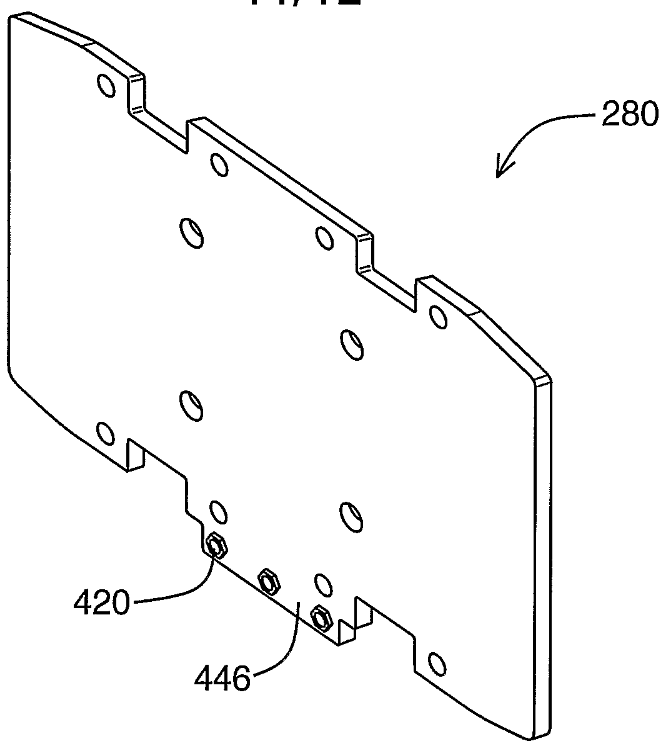

FIG. 8A

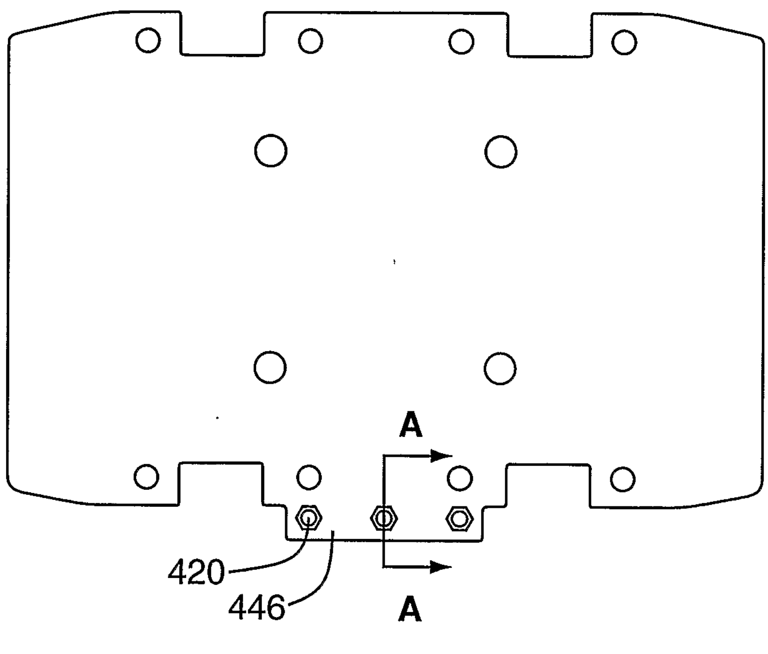

FIG. 8B

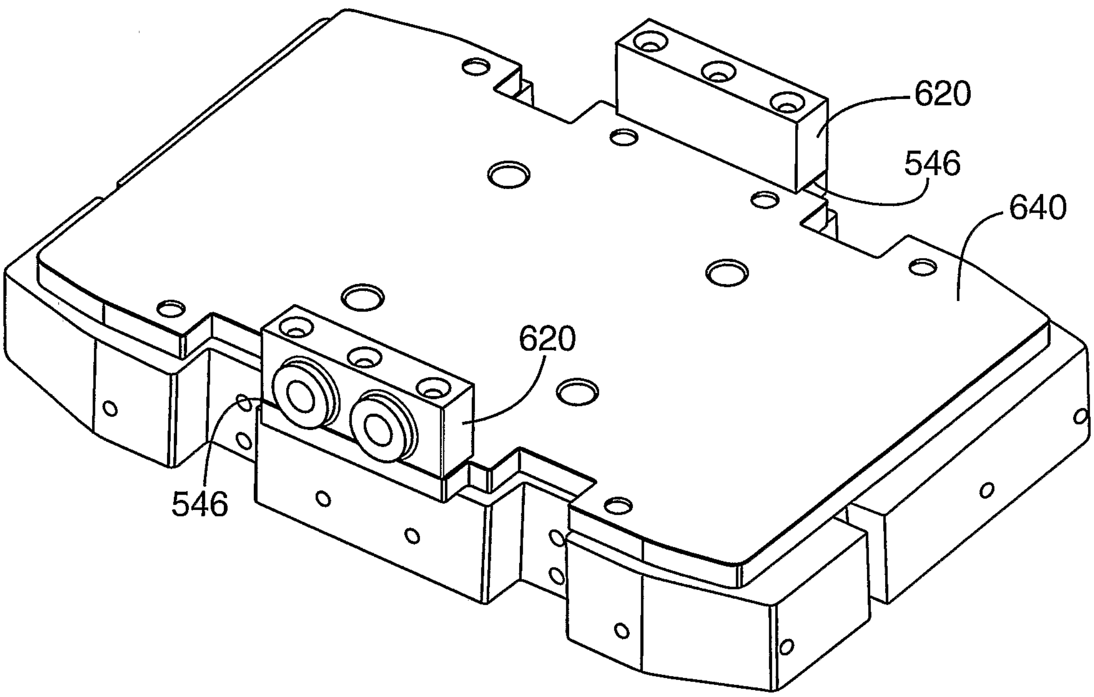

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2004/001512

A. CLASSIFICATION OF SUBJECT MATTER IPC[7] HO1M-2/20; HO1M-2/30; HO1M-8/24

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC[7]: H01M

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 practicable, search terms used) USPTO, DELPHION, CANADIAN PATENT DATABASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	US6653003 (Tsai et al.) 25 November 2003 (25.11.2003) (col. 1, lines 47-66, col. 2, lines 24-29, and Figures 2 and 3)	1,2,11,12
X	US6004692 (Muffoletto et al.) 21 December 1999 (21.11.1999) (col. 3, lines 1-17, 44-55, and 61-77, col. 4, lines 1-9, and Figures 2-11)	1
Y, P	US6727012 (Chen et al.) 27 April 2004 (27.04.2004)	1-29
Y, P	US20040137299A1 (Mazza et al.) 15 July 2004 (15.07.2004)	1-29
Y, P	US20040151952A1 (Brady et al.) 05 August 2004 (05.08.2004)	1-29
A	US6669826 (Milgate, Jr. et al.) 30 December 2003 (30.12.2003)	1, 12, 22
A	US6495278 (Schmid et al.) 17 December 2002 (17.12.2002)	1, 12, 22

Further documents are listed in the continuation of Box C.   Patent family members are listed in annex.

* Special categories of cited documents :
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"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
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Date of the actual completion of the international-type search
26 November 2004 (26-11-2004)

Date of mailing of the international-type search report
07 January 2005 (07-01-2005)

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Authorized officer
Robert Salvador (819) 997-2166

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2004/001512

Patent Document Cited in Search Report	Publication Date	Patent Family Member	Publication Date
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