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(54) Title of Invention: Electric automobile battery temperature regulation device and regulation method

(57) Abstract:

[Object] To improve battery performance and improve battery longevity by enabling regulation of the temperature of a battery installed in a vehicle.

[Resolution Means] A plurality of battery cells 3 is housed inside battery housing spaces 9 of battery cases 5 mounted on the bottom surface of the chassis floor of an electric automobile. Between the battery housing spaces 9, Peltier elements 17 in which a heat generation or heat absorption action is exhibited depending on the direction of a supplied electric current are provided in a state in close contact with the outer surface of the battery housing spaces 9. The temperature of the battery cells 3 is detected by a temperature sensor, the direction of the electric

current supplied to the Peltier elements 17 changes depending on the temperature, and the battery cells 3 are heated or cooled.

[Scope of Claims]

[Claim 1]

An electric automobile battery temperature regulation device comprising:

a temperature detection means for detecting the temperature of a battery that is a running drive source installed in a vehicle;

a heat-exchange element the temperature of which changes depending on the electric current supplied, and which causes the temperature of the battery to change through heat transfer; and

a temperature control means that operates so as to cause the temperature of the heat-exchange element to change in accordance with the temperature of the battery detected by the temperature detection means.

[Claim 2]

The electric automobile battery temperature regulation device according to Claim 1, wherein:

the battery is housed in a battery housing space provided in a battery case installed in the chassis, in a state in close contact with the inner surface thereof; and

the heat-exchange element is in close contact with the outside surface between battery housing spaces.

[Claim 3]

The electric automobile battery temperature regulation device according to Claim 1, wherein a plurality of batteries is provided and a temperature detection means and a heat-exchange element are provided for each of the plurality of batteries.

[Claim 4]

The electric automobile battery temperature regulation device according to Claim 1, wherein the heat-exchange element is a Peltier element that generates heat or absorbs heat depending on the direction of the electric current supplied thereto.

[Claim 5]

An electric automobile battery temperature regulation method that supplies an electric current to a heat-exchange element and causes heat to be generated or absorbed in accordance with the temperature of a battery that is the running drive source installed in a vehicle body, and heats or cools the battery through the generation of heat or absorption of heat.

[Claim 6]

The electric automobile battery temperature regulation method according to Claim 5,

wherein the generation of heat by the heat-exchange element when heating the battery is accomplished by an electric current from an outside power source used when charging the battery.

[Detailed Description of the Invention]

[0001]

[Technical Field]

The present invention relates to a battery temperature regulation device and regulation method for an electric automobile having a battery as the running drive source.

[0002]

[Problem to be solved by the invention]

It is an object of the present invention to improve battery performance and improve battery longevity by enabling regulation of the temperature of a battery installed in a vehicle.

[0003]

[Means for Resolving the Problem]

In order to achieve the above-described object, the invention according to Claim 1 comprises a temperature detection means for detecting the temperature of a battery that is a running drive source installed in a vehicle; a heat-exchange element the temperature of which changes depending on the electric current supplied, and which causes the temperature of the battery to change through heat transfer; and a temperature control means that operates so as to cause the temperature of the heat-exchange element to change in accordance with the temperature of the battery detected by the temperature detection means.

[0004]

With an electric automobile battery temperature regulation device having this kind of configuration, when the battery temperature detected by the temperature detection means becomes high, for example at least as high as a given temperature, due to power consumption, the temperature control means acts to supply an electric current to a heat-exchange element and lower the temperature, and the heat-exchange element with reduced temperature cools the battery.

[0005]

The invention according to Claim 2 is the invention according to Claim 1 wherein the battery is housed in a battery housing space provided in a battery case installed in the chassis, in a state in close contact with the inner surface thereof; and the heat-exchange element is in close

contact with the outside surface between battery housing spaces.

[0006]

With the above-described configuration, the heat of the heat-exchange element is efficiently transferred to the battery via the wall surface that forms the battery housing space.

