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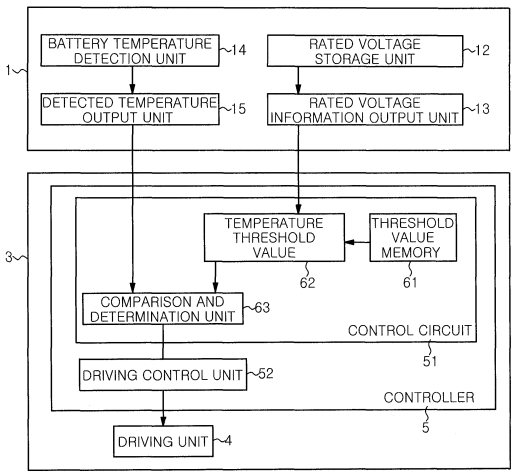
(54) **ELECTRIC TOOL**

(57) This electric tool is provided with: a battery pack (1) that includes a battery cell; and an electric tool main body (3) in which a driving unit (4) is driven by power supplied from the battery pack (1). The electric tool main body (3) is provided with a controller (5) that controls the driving unit (4). The battery pack (1) is provided with: a rated voltage storage unit (12) at which information of a rate voltage of the battery pack is stored; a rated voltage information output unit (13) that outputs the information of the rated voltage stored at the rated voltage storage unit to the controller (5); a battery temperature detection unit (14) that detects the temperature of the battery cell (11); and a detected temperature output unit (15) that outputs the temperature value detected by the battery temperature detection unit (14) to the controller (15). The controller (5) limits the output of the driving unit (4) when the temperature value of the battery cell (11) exceeds a temperature threshold value determined in accordance with the rated voltage.

FIG. 1



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Description

Field of the Invention

[0001] The present invention relates to an electric tool.

Background of the Invention

[0002] Conventionally, an electric tool is known (see, e.g., Patent Document 1). The electric tool described in Patent Document 1 includes a battery pack having a battery cell, and a electric tool main body in which a driving unit is driven by power supplied from the battery pack. In this type of electric tool, when a current flows in the battery cell, the battery cell emits heat. The heat emission from the battery cell occurs during electric discharge as well as during electric charge.

[0003] However, the battery cell may deteriorate at a high temperature. Therefore, the electric tool of Patent Document 1 is provided with a temperature sensor for detecting a temperature of the battery cell and restricts an output of a motor when a temperature value obtained by the temperature sensor exceeds a predetermined value (temperature threshold value).

[0004] In the electric tool of Patent Document 1, the temperature threshold value is changed depending on the types of battery packs. The types of the battery packs may include, e.g., a lithium ion battery, a nickel metal hydride battery, a nickel cadmium battery and the like. Accordingly, when the battery cell is electrically discharged, the battery cell is prevented from reaching a high temperature.

[0005] Patent Document 1: Japanese Patent Application Publication No. 2006-247821

[0006] However, in the electric tool in which the temperature threshold value is changed depending on the types of the battery packs, when the same type of battery packs having different rated voltages are used, the temperature increase speed of the battery pack varies in accordance with a rated voltage of the battery pack. In other words, in the battery pack having a high rated voltage, the temperature of the battery cell may quickly reach a temperature threshold value. Therefore, even if the driving unit is controlled after the temperature of the battery cell reaches the temperature threshold value, the battery cell may reach a high temperature due to temperature increase due to overshoot depending on the rated voltage of the battery pack, and the facilitation of deterioration of the battery cell may not be prevented.

Summary of the Invention

[0007] In view of the above, the present invention provides an electric tool capable of effectively preventing a battery pack from being deteriorated by a temperature increase even in the case of using a battery pack having a high rated voltage.

[0008] An electric tool in accordance with an aspect of the present invention includes: a battery pack including a battery cell, and an electric tool main body in which a driving unit is driven by power supplied from the battery pack. The electric tool main body has a controller for controlling the driving unit. The battery pack includes: a rated voltage storage unit in which information of a rate voltage of the battery pack is stored; a rated voltage information output unit for outputting the information on the rated voltage which is stored in the rated voltage storage unit to the controller; a battery temperature detection unit for detecting a temperature of the battery cell; and a detected temperature output unit for outputting the temperature value detected by the battery temperature detection unit to the controller. When the temperature value of the battery cell exceeds a temperature threshold value determined in accordance with the rated voltage, the controller limits the output of the driving unit.

[0009] Further, in the electric tool, it is preferable that, when the controller cannot identify the rated voltage information, the controller uses a temperature threshold value corresponding to the highest rated voltage as the temperature threshold value to limit the output of the driving unit.

[0010] An electric tool in accordance with another aspect of the present invention includes: a battery pack including a battery cell; and an electric tool main body in which a driving unit is driven by power supplied from the battery pack. The electric tool main body includes a controller for controlling the driving unit. The battery pack includes: a rated voltage storage unit for storing information on a rated voltage of the battery pack; a rated voltage information output unit for outputting the information on the rated voltage which is stored in the rated voltage storage unit to the controller; a battery temperature detection unit detecting a temperature of the battery cell at a predetermined interval; and a detected temperature output unit for outputting the temperature detected by the battery temperature detection unit to the controller. The controller includes: a temperature comparison and determination unit for determining whether or not a temperature of the battery cell exceeds a temperature threshold value; a consecutive excess count uinit for counting the number of consecutive determinations that the temperature determined by the temperature comparison and determination unit exceeds the temperature threshold value; and a control start determination unit for starting limit of an output of the driving unit when the number counted by the consecutive excess count unit exceeds a count threshold value determined by the rated voltage.

[0011] Further, in the electric tool, it is preferable that, when the controller cannot identify the rated voltage information, the controller uses a count threshold value corresponding to a highest rated voltage as the count threshold value to limit an output of the driving unit.

[0012] In accordance with the electric tool of the present invention, the deterioration of the battery pack due to the temperature increase can be effectively prevented even in the case of using the battery pack having

a high rated voltage.

Brief Description of the Drawings

[0013] The objects and features of the present invention will become apparent from the following description of embodiments, given in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram of an electric tool in accordance with a first embodiment of the present invention;
Fig. 2 shows a battery pack and an power tool main body of the electric tool of the first embodiment;
Fig. 3 is a circuit diagram of the electric tool of the first embodiment;
Figs. 4A and 4B are graphs showing relationship between time and a temperature of the battery cell of the battery pack of the first embodiment, wherein Fig. 4A shows a case of using a battery pack having a rated voltage higher than a normal rated voltage and Fig. 4B shows a case of using a battery pack having a rated voltage lower than the normal rated voltage;
Figs. 5A and 5B are graphs showing relationship between time and a temperature of a battery cell of a battery pack of a reference example, wherein Fig. 5A shows a case of using a conventional battery pack, and Fig. 5B shows a case of using a battery pack having a rated voltage higher than the normal rated voltage;
Fig. 6 is a block diagram of an electric tool in accordance with a second embodiment of the present invention; and
Figs. 7A and 7B are graphs showing relationship between time and a temperature of a battery cell in the case of using a battery pack having a high rated voltage, wherein Fig. 7A shows control of the second embodiment and Fig. 7B shows control of the reference example.

Detailed Description of the Embodiments

[0014] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. Like reference numerals will be used for like or similar parts throughout the entire drawings, and redundant description thereof will be omitted.

