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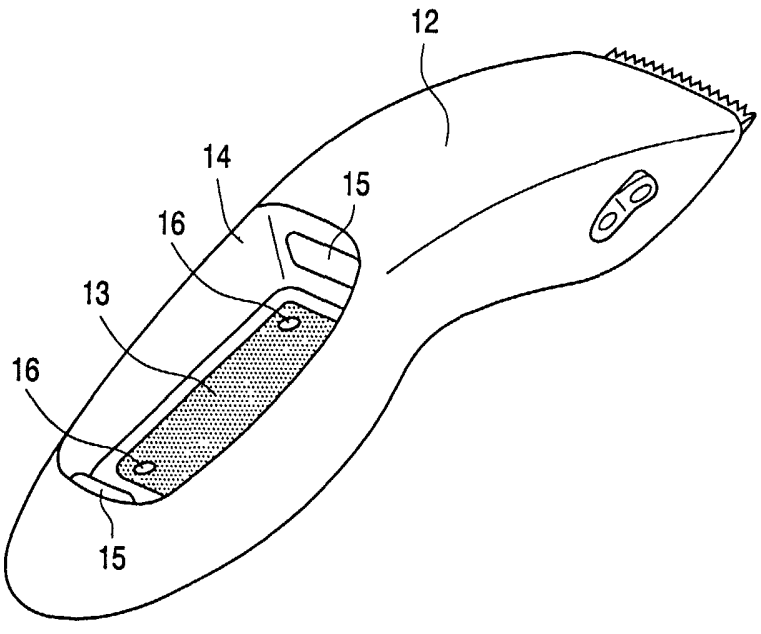
(54) Title: ELECTRICAL APPLIANCE AND BATTERY



(57) Abstract: The invention relates to an electrical appliance provided with a substantially gastight housing, characterized in that the appliance is provided at the inside of its housing with a catalytic surface for converting hydrogen evolved by a hydrogen source present in the electrical appliance. The invention also relates to a battery comprising a housing which is substantially impermeable to mediums and which is provided with a pressure relief valve, and an assembly of an anode, a cathode, and a separator layer positioned between the anode and the cathode, which assembly is positioned in the housing and is at least partly surrounded by an electrolytic solution, characterized in that the battery is provided with a catalytic surface for converting hydrogen gas produced by the assembly at the side of the housing facing away from the assembly.

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Electrical appliance and battery

The invention relates to an electrical appliance provided with a substantially gastight housing. The invention also relates to a battery comprising a housing which is substantially impermeable to mediums and which is provided with a pressure relief valve and with an assembly of an anode, a cathode, and a separator layer positioned between the anode and the cathode, which assembly is positioned in the housing and is at least partly surrounded by an electrolytic solution.

Electrical equipment provided with a substantially gastight housing is mostly used in surroundings which may be humid or wet. Examples of this are shaving equipment, toothbrushes, pocket torches, and the like. Since the housing is at least substantially gastight, combustible gas may accumulate at the inside of this equipment, in particular hydrogen gas. This hydrogen gas may be evolved by a battery present in an appliance, but alternative hydrogen sources are also possible such as, for example, a short-circuit of an electrical circuit (printed circuit board) caused by the presence of water (for example condensation). In the prior art, the solution to this problem is sought in a timely removal of the gases present in the housing. This may be achieved, for example, in that a membrane permeable to hydrogen is made to form part of the housing. Among the disadvantages of such membranes, however, are that their presence in a housing is comparatively expensive, that a membrane forms an interruption in the housing, that the membrane is comparatively vulnerable, and that the membrane may at the same time be permeable to liquids and/or gases other than hydrogen.

The invention has for its object to provide an electrical appliance provided with a substantially gastight housing with which hazardous situations resulting from a release of hydrogen gas in the housing of the electrical appliance can be prevented without the disadvantages of the inclusion of a membrane in the housing as described above.

To achieve this object, the invention provides an electrical appliance provided with a substantially gastight housing which is characterized in that the appliance is provided at the inside of its housing with a catalytic surface for converting hydrogen evolved by a hydrogen source present in the electrical appliance. If the appliance is powered by a battery arranged in the appliance, said hydrogen source may be formed by the battery, in particular if this battery is provided with a pressure relief valve for discharging an overpressure from the

battery. The catalyst, however, is also capable of neutralizing hydrogen in the housing originating from sources other than a battery. The combustible hydrogen gas can be recombined to water in that the hydrogen gas present in the housing is brought into contact with a suitable catalyst. Hazardous situations such as combustion and/or explosion of the hydrogen gas can be counteracted or prevented through recombination of the combustible hydrogen gas, or at least of a portion thereof. This renders the removal of the hydrogen gas through a membrane unnecessary.

Providing the catalytic surface adjacent a source capable of generating sparks in the electrical appliance prevents at least to a substantial degree that a spark-generating source comes into contact with hydrogen gas. The spark-generating source is thus as it were screened off from the hydrogen gas. If an ignition source is absent, hydrogen gas will not be ignited, which will enhance the safety of the construction still further. Examples of spark-generating sources are: switches, motors, sliding contacts, and the like.

In a preferred embodiment, the catalytic surface is provided at least adjacent an accommodation space for the battery which forms part of the electrical appliance. Such a positioning of the catalyst with respect to the battery to be placed in said accommodation space is favorable because the gases ventilated from the battery come into contact with the