[0007]

The invention according to Claim 3 is the invention according to Claim 1 wherein a plurality of batteries is provided and a temperature detection means and a heat-exchange element are provided for each of the plurality of batteries.

[0008]

With the above-described configuration, the temperatures of a plurality of batteries are made uniform.

[0009]

The invention according to Claim 4 is the invention according to Claim 1 wherein the heat-exchange element is a Peltier element that generates heat or absorbs heat depending on the direction of the electric current supplied thereto.

[0010]

With the above-described configuration, if the Peltier element is such that heat is generated by an electric current being supplied so that one terminal becomes the positive pole side, heat is absorbed by an electric current being supplied so that the other terminal becomes the negative pole side.

[0011]

The invention according to Claim 5 supplies an electric current to a heat-exchange element and causes heat to be generated or absorbed heat in accordance with the temperature of a battery that is the running drive source installed in a vehicle body, and heats or cools the battery through the generation of heat or absorption of heat.

[0012]

With the above-described battery temperature regulation method, when the battery temperature is high, the heat-exchange element is caused to absorb heat and cools the battery, and when the battery temperature is low, the heat-exchange element is cased to generate heat and heats the battery.

[0013]

The invention according to Claim 6 is the battery temperature regulation method according to Claim 5 wherein the generation of heat by the heat-exchange element when heating the battery is accomplished by an electric current from an outside power source used when charging the battery.

[0014]

With the above-described battery temperature regulation method, the battery heating operation is accomplished without consuming the electric power of the battery.

[0015]

[Efficacy of the Invention]

With the invention according to Claim 1, the temperature of the battery can be regulated by the heat-exchange element, so use of the battery at the optimal temperature becomes possible, making it possible to improve battery performance and to improve battery longevity.

[0016]

With the invention according to Claim 2, the heat of the heat-exchange element can be efficiently transferred to the battery via the wall surface forming the battery housing space.

[0017]

With the invention according to Claim 3, the temperatures of a plurality of batteries are made uniform, so it becomes possible to improve performance and longevity as an assembled battery.

[0018]

With the invention according to Claim 4, it is possible to prevent increases in battery temperature caused by electric power consumption, and it is also possible to avoid using the battery in a low-temperature state under conditions with low surrounding temperatures such as in cold regions.

[0019]

With the invention according to Claim 5, when the battery temperature is high it is possible cause the heat-exchange element to absorb heat and cool the battery and when the battery temperature is low it is possible to cause the heat-exchange element to generate heat and heat the battery, so it is possible to prevent the temperature of the battery from becoming high due to power consumption and it is also possible to avoid using the battery in a low-temperature state under conditions with low surrounding temperatures such as in cold regions.

[0020]

With the invention according to Claim 6, when the action of heating the battery is accomplished, electric power from the battery is not consumed, so it is possible to achieve improvement in battery performance and improvement in battery longevity without the operating range of the vehicle per charge becoming shorter.

[0021]

[Embodiment]

Below, an embodiment of the present invention will be described with reference to the drawings.

[0022]

FIG. 1 is a disassembled oblique view of a battery retention structure provided with a battery temperature regulation device for an electric automobile showing one embodiment of the present invention, and FIG. 2 is a side view of an electric automobile showing a state in which a battery is mounted on a chassis 1 by this retention structure. Two battery cases 5 that house cylindrical battery cells 3 comprising the battery are mounted by brackets 7 on the floor bottom surface 1a of the chassis, arranged extending in the front-to-back direction of the vehicle, parallel in the direction of vehicle width. Inside a motor room R of the chassis 1, a motor 4 is provided for driving running by being operated by the above-described battery cells 3.

[0023]

The battery case 5 is made of an aluminum extruded material, and as shown in FIG. 3, which is a frontal view viewed from the chassis front side in FIG. 2, eight battery housing spaces 9 where the battery cells 3 are housed are formed in total, with four each on an upper and a lower level. Each of these battery housing spaces 9 passes through in the front-to-back direction of the chassis.