[0015] As shown in Fig. 2, an electric tool of a first embodiment includes a battery pack 1 and a electric tool main body 3 having a driving unit 4. In the electric tool, the battery pack 1 is detachably attached to a battery pack mounting portion 32 provided at a lower end portion of a grip 31 of the electric tool main body 3. The electric tool is configured such a manner that the driving unit 4 installed in the electric tool main body 3 is driven by power from the battery pack 1. The electric tool includes a controller 5 in the electric tool main body 3, and the controller 5 controls the driving unit 4 driven by the power from the battery pack 1.

[0016] The battery pack 1 has a plurality of battery cells 11 and supplies power to the driving unit 4 of the electric tool main body 3. As shown in Fig. 3, the battery pack 1 has the aforementioned battery cells 11, a rated voltage storage unit 12, a rated voltage information output unit 13, a battery temperature detection unit 14, and a detected temperature output unit 15. The battery pack 1 is accommodated in a battery pack housing 10, as shown in Fig. 2.

[0017] The battery cell 11 includes a plurality of secondary battery cells. The secondary battery cells of the present embodiment are formed of lithium batteries. The battery cells 11 of the present embodiment have a rated voltage of, e.g., 3.6 V. The battery cells 11 are electrically connected to power output terminals 16 provided to the battery pack housing 10 to be exposed to the outside.

[0018] The information on the rated voltage of the battery pack 1 is stored in the rated voltage storage unit 12. The rated voltage storage unit 12 is formed of a non-volatile memory, a resistor or the like. For example, when the rated voltage storage unit 12 is formed of a non-volatile memory, the information on the rated voltage includes data of the rated voltage, and such data are stored in the memory. When the rated voltage storage unit 12 is formed of a resistor, the information on the rated voltage includes a resistance value corresponding to the rated voltage (i.e., a resistance value that varies in accordance with rated voltages). In that case, the controller 5 is configured to identify rated voltages associated with resistance values.

[0019] The rated voltage information output unit 13 outputs the information on the rated voltage stored in the rated voltage storage unit 12 to the controller 5 in the electric tool main body 3. The rated voltage information output unit 13 of the present embodiment is formed of an information output terminal electrically connected to the rated voltage storage unit 12. As shown in Fig. 2, the rated voltage information output unit 13 is provided to the battery pack housing 10 to be exposed to the outside.

[0020] The battery temperature detection unit 14 detects a temperature of the battery cells 11. The battery temperature detection unit 14 includes a temperature detection element (e.g., a thermister). The battery temperature detection unit 14 converts the detected temperature of the battery cells 11 to electrical information which can be output.

[0021] The detected temperature output unit 15 outputs the temperature detected by the battery temperature detection unit 14 to the controller 5 in the electric tool main body 3. The detected temperature output unit 15 includes a temperature output terminal electrically connected to the battery temperature detection unit 14. As shown in Fig. 2, the detected temperature output unit 15 is provided to the battery pack housing 10 to be exposed to the outside.

[0022] The battery pack 1 configured as described

above is detachably attached to the battery pack mounting portion 32 provided at the lower end portion of the grip 31 of the electric tool main body 3.

[0023] As shown in Fig. 3, the electric tool main body 3 includes the driving unit 4, the controller 5 for controlling the driving unit 4, an information input terminal 33 connected to the information output terminal, a temperature input terminal 34 connected to the temperature output terminal. The electric tool main body 3 also includes a trigger switch 35, and a power supply switch unit 36 for switching ON/OFF states of the operation in conjunction with the trigger switch 35. As shown in Fig. 2, the electric tool main body 3 has an outer main body housing 37. The main body housing 37 accommodates therein a part of the driving unit 4, the controller 5, the information input terminal 33, the temperature input terminal 34, the trigger switch 35, the power supply switch 361 and the like.

[0024] The driving unit 4 rotates a rotation output unit 42. The driving unit 4 includes a motor M serving as a driving source, and a power transmission unit (not shown) which is connected to the motor M to transmit power to the rotation output unit 42. The rotation output unit 42 is configured in such a manner that a leading end tool is detachably attached thereto. In the driving unit 4, the motor M and the power transmission unit are accommodated in the main body housing 37 and the rotation output unit 42 is exposed from one end of the main body housing 37.

[0025] The controller 5 includes a controlr circuit 51 for electrically controlling the electric tool, and a driving controller 52 for controlling driving of the motor M in accordance with a signal output from the control circuit 51.

[0026] The control circuit 51 has a microprocessor as a main component. The control circuit 51 is electrically connected to the rated voltage storage unit 12 through the information input terminal 33 and the information output terminal. The control circuit 51 is electrically connected to the battery temperature detection unit 14 through the temperature input terminal 34 and the temperature output terminal. The control circuit 51 is electrically connected to the battery cells 11 through power input terminals 38 and the power output terminals 16. The detailed configuration of the control circuit 51 will be described later.

[0027] The driving control unit 52 is electrically connected to the motor M and the control circuit 51 and controls the rotation speed of the motor M. The driving control unit 52 of the present embodiment includes a switching device. The driving control unit 52 receives the signal output from the control circuit 51 and switches ON/OFF the switching device, thereby controlling the rotation speed of the motor M.

[0028] The information input terminal 33 is electrically connected to the control circuit 51 and provided inside the battery pack mounting portion 32 of the main body housing 37. When the battery pack 1 is mounted in the battery pack mounting portion 32, the information input terminal 33 is connected to the rated voltage information output unit 13 serving as the information output terminal of the battery pack 1.

[0029] The temperature input terminal 34 is electrically connected to the controller 5 and provided in the battery pack mounting portion 32 of the main body housing 37. When the battery pack 1 is mounted in the battery pack mounting portion 32, the temperature input terminal 34 is connected to the detected temperature output unit 15 serving as the temperature output terminal of the battery pack 1.

[0030] The trigger switch 35 is driven in conjunction with a trigger handle 351 that can protrude from and retreat into the grip 31 of the main body housing 37. The trigger switch 35 switches ON/OFF states of the power supply switch 361 in conjunction with the ON/OFF operation. When a user switches ON the trigger switch 35 by pushing the trigger handle 351, the power supply switch 361 is switched ON in conjunction therewith. Accordingly, the power is supplied to the control circuit 51 through the power supply switch 361 and a constant voltage source 39.

[0031] As shown in Fig. 3, the trigger switch 35 includes a variable resistor 352 for varying a resistance value in accordance with the pushed amount oof the trigger handle 351. When a user pushes the trigger handle 351, the trigger switch 35 sets a resistance value in accordance with the pushed amount. The control circuit 51 receives the resistance value and outputs to the driving control unit 52 a signal to drive the motor M at a rotation speed in accordance with the resistance value. Further, when a user pushes the trigger handle 351 to a maximum extent, the motor M is driven at a full rotation speed. Meanwhile, when a user releases the trigger handle 351 so that the trigger handle 351 returns to the original position and then switches off the trigger switch 35, the trigger switch 35 short-circuits the voltage input terminals of the motor M, thereby limiting the driving of the motor M.

[0032] Here, in the electric tool, when a user manipulates the trigger handle 351 to maintain the ON state, the current constantly flows through the battery cells 11 of the battery pack 1. Accordingly, the temperature of the battery cells 11 is increased. However, if the battery cells 11 are exposed to a high temperature, performance thereof is remarkably deteriorated. Therefore, the electric tool of the present embodiment is configured to detect a temperature of the battery cells 11 and allow the controller 5 to limit the output of the motor M when the temperature of the battery cells 11 exceeds a temperature threshold value. Particularly, the temperature threshold value of the present embodiment is determined by the rated voltage of the battery pack 1, which will be described hereinafter.

