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(54) Title: COMPACT TEMPERATURE CONTROL SYSTEM AND METHOD FOR ENERGY MODULES

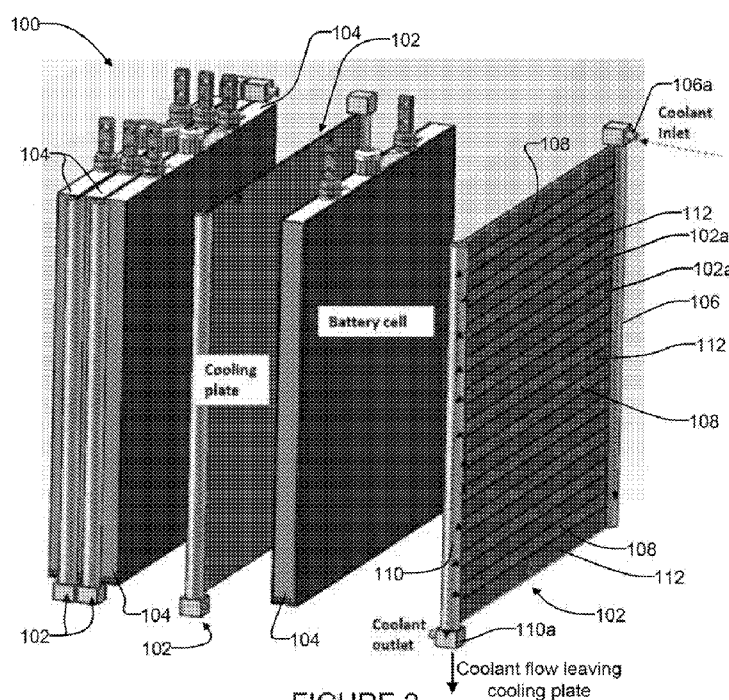


FIGURE 2

(57) Abstract: The present disclosure relates to an energy module having a plurality of energy generating cells, and at least one cooling plate having opposing surfaces. The cooling plate is disposed between an adjacent pair of the energy generating cells such that the opposing surfaces of the cooling plate are in contact with surfaces of the adjacent pair of energy generating cells. The cooling plate has at least one coolant flow channel configured to receive a coolant flow therethrough to limit propagation of heat from one to the other of either one of the adjacent pair of energy generating cells when either one of the adjacent pair of energy generating cells fails.

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CLAIMS

What is claimed is:

1. An energy module comprising:

5 a plurality of energy generating cells;

at least one cooling plate having flat, opposing surfaces, the at least one cooling plate being disposed between an adjacent pair of said plurality of energy generating cells such that the opposing surfaces of the at least one cooling plate are in contact with surfaces of the adjacent pair of energy generating cells; and

10 the at least one cooling plate including at least one coolant flow channel configured to receive a coolant flow therethrough to limit propagation of heat from one to the other of either one of the adjacent pair of energy generating cells when either one of the adjacent pair of energy generating cells fails.

15 2. The energy module of claim 1, wherein the at least one said cooling plate comprises a plurality of coolant flow channels extending therethrough.

3. The energy module of claim 2, wherein the coolant flow channels are arranged parallel to one another and spaced apart within the cooling plate.

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4. The energy module of claim 2, wherein the at least one cooling plate comprises a first wall portion having material portions removed to help form the flow channel, and a second wall portion secured to the first wall portion to fully form the coolant flow channels.

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5. The energy module of claim 4, wherein the second wall portion also includes material portions removed therefrom which, when the second wall portion is placed against the first wall portion, forms the coolant flow channels.

30 6. The energy module of claim 2, further comprising an inlet manifold in communication with a first edge portion of the at least one cooling plate which supplies the coolant flow to the coolant flow channel.

7. The energy module of claim 3, further comprising an outlet manifold in communication with a second edge portion spaced apart from said first edge portion for receiving the coolant flow flowing through the coolant flow channel.