[0024]

In each of these battery housing spaces 9, three battery cells 3 are housed in a state connected in series. Consequently, in one battery case 5 provided with eight battery housing spaces 9, 24 battery cells 3 are housed, and here, two battery cases 5 are used, so in the vehicle as a whole, 48 battery cells 3 are used. The above-described battery cells 3 are housed in a state virtually cohering to the inner surface of the battery housing spaces 9.

[0025]

As shown in FIG. 3, cooling wind introduction spaces 11 and 13 that pass through in the chassis front-to-back direction are respectively formed on the top side and the bottom side of the battery housing spaces 9 in the battery cases 5. By introducing outside air to the cooling wind introduction spaces 11 and 13, the battery cells 3 are cooled.

[0026]

In addition, penetrating holes 15 that pass through in the chassis front-to-back direction are also formed between four mutually adjacent battery housing spaces 9, and between the battery housing spaces 9 on the left and right ends in FIG. 3 and the side walls of the battery cases 5. Furthermore, in these penetrating holes 15, Peltier elements 17 are provided as heat-exchange elements, in a state in close contact with the outside surface of the battery housing spaces 9. These Peltier elements 17 change temperature by heating or cooling depending on the direction of an electric current supplied by a voltage being impressed, and heat or cool the battery cells 3 to change the temperature of such, and are positioned at each of the battery cells 3 so as to be able to change the temperature of all of the battery cells 3. FIG. 4 is a planar view showing the arrangement positions of these Peltier elements 17, and FIG. 5 is a side view of the same.

[0027]

At both ends of the battery cases 5 in the chassis front-to-back direction, terminal covers 19 that close in a sealed state the battery housing spaces 9 and the penetrating holes 15, with the exception of the upper and lower cooling wind introduction spaces 11 and 13, are fixed by bolts or the like. On the inner surfaces of these terminal covers 19, undepicted terminal plates are provided that adhere in a state pressed again the terminals of the battery cells 3. These terminal plates are formed in a shape such that the 24 battery cells 3 provided in one of the battery cases 5 are electrically connected in series, and from both ends connected in series, lead wires or the like are drawn to the outside, although such are not represented in the drawings.

[0028]

In addition, exhaust ducts 21 are mounted in a state in which the terminal covers 19 are mounted, to the ends of the two battery cases 5 in the chassis rear direction. On the top surface of the exhaust duct 21 on the chassis rear side, a bulging section 21a that protrudes upward is formed, and in a concave section on the inner surface of this bulging section 21a, an exhaust fan 23 is provided to exhaust to the outside air that has been introduced to the cooling wind introduction spaces 11 and 13.

[0029]

FIG. 6 is an electric circuit diagram of a battery temperature regulation device provided with the Peltier element 17. One end of the Peltier device 17 on the bottom side in the drawing is connected to the emitter of a first transistor 25, the collector of the first transistor 25 is connected to the positive pole side of the battery cell 3 and the base is connected to the output terminal of a first comparator 29 via a resistor 27.

[0030]

The other end of the Peltier device 17 on the top side in the drawing is connected to the emitter of a second transistor 31, the collector is connected to the positive pole side of the battery cell 3 and the base is connected to the output terminal of a second comparator 35 via a resistor 33. In addition, the terminal on the positive pole side of the battery cell 3 is connected to the power source terminals of the first and second comparators 29 and 35 via a resistor 37.

[0031]

The positive input terminals of the first and second comparator 29 and 35 are connected to a thermocouple-type battery temperature sensor 39. This battery temperature sensor 39 comprises a temperature detection means for detecting the temperature of the battery cell 3, and is provided for each of the battery cells 3, although such is not depicted in FIG. 1 through FIG. 5. A reference voltage is supplied to the negative input terminals of the first and second comparators 29 and 35, and in order to stabilize this reference voltage, a Zener diode 41 is provided.