[0033] As shown in Fig. 1, the control circuit 51 includes a threshold value memory 61 in which a plurality of different temperature threshold values are stored, a temperature threshold value acquisition unit 62 for acquiring the temperature threshold values stored in the threshold value memory 61, and a comparison and determination

unit 63 for comparing the temperature of the battery cells 11 and the temperature threshold value.

[0034] The threshold value memory 61 previously stores therein a plurality of temperature threshold values corresponding to the rated voltage of the battery pack 1. In other words, the threshold value memory 61 stores a first temperature threshold value corresponding to a first rated voltage and a second temperature threshold value corresponding to a second rated voltage. In the same manner, a third temperature threshold value, a fourth temperature threshold value ... are stored in correspondence with a third rated voltage, a fourth rated voltage ....

[0035] The temperature threshold value acquisition unit 62 is connected to the information input terminal 33, and thus is electrically connected to the rated voltage information output unit 13 serving as the information output terminal of the battery pack 1 when the battery pack 1 is mounted at the electric tool main body 3. When the rated voltage information is input from the rated voltage information output unit 13, the temperature threshold value acquisition unit 62 acquires the temperature threshold value corresponding thereto from the threshold value memory 61. For example, when the rated voltage of the battery pack 1 is a first rated voltage, if the information on the first rated voltage is input from the rated voltage information output unit 13, the temperature threshold value acquisition unit 62 acquires the first temperature threshold value from the threshold value memory 61.

[0036] Further, when the rated voltage information input from the rated voltage information output unit 13 cannot be identified, the temperature threshold value acquisition unit 62 acquires a temperature threshold value corresponding to the highest rated voltage among the temperature threshold values stored in the threshold value memory 61.

[0037] The temperature threshold value acquisition unit 62 outputs the information on the temperature threshold value acquired from the threshold value memory 61 to the comparison and determination unit 63.

[0038] The comparison and determination unit 63 is connected to the temperature input terminal 34 and thus is electrically connected to the detected temperature output unit 15 serving as the temperature output terminal of the battery pack 1 when the battery pack 1 is mounted at the electric tool main body 3. Accordingly, the data of the temperature value from the battery temperature detection unit 14 is input to the comparison and determination unit 63. When the data of the temperature value is input from the battery temperature detection unit 14 and the information on the temperature threshold value is input from the temperature threshold value acquisition unit 62, the comparison and determination unit 63 compares the temperature value of the battery cells 11 with the temperature threshold value determined in accordance with the rated voltage. When it is determined that the temperature value of the battery cells 11 exceeds the temperature threshold value determined in accordance with the rated voltage, the comparison and determination unit 63 outputs a signal that limits the output of the motor M to the driving control unit 52.

[0039] When receiving the signal of the driving control from the comparison and determination unit 63, the driving control unit 52 controls the driving of the motor M based thereon. At this time, the driving control unit 52 limits the output of the motor M. The driving control unit 52 may stop the driving of the motor M or reduce the rotation speed of the motor M without stopping the motor M.

[0040] In the electric tool of the present embodiment, it is determined whether or not the temperature value of the battery cells 11 exceeds the temperature threshold value by using the temperature threshold value determined in accordance with the rated voltage of the battery pack 1. Accordingly, when the battery pack 1 having a high rated voltage is mounted at the electric tool, the temperature threshold value can be set to a lower value (temperature threshold value B) obtained by deducting the amount of temperature increase due to overshoot of the battery pack 1 having a high rated voltage from the maximum tolerable temperature value (temperature threshold value A) (see Fig. 4A). Further, in case of using the battery pack 1 having a low rated voltage, the temperature threshold value may be set to a value higher than the temperature threshold value B of the high rated voltage (temperature threshold value C) (see Fig. 4B). Herein, the maximum tolerable temperature value (temperature threshold value A) indicates the maximum temperature value that hardly affects the performance of the battery cells 11.

[0041] Meanwhile, the conventional electric tool uniformly sets the temperature threshold value in consideration of the temperature increase due to the overshoot from the temperature threshold value A (i.e., the maximum tolerable temperature value) (see Fig. 5A) in order to protect the battery cells 11 of the battery pack 1, i.e., in order to prevent the temperature thereof from reaching the maximum tolerable temperature.

[0042] If the temperature threshold value is set to be considerably lower than the temperature threshold value A in consideration of the temperature increase due to the overshoot, the temperature threshold value becomes too low in the case of using the battery pack 1 having a low rated voltage in which the overshoot is suppressed. In other words, if the electric tool is used in that case, the output of the driving unit 4 is frequently limited, and the excessive limit may occur.

[0043] Meanwhile, if the temperature threshold value is set to be slightly lower than the temperature threshold value A, the temperature of the battery pack 1 exceeds the temperature threshold value A in the case of using the battery pack 1 having a high rated voltage in which the temperature increase due to the overshoot is high (see Fig. 5B). This is because the temperature of the battery pack 1 having a high rated voltage is quickly increased while using the battery pack 1.

[0044] In this regard, the electric tool of the present

embodiment determines the temperature threshold value in accordance with the rated voltage of the battery pack 1, so that the output of the driving unit 4 can be limited by using different temperature threshold values for the rated voltages (Figs. 4A and 4B). Therefore, the deterioration of the battery pack 1 can be prevented while preventing excessive limit of the output of the driving unit 4.

[0045] Further, in the electric tool of the present embodiment, when the temperature threshold value acquisition unit 62 cannot identify the rated voltage information, the temperature threshold value corresponding to the highest rated voltage is acquired as the temperature threshold value. Therefore, if the information of the rated voltage cannot be transferred to the controller 5, the battery cells 11 of the battery pack 1 can be prevented from reaching a high temperature to be deteriorated.

[0046] Hereinafter, the second embodiment will be described with reference to Figs. 6, 7A and 7B. The second embodiment is substantially the same as the first embodiment, so that like reference numerals will be used for like parts and redundant description will be omitted. Only the differences will be described mainly.

[0047] In the electric tool of the present embodiment, the configuration of the control circuit 51 of the controller 5 and the configuration of the battery temperature detection unit 2 are different from those of the first embodiment, and other configurations are the same.

[0048] The battery temperature detection unit 2 of the present embodiment detects the temperature of the battery cells 11 at a predetermined time interval. The battery temperature detection unit 2 is formed of a temperature detection element (e.g., a thermister). The battery temperature detection unit 2 converts the detected temperature of the battery cells 11 to electrical information which can be output.

[0049] As shown in Fig. 6, the control circuit 51 of the present embodiment includes a temperature comparison and determination unit 71, a threshold value memory 72 having a count threshold value storage unit 721 and a temperature threshold value storage unit 722, a consecutive excess count unit 73, a count threshold value acquisition unit 74, and a control start determination unit 75.

[0050] The temperature comparison and determination unit 71 is connected to the temperature input terminal 34 (see Fig. 3) and thus is electrically connected to the detected temperature output unit 15 serving as the temperature output terminal when the battery pack 1 is mounted at the electric tool main body 3. Accordingly, the data of the temperature value of the battery cells 11 is input from the battery temperature detection unit 2 to the temperature comparison and determination unit 71. When the data of the temperature value is input from the battery temperature detection unit 2, the temperature comparison and determination unit 71 acquires a predetermined temperature threshold value stored in the threshold value memory 72. Accordingly, the temperature comparison and determination unit 71 determines whether or not the temperature value of the battery cells 11 exceeds a predetermined temperature threshold value. The temperature comparison and determination unit 71 outputs the determined information to the consecutive excess count unit 73.

