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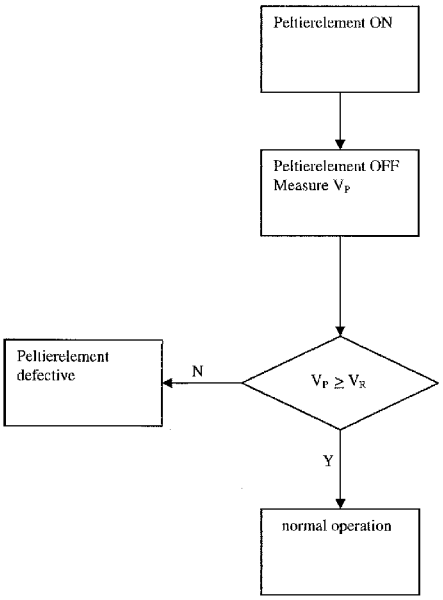
(54) **Title**: METHOD FOR TESTING A PELTIER ELEMENT AS WELL AS A SMALL ELECTRICAL APPLIANCE WITH A PELTIER ELEMENT AND A SAFETY DEVICE

Fig. 2



(57) **Abstract**: A method with the following steps is described for testing a Peltier element: - applying a voltage to the Peltier element, - switching off the voltage at the end of a defined period of time, - measuring the voltage at the Peltier element and - comparing the measured voltage with a reference value. Furthermore, a small electrical appliance (for example an electric shaver) with a Peltier element is described, which small electrical appliance has a safety device which ensures that a malfunction of the Peltier element cannot result in danger to the user.

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METHOD FOR TESTING A PELTIER ELEMENT AS WELL AS A SMALL ELECTRICAL APPLIANCE WITH A PELTIER ELEMENT AND A SAFETY DEVICE

FIELD OF THE INVENTION

The invention relates to a method for testing a Peltier element as well as to a small electrical appliance, such as an electric shaver, with a Peltier element and a safety device.

BACKGROUND OF THE INVENTION

WO 2010/003603 A1 discloses a shaver which has a Peltier element for cooling the skin of a user while shaving. With Peltier elements, the danger exists that the element may be destroyed by mechanical or thermal effects. For example, the element may break if it falls down or the electrical connections may be damaged by overheating. As a result, the internal resistance and the cooling performance of the element change. This can lead to the situation that the element may no longer cool and heats up instead, such that also the side of the element which is actually to be cooled becomes so hot that the user can be burned on it.

It is the object of the present patent application to specify a simple and reliable method for testing a Peltier element as well as a small electrical appliance with a Peltier element, given that the user is protected against any malfunctioning of the Peltier element.

SUMMARY OF THE INVENTION

This object is accomplished via a method in which the following steps are carried out in order to check a Peltier element: to begin with, a voltage is applied to the Peltier element for a certain period of time. At the end of this period of time, the voltage at the Peltier element is switched off, and after this the voltage at the Peltier element is measured and compared with a reference value.

This method makes use of the nature of a Peltier element to function as both a heating or cooling element and a thermoelectric generator. By applying the voltage, a current is caused to

flow through the Peltier element for a certain period of time, which ensures that – if the Peltier element is intact – a temperature difference arises between the cold side of the Peltier element and the warm side of the Peltier element. Therefore, after the voltage is switched off a thermoelectric voltage which corresponds to this temperature difference will be measurable at the Peltier element. However, if the Peltier element is not intact no temperature difference or only a smaller temperature difference occurs and therefore no (or only a comparatively small) thermoelectric voltage can be measured either. The measured thermoelectric voltage is therefore compared with at least one reference value and, if necessary, a function is triggered – for example a display device is activated or a control signal is generated – if the comparison reveals that the Peltier element is defective, that is, if the measured thermoelectric voltage is outside of the permissible range defined by the reference value

This method is intended for testing a Peltier element which is installed in a small electric device, for example an electric shaver. The small electrical appliance has a safety device which ensures that a malfunction of the Peltier element cannot become dangerous for the user. The safety device is suitable for carrying out the steps of the method described above and contains a safety circuit (for example a microcontroller) and a switch which can be controlled by the safety circuit. The safety circuit is connected with a device for measuring the thermoelectric voltage of the Peltier element and has a device for comparing the measured voltage with at least one reference value. The controllable switch is connected in series with the Peltier element and a power supply device. The safety device furthermore may have at least one display device which is activated by the safety circuit when the Peltier element is defective. In the case of a motor-driven small electrical appliance which has a control circuit for the motor, the safety circuit may be connected with the control circuit in order to prevent the motor of the small electrical appliance being switched on if the Peltier element is defective. In this way, the user can be prevented from using the defective small electrical appliance. The safety circuit and the control circuit may be implemented in a single microcontroller.

The safety device is advantageously always activated when the small electrical appliance is switched on by a user and then carries out a test of the Peltier element which advantageously takes only fractions of a second. If the safety device is connected with the control circuit of the small electrical appliance and the safety device establishes that the Peltier element is in order, it outputs a corresponding signal to the control circuit, which thereupon switches on the small

electrical appliance with a delay which practically cannot be perceived by the user. Of course, the testing of the Peltier element can be repeated at certain time intervals.