[0032]

The above-described first comparator 29 outputs a signal and causes the first transistor 25 to conduct when the temperature of the battery cell 3 detected by the battery temperature sensor 39 is at least as high as a first prescribed value. At this time, the electric current supplied from the battery cell 3 flows in a direction toward the Peltier element 17 via the first transistor 25, as indicated by the solid arrows. At this time, the Peltier element 17 exhibits a heat-absorbing action.

[0033]

On the other hand, the second comparator 35 outputs a signal and causes the second transistor 31 to conduct when the temperature of the battery cell 3 detected by the battery temperature sensor 39 is at least as low as a second prescribed value lower than the first prescribed value. At this time, the electric current supplied from the battery cell 3 flows in a direction toward the Peltier element 17 via the second transistor 31, as indicated by the dashed arrows. At this time, the Peltier element 17 exhibits a heat-generating action.

[0034]

The battery cell 3 is heated or cooled via the side surface of the battery housing space 9 by the heat-generation or heat-absorption of the Peltier element 17, so the above-described first and second comparators 29 and 35 and the first and second transistor 25 and 31 comprise a temperature control means that acts so as to cause the temperature of the Peltier element 17 to change in accordance with the temperature of the battery cell 3 detected by the battery temperature sensor 39.

[0035]

In an electric automobile battery temperature regulation device as described above, the temperature of the battery cells 3 rises through power consumption, and battery cells 3 whose temperature has risen are cooled by outside air being introduced into the cooling wind introduction spaces 11 and 13, but when the battery temperature even then is high and is at least the first prescribed value, the battery temperature sensor 39 detects this, the first comparator 29 cause the first transistor 25 to conduct and through this an electric current flows as indicated by the solid arrows, the Peltier element 17 exhibits a heat-absorbing action and the battery cells 3 are cooled.

[0036]

On the other hand, when the surrounding temperature is low, particularly in cold regions or the like, the temperature of the battery cells 3 drops, and when this temperature drop is detected by the battery temperature sensor 39 and the temperature becomes the second prescribed value or less, the battery temperature sensor 39 detects this, the second comparator 35 causes the second transistor 31 to conduct and through this an electric current flows as indicated by the dashed arrows, the Peltier element 17 exhibits a heat-generating action and the battery cells 3 are heated.

[0037]

In this manner, the battery cells 3 can be used at the optimal temperature by being cooled or heated, so performance and longevity increase. In cold regions and the like, when heating the battery cells 3 when charging the battery, a charging current is used when charging the battery cells 3, as indicated by the double-broken arrows, and electric power from the battery cells 3 is not consumed, so improvement in the performance and longevity of the battery cells 3 can be achieved without shortening the operating range of the vehicle.

[0038]

In addition, Peltier elements 17 are provided for each of the plurality of battery cells 3, so uniformity in temperature can be achieved in each of the battery cells 3, and performance and longevity as an assembled battery can be improved.

[Brief Description of the Drawings]

[FIG. 1] is a disassembled oblique view of a battery retention structure provided with a battery temperature regulation device for an electric automobile showing one embodiment of the present invention.

[FIG. 2] is a side view of an electric automobile showing a state in which a battery is mounted on a chassis by the retention structure of FIG. 1.

[FIG. 3] is a frontal view showing the battery case used in FIG. 2 as viewed from the

front side of the chassis.

[FIG. 4] is a planar view showing the arrangement positions of the Peltier elements installed in the battery case.

[FIG. 5] is a side view showing the arrangement positions of the Peltier elements installed in the battery case.

[FIG. 6] is an electric circuit diagram of a battery temperature regulation device provided with a Peltier element.

[Description of Reference Symbols]

3 Battery cell (battery)

5 Battery case

9 Battery housing space

17 Peltier element (heat-exchange element)

25 First transistor (temperature control means)

29 First comparator (temperature control means)

31 Second transistor (temperature control means)

35 Second comparator (temperature control means)

39 Battery temperature sensor (temperature control means)

[Drawings]
[FIG. 1]

[FIG. 2]

[FIG. 3]

[FIG. 4]

[FIG. 5]

[FIG. 6]