[0051] The consecutive excess count unit 73 counts "+1" when the temperature comparison and determination unit 71 determines that "the temperature of the battery cells 11 exceeds the temperature threshold value." Meanwhile, the consecutive excess count unit 73 resets the number that has been counted when the temperature comparison and determination unit 71 determines that "the temperature value of the battery cells 11 is smaller than the temperature threshold value." In other words, the consecutive excess count unit 73 counts the number of times of consecutive determinations that the temperature of the battery cells 11 exceeds the temperature threshold value.

[0052] The threshold value memory 72 includes a count threshold value storage unit 721 that stores the count threshold value, and a temperature threshold value storage unit 722 that stores a predetermined temperature threshold value.

[0053] The count threshold value storage unit 721 previously stores therein a plurality of count number threshold values corresponding to the rated voltage of the battery pack 1 (hereinafter, referred to as "count threshold value"). In other words, the count threshold value storage unit 721 stores therein a first rated voltage and a first count threshold value corresponding thereto, and a second count threshold value corresponding to a second rated voltage. In the same manner, a third count threshold value, a fourth count threshold value ... are stored in correspondence with a third rated voltage, a fourth rated voltage ....

[0054] The temperature threshold value storage unit 722 stores a predetermined temperature threshold value. Unlike in the first embodiment, the temperature threshold value storage unit 722 stores a constant temperature threshold value.

[0055] The count threshold value acquisition unit 74 is connected to the information input terminal 33 and thus connected to the rated voltage information output unit 13 serving as the information output terminal when the battery pack 1 is mounted at the electric tool main body 3. When the rated voltage information is input from the rated voltage information output unit 13, the count threshold value acquisition unit 74 acquires the count threshold value corresponding thereto from the threshold value memory 72. For example, when the rated voltage of the battery pack 1 is the first rated voltage and the information on the first rated voltage is input from the rated voltage information output unit 13, the count threshold value acquisition unit 74 acquires the first count threshold value from the threshold value memory 72.

[0056] Further, when the rated voltage information input from the rated voltage information output unit 13 cannot be identified, the count threshold value acquisition unit 74 acquires a count threshold value corresponding

to the highest rated voltage among the count threshold values stored in the threshold value memory 72.

[0057] The count threshold value acquisition unit 74 outputs the information on the count threshold value acquired from the threshold value memory 72 to the control start determination unit 75.

[0058] When the data output from the consecutive excess count unit 73 and the data output from the count threshold value acquisition unit 74 are input, the control start determination unit 75 compares the count number of the consecutive excess count unit 73 with the count threshold value. When it is determined that the count number exceeds the count threshold value determined in accordance with the rated voltage, the control start determination unit 75 outputs a signal to start to limit the output of the motor M to the driving control unit 52.

[0059] The electric tool of the present embodiment detects the temperature of the battery cells 11 at a predetermined time interval and determines whether or not the limit of the output of the driving unit 4 is to be started based thereon. Therefore, the output of the driving unit 4 can be accurately limited.

[0060] The electric tool of the present embodiment detects the temperature of the battery cells 11 at a predetermined time interval and counts the number of consecutive determinations that the measured temperature of the battery cells 11 exceeds a predetermined temperature threshold value. Further, when the counted number reaches a predetermined number, the output of the driving unit 4 is limited first. In general, when the limit of the output of the driving unit 4 is started, a time lag occurs after the temperature of the battery cells 11 reaches a predetermined temperature threshold value (see Fig. 7B). At this time, if the battery pack 1 having a high rated voltage is used, the temperature may be increased considerably during the time lag.

[0061] In this regard, in the electric tool of the present embodiment, in the case of using the battery pack 1 having a high rated voltage in order to determine the count threshold value in accordance with the rated voltage, the time lag can be reduced by using a small number of count threshold values (see Fig. 7A). Further, in the case of using the battery pack 1 having a low rated voltage, the electric tool of the present embodiment can operate in accordance with various states by using a large number of count threshold values.

[0062] Accordingly, even in the case of using the battery pack 1 having a high rated voltage, the electric tool of the present embodiment can prevent the temperature of the battery cells 11 from being increased considerably by the time lag until the start of the control after the temperature of the battery cells 11 reaches the temperature threshold value. Therefore, in accordance with the electric tool of the present embodiment, the deterioration of the battery pack 1 can be prevented.

[0063] When the count threshold value acquisition unit 74 cannot identify the rated voltage information, the electric tool of the present embodiment acquires acquires the count threshold value corresponding to the highest rated voltage as the count threshold value. Therefore, if the information of the rated voltage is not transferred to the controller 5, the battery cells 11 of the battery pack 1 can be prevented from reaching a high temperature and being deteriorated.

[0064] In the second embodiment, a constant temperature threshold value is used as the temperature threshold value. However, as in the first embodiment, the temperature threshold value may be determined in accordance with the rated voltage of the battery pack 1.

[0065] While the invention has been shown and described with respect to the embodiments, the present invention is not limited to the above-described examples. Various changes and modification may be made without departing from the scope of the invention as defined in the following claims, and such modifications are also included in the technical scope of the present invention.

Claims

1. An electric tool comprising:

   a battery pack including a battery cell; and
   an electric tool main body in which a driving unit is driven by power supplied from the battery pack,
   wherein the electric tool main body has a controller for controlling the driving unit,
   wherein the battery pack includes:

   a rated voltage storage unit in which information of a rate voltage of the battery pack is stored;
   a rated voltage information output unit for outputting the information on the rated voltage which is stored in the rated voltage storage unit to the controller;
   a battery temperature detection unit for detecting a temperature of the battery cell; and
   a detected temperature output unit for outputting the temperature value detected by the battery temperature detection unit to the controller, and
   wherein when the temperature value of the battery cell exceeds a temperature threshold value determined in accordance with the rated voltage, the controller limits the output of the driving unit.

2. The electric tool of claim 1, wherein when the controller cannot identify the rated voltage information, the controller uses a temperature threshold value corresponding to a highest rated voltage as the temperature threshold value to limit the output of the driving unit.

3. An electric tool comprising:

a battery pack including a battery cell; and
a electric tool main body in which a driving unit is driven by power supplied from the battery pack,
wherein the electric tool main body includes a controller for controlling the driving unit,
wherein the battery pack includes:

a rated voltage storage unit for storing information on a rated voltage of the battery pack;
a rated voltage information output unit for outputting the information on the rated voltage which is stored in the rated voltage storage unit to the controller;
a battery temperature detection unit detecting a temperature of the battery cell at a predetermined interval; and
a detected temperature output unit for outputting the temperature detected by the battery temperature detection unit to the controller,

wherein the controller includes:

a temperature comparison and determination unit for determining whether or not a temperature of the battery cell exceeds a temperature threshold value;
a consecutive excess count uinit for counting the number of consecutive determinations that the temperature determined by the temperature comparison and determination unit exceeds the temperature threshold value; and
a control start determination unit for starting limit of an output of the driving unit when the number counted by the consecutive excess count unit exceeds a count threshold value determined by the rated voltage.

4. The electric tool of claim 3, wherein when the controller cannot identify the rated voltage information, the controller uses a count threshold value corresponding to a highest rated voltage as the count threshold value to limit an output of the driving unit.