Advantageously, the safety device may also have a temperature sensor which measures the temperature of the warm side of the Peltier element or the temperature in the surroundings of the warm side of the Peltier element and which is connected with the safety circuit. By measuring the thermoelectric voltage at the Peltier element, the safety circuit can determine the temperature of the cold side of the Peltier element while taking the temperature measured by the temperature sensor into consideration. In the case of an electric shaver whose Peltier element should cool the skin of a user while shaving, the cold side is the side of the Peltier element which can come into contact with the skin of the user. If the temperature of the cold side is not within a certain temperature range which is defined by a first and a second limiting value, the safety circuit may also activate a warning device and/or prevent the driving mechanism of the shaver from being switched on.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained by means of an exemplary embodiment of a small electrical appliance, the safety device of which operates according to the method according to the invention.

Figure 1 shows a circuit arrangement with a safety circuit; and

Figure 2 shows a workflow diagram.

DETAILED DESCRIPTION OF THE INVENTION

The circuit arrangement shown in Figure 1 has a safety circuit, for example a microcontroller µC which is connected with a controllable switch T, for example a transistor. The controllable switch T is connected in series with a Peltier element P. A device for measuring the voltage V_P at the Peltier element P has an analog/digital converter ADC, the inputs of which are connected in parallel with the Peltier element P and the output of which is connected to the microcontroller µC.

The microcontroller µC is designed for testing the Peltier element P. For this purpose it contains a known device for triggering the controllable switch T, a device for generating a reference voltage V_R and a device for comparing the voltage V_P supplied by the analog/digital converter ADC with the reference voltage V_R. Furthermore, a workflow controller which controls the steps of the method shown schematically in Figure 2 is implemented in the microcontroller µC.

This circuit arrangement is intended for a small electrical appliance, advantageously for an electric shaver, with a Peltier element, what is known as the warm side of which is connected thermally with a cooling body and what is known as the cold side of which is disposed in the shaver so that it can cool the skin of a user while shaving. Otherwise, the shaver contains a known control circuit with which the functions of the shaver – for example its motor – can be controlled. The control circuit may be implemented in the microcontroller µC or separately therefrom.

For a different embodiment (which is not shown in the Figures) the safety device also includes yet another temperature sensor which is in thermal contact with the warm side of the Peltier element P and is connected electrically with the safety circuit. The safety circuit, for example a microcontroller, contains a device for determining the temperature of the cold side of the Peltier element, which determines the temperature of the cold side of the Peltier element from the temperature of the warm side of the Peltier element (supplied by the temperature sensor) and the voltage at the Peltier element (supplied by the analog/digital converter ADC). The workflow controller is designed so that the cold side of the Peltier element P is brought to a temperature which lies within a temperature range stored in the microcontroller and is perceived by a user as pleasant, for example in a range between 10°C and 20°C. For this purpose the controllable switch T is correspondingly triggered by the safety circuit. In a further embodiment the workflow controller is designed so that the cold side of the Peltier element cannot assume an excessively high temperature, meaning that if necessary said workflow controller interrupts the supply of current to the Peltier element P in good time by means of the controllable switch T.

The steps of the method for testing the Peltier element are shown in Figure 2. To begin with, the Peltier element P is switched on over the controllable switch T so that, if the Peltier element is intact, a temperature difference develops between its warm and cold sides. After a

brief period of time, for example about 2 ms, the Peltier element is switched off and immediately afterwards the voltage V_P at the Peltier element is measured and compared by the microcontroller μC with the reference voltage V_R. If the voltage V_P is higher than the reference voltage V_R the Peltier element is in order, and if the voltage V_P is lower than the reference voltage V_R the Peltier element is defective. In an additional step (which is not shown in Figure 2) it is possible to differentiate between a defective Peltier element and a reversal of polarity.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm.”

CLAIMS

What is claimed is:

1. A method for testing a Peltier element, characterized by the following steps:
   - applying a voltage (V) to the Peltier element,
   - switching off the voltage (V) at the end of a defined period of time,
   - measuring the voltage (V_P) at the Peltier element and
   - comparing the measured voltage (V_P) with a reference value (V_R).

2. The method according to Claim 1, characterized in that the magnitude of the voltage (V_P) at the Peltier element is compared with the reference value (V_R).

3. The method according to any of the preceding Claims, characterized in that a display device is activated or a control signal is generated when the comparison reveals that the measured voltage (V_P) lies outside of the permissible range defined by the reference value.

4. Small electrical appliance, for example an electric shaver, with a Peltier element, the cold side of which is accessible to a user, characterized by a safety device which is suitable for carrying out the method steps according to any of the preceding claims.