5 8. The energy module of claim of claim 7, further comprising:
 an inlet port fitting for connecting the inlet manifold to a supply source of the coolant flow; and
 an outlet port fitting for channeling the coolant flow out from the at least one cooling plate.

10 9. The energy module of claim 7, wherein the at least one cooling plate is comprised at least partially of at least one of nickel and copper.

 10. The energy module of claim 1, wherein:
15 the at least one cooling plate forms a planar component having a height and width,
 the adjacent pair of energy generating cells each have a height and a width; and
 the height and width of the at least one cooling plate being approximately the same as the height and width of the at least one cooling plate.

20 11. The energy module of claim 1, wherein:
 the at least one cooling plate has a first thickness;
 the adjacent pair of energy generating cells each having a second thickness; and
 the first thickness is no more than about 10% of the second thickness.

25 12. The energy module of claim 1, wherein the coolant flow channel comprises at least one of:
 a linear flow path; and
 a serpentine shape.

30 13. The energy module of claim 2, wherein the plurality of coolant flow channels are arranged parallel to one another and comprise the same cross sectional shape and dimension, and extend from a first longitudinal edge of the at least one cooling plate to a second longitudinal edge of the at least one cooling plate.

14. An energy module comprising:

a plurality of energy generating cells spaced parallel to one another;

a plurality of cooling plates having flat opposing surfaces, each one of the cooling plates being disposed between an associated adjacent pair of said plurality of energy generating cells such that the flat opposing surfaces of the at least one cooling plate are in contact with surfaces of the cooling plate's associated adjacent pair of energy generating cells; and

each one of the cooling plates including:

a plurality of coolant flow channels extending internally within the cooling plate from a first longitudinal edge to a second longitudinal edge opposite the first longitudinal edge; and

each of the coolant flow channels configured to receive a coolant flow therethrough to limit propagation of heat from one to the other of either one of its said associated adjacent pair of energy generating cells, when either one of the associated adjacent pair of energy generating cells fails.

15. The energy module of claim 14, wherein each one of the cooling plates comprises:

a first wall portion having material portions removed to help form the flow channel; and a second wall portion secured to the first wall portion to fully form the coolant flow channels while maintaining the flat opposing surfaces.

16. The energy module of claim 15, wherein the second wall portion also includes material portions removed therefrom which cooperate to help form the coolant flow channels when the first and second wall portions are secured together against one another in facing relationship.

17. The energy module of claim 14, each said cooling plate further comprising:

an inlet manifold secured to the first longitudinal edge thereof for supplying the coolant flow to each of the coolant flow channels; and

an outlet manifold secured to the second longitudinal edge thereof for receiving the coolant flow from each of said coolant flow channels.

18. The energy module of claim 14, further comprising:

an elongated supply module having first and second inlets, the first inlet being in communication with a first subquantity of the plurality of cooling plates and supply the coolant flow to the first subplurality of cooling plates, and the second inlet being in communication with a second subquantity of the plurality of cooling plates and supplying a separate quantity of the cooling flow to the second subquantity of the plurality of cooling plates; and

an elongated return module being in communication with the first and second subpluralities of cooling plates to receive the cooling fluid from the first subplurality of cooling plates and to feed the received cooling fluid to the second subplurality of cooling plates.

19. A method of making a cooling plate for an energy module, comprising:

dimensioning first and second material sections to have a height and a width approximately equal to a height and width of an energy generating cell;

removing sections of material from at least one of the first and second material sections to at least partially form a plurality of flow channels therethrough, from a first longitudinal edge to a second longitudinal edge of thereof;

securing the first and second material sections together to fully form the plurality of flow channels, and such that the first and second material sections form a unitary assembly with flat opposing surfaces;

securing an inlet manifold to the first longitudinal edge to enable a coolant to be fed into the fully formed flow channels;

securing an outlet manifold to the second longitudinal edge to enable the coolant flowing through the plurality of fully formed flow channels to be received; and

further dimensioning a thickness of the unitary assembly such that the thickness is no more than 10% of an overall thickness of the energy generating cell.