FIG. 1

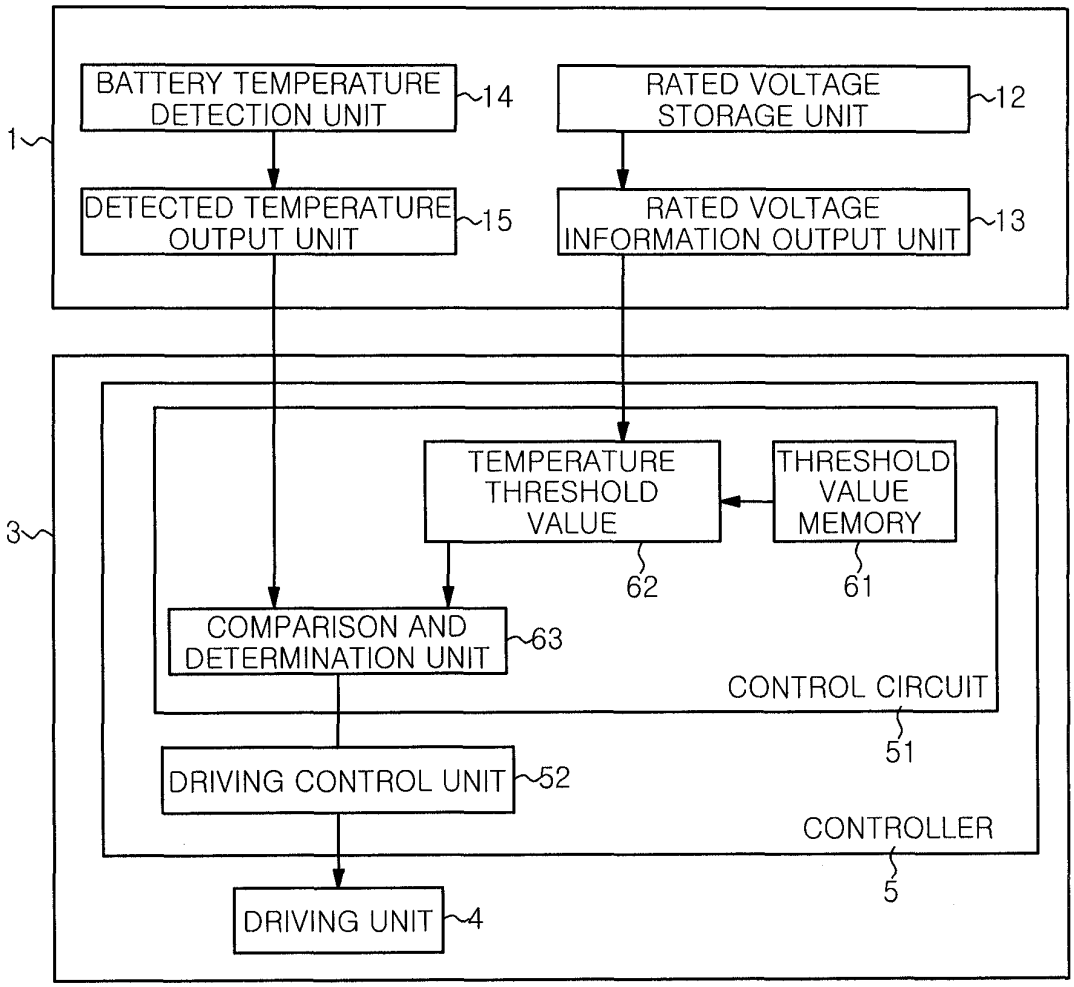

1
BATTERY TEMPERATURE DETECTION UNIT
14
RATED VOLTAGE STORAGE UNIT
12
DETECTED TEMPERATURE OUTPUT UNIT
15
RATED VOLTAGE INFORMATION OUTPUT UNIT
13
3
TEMPERATURE THRESHOLD VALUE
62
THRESHOLD VALUE MEMORY
61
COMPARISON AND DETERMINATION UNIT
63
CONTROL CIRCUIT
51
DRIVING CONTROL UNIT
52
CONTROLLER
5
DRIVING UNIT
4