5. Small electrical appliance according to Claim 4, characterized in that the safety device has a safety circuit such as a microcontroller (µC), a device for measuring the voltage (V_P) at the Peltier element (P) which is connected with the safety circuit, and a controllable switch (T) which is connected in series with the Peltier element (P) and can be controlled by the safety circuit.

6. Small electrical appliance according to Claim 5, characterized in that it has a display device which can be controlled by the safety circuit (µC).

7. Small electrical appliance according to any of the Claims 4 to 6, characterized in that the safety device has a temperature sensor.

8. Small electrical appliance according to Claim 7, characterized in that the safety device switches off the small electrical appliance and/or activates a warning device when the

temperature of the cold side of the Peltier element is higher than a first limiting value or lower than a second limiting value.

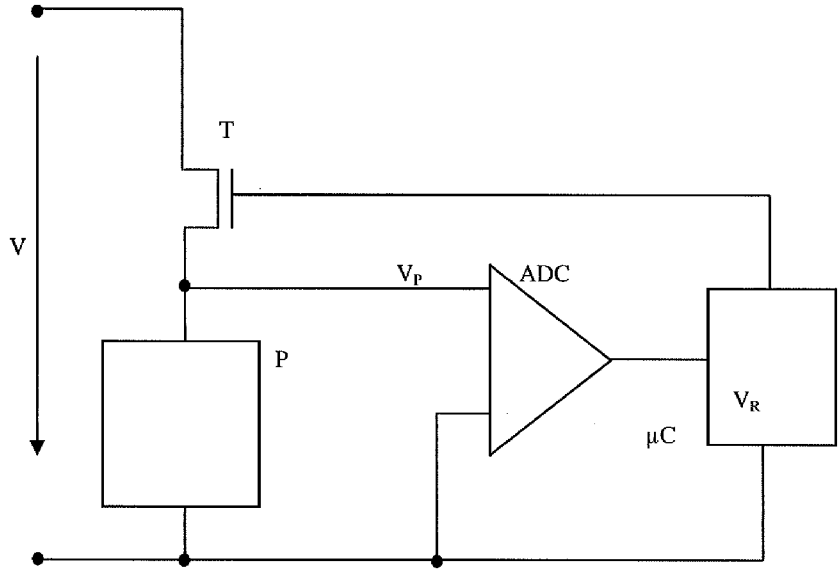
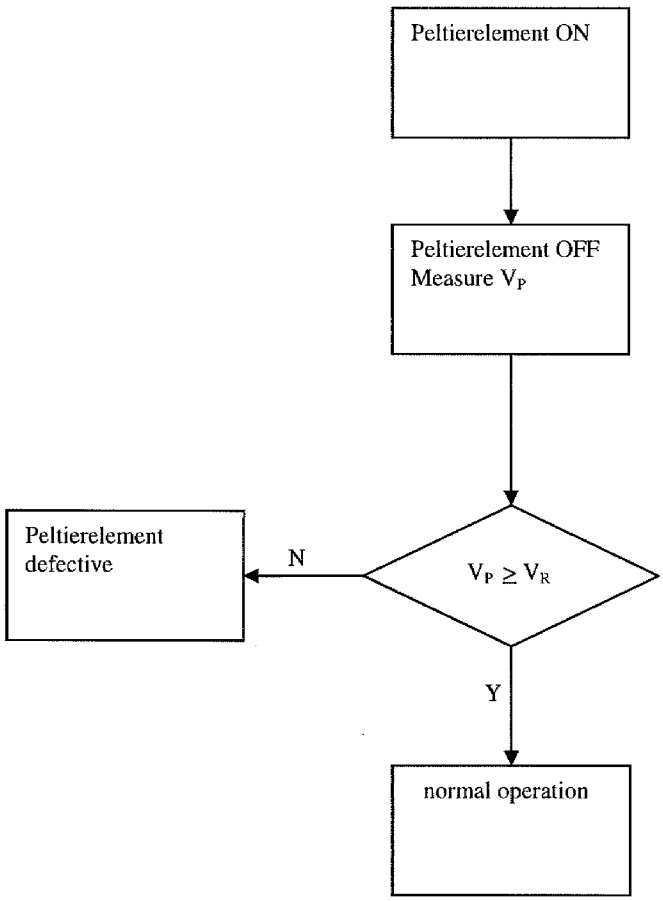


Fig. 1

Fig. 2


Peltierelement ON
Peltierelement OFF
Measure V_P
$V_P \geq V_R$
N
Peltierelement
defective
Y
normal operation

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L35/00 B26B19/38
ADD.

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)
B26B G01R H01L F25B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2005/139248 A1 (STRNAD RICHARD J [US]) 30 June 2005 (2005-06-30)	1-3
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A	KR 2005 0013300 A (TONG YANG MACHINERY & ENGINEER) 4 February 2005 (2005-02-04) abstract	1-8
A	US 2010/153066 A1 (FEDERER PAUL [CH] ET AL) 17 June 2010 (2010-06-17) paragraph [0017] - paragraph [0023]; figures 1,2	1-8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 April 2012	23/04/2012

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/051277

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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