FIG. 2

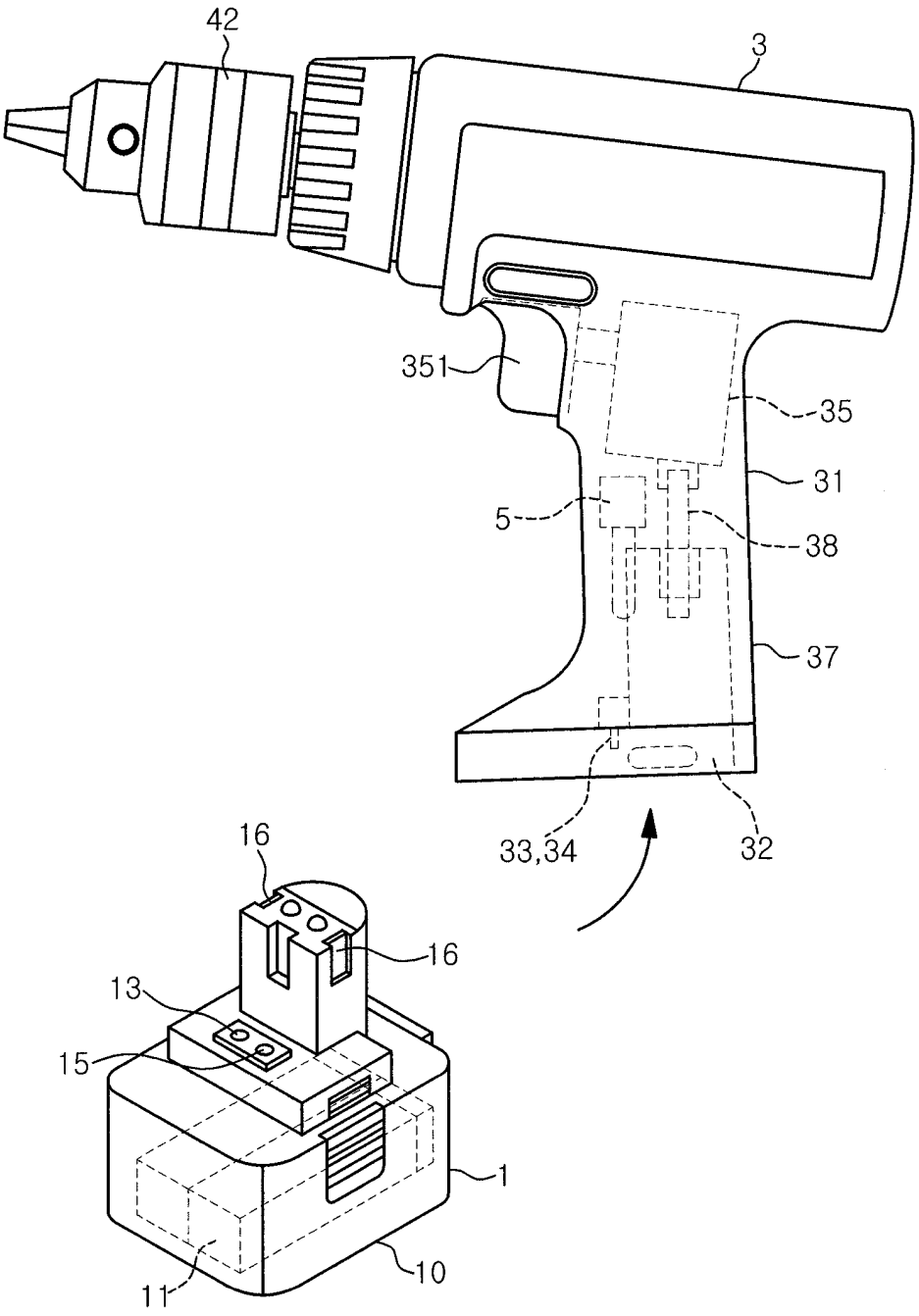
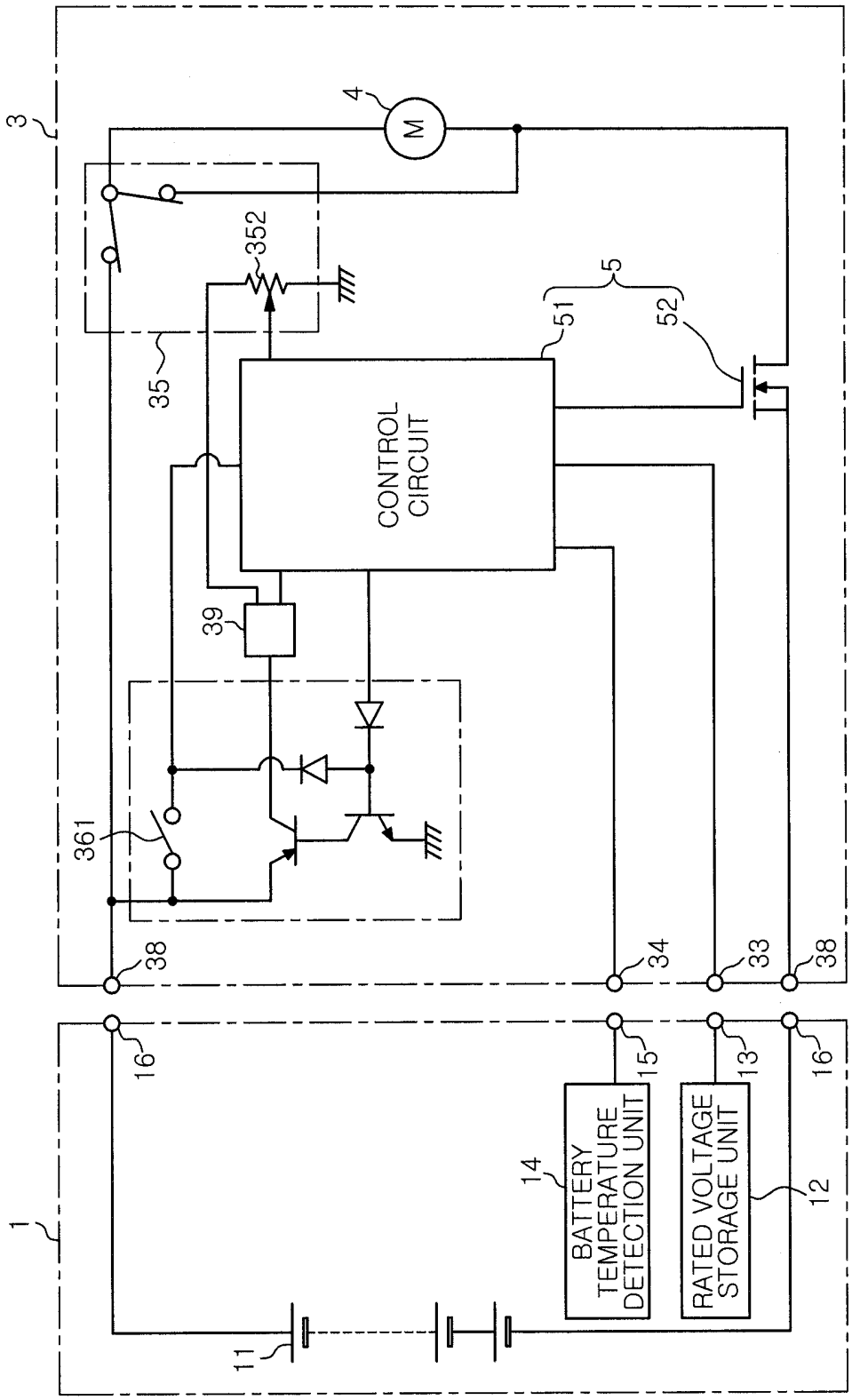


FIG. 3


3
4
M
352
5
51
52
35
CONTROL CIRCUIT
39
361
38
34
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16
BATTERY TEMPERATURE DETECTION UNIT
15
14
RATED VOLTAGE STORAGE UNIT
13
12
16
11

FIG. 4A

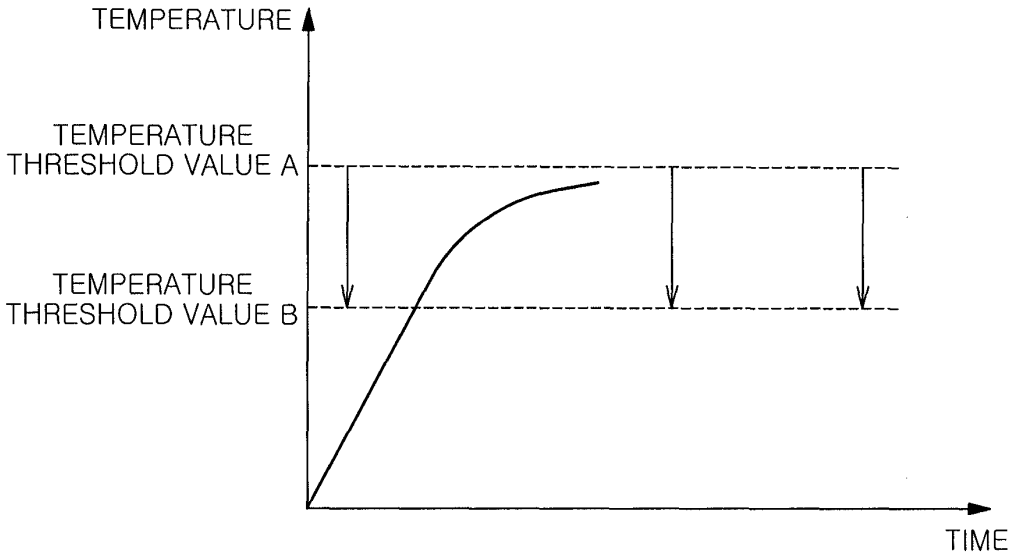

TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE B
TIME

FIG. 4B

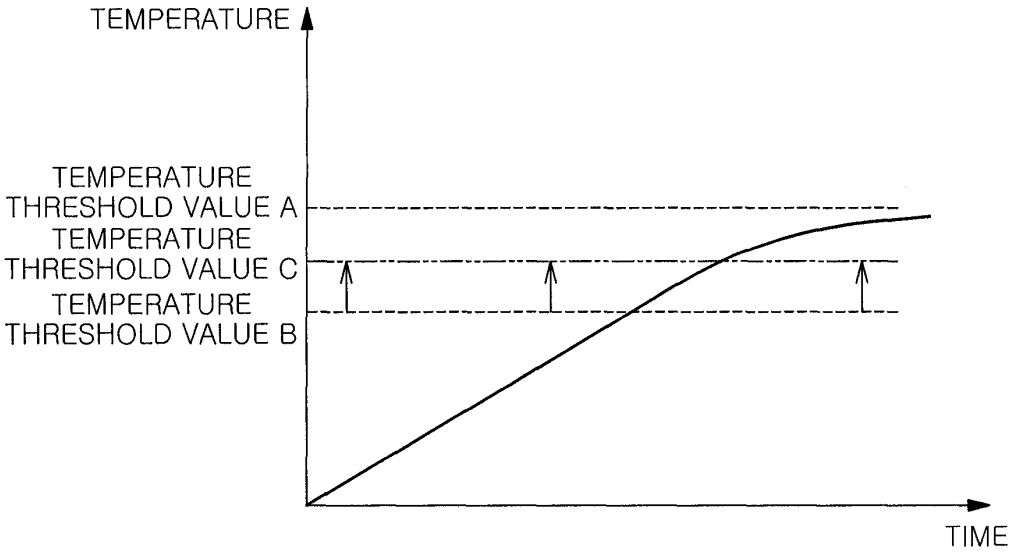

TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE C
TEMPERATURE THRESHOLD VALUE B
TIME

FIG. 5A

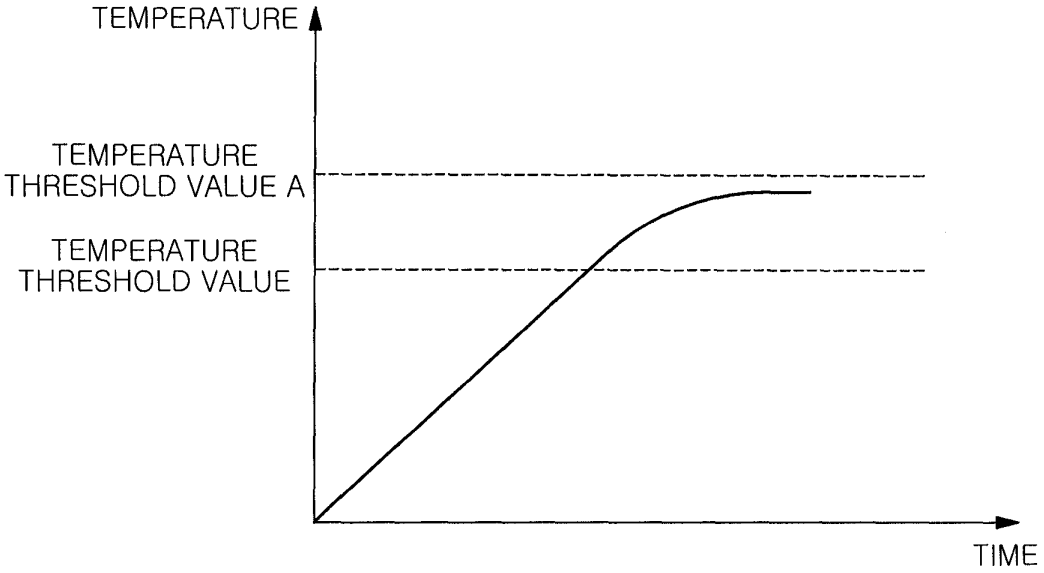

TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE
TIME

FIG. 5B

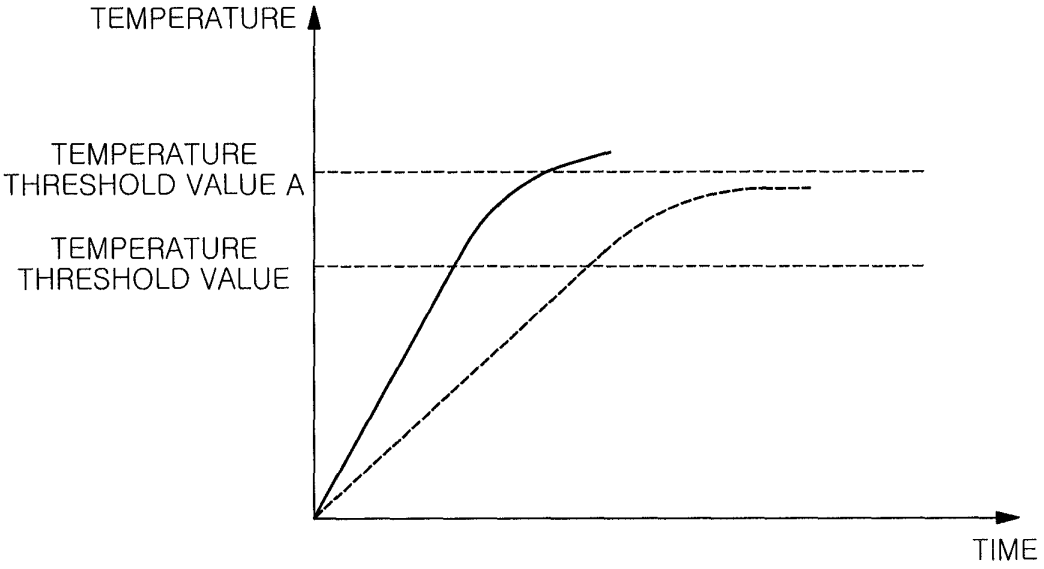
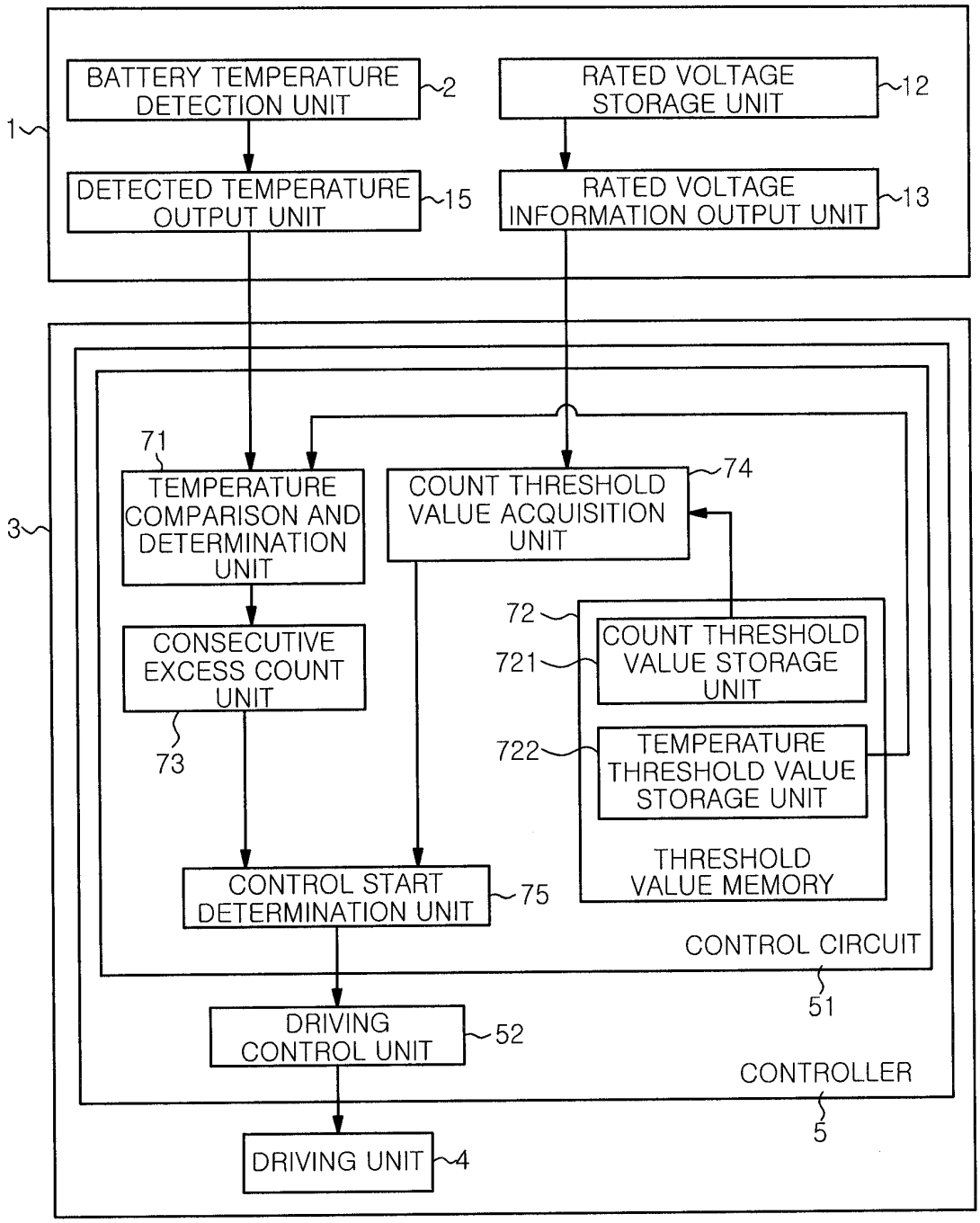

TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE
TIME

FIG. 6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BATTERY TEMPERATURE DETECTION UNIT
2
RATED VOLTAGE STORAGE UNIT
12
DETECTED TEMPERATURE OUTPUT UNIT
15
RATED VOLTAGE INFORMATION OUTPUT UNIT
13
3
71
TEMPERATURE COMPARISON AND DETERMINATION UNIT
COUNT THRESHOLD VALUE ACQUISITION UNIT
74
CONSECUTIVE EXCESS COUNT UNIT
73
72
721
COUNT THRESHOLD VALUE STORAGE UNIT
722
TEMPERATURE THRESHOLD VALUE STORAGE UNIT
THRESHOLD VALUE MEMORY
CONTROL START DETERMINATION UNIT
75
CONTROL CIRCUIT
51
DRIVING CONTROL UNIT
52
CONTROLLER
5
DRIVING UNIT
4

FIG. 7A

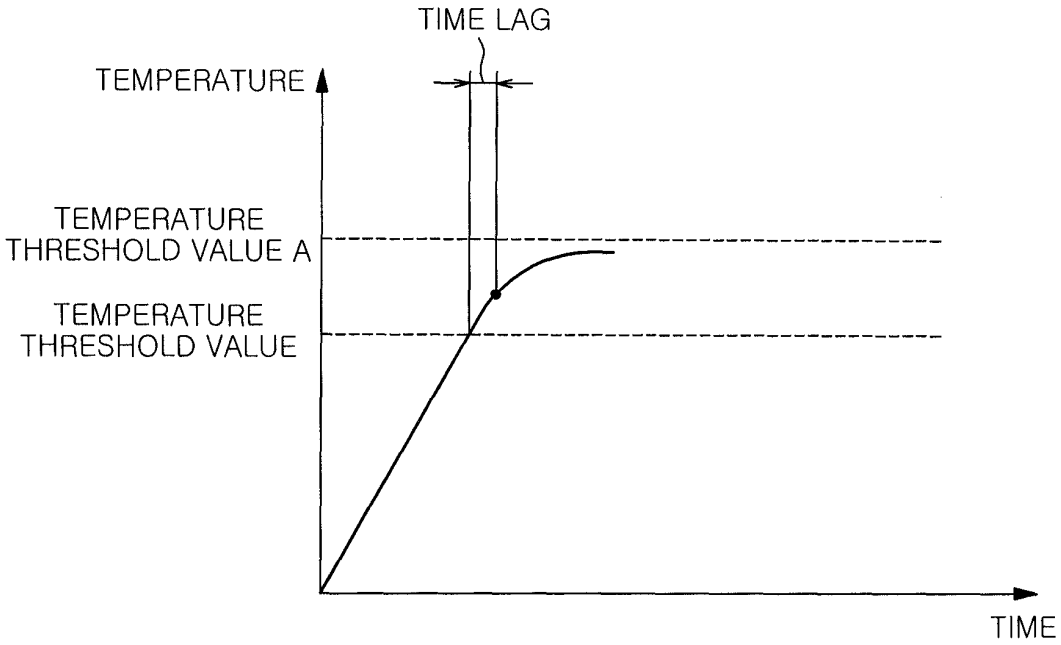
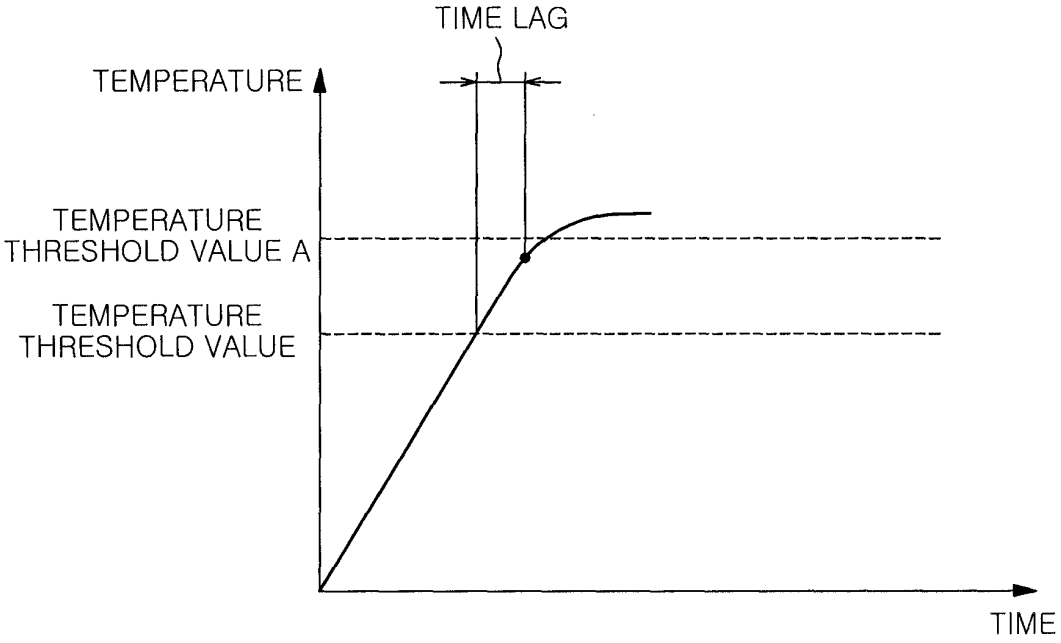

TIME LAG
TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE
TIME

FIG. 7B


TIME LAG
TEMPERATURE
TEMPERATURE THRESHOLD VALUE A
TEMPERATURE THRESHOLD VALUE
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/001481

A. CLASSIFICATION OF SUBJECT MATTER
B25F5/00(2006.01)i

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)
B25F5/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-247821 A (Matsushita Electric Works, Ltd.), 21 September 2006 (21.09.2006), entire text; all drawings (Family: none)	1-4
A	JP 2011-156625 A (Hitachi Koki Co., Ltd.), 18 August 2011 (18.08.2011), paragraphs [0030] to [0040] & WO 2011/096582 A2	1-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 December, 2012 (04.12.12)	18 December, 2012 (18.12.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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Patent documents cited in the description

- JP 2006247821 A **[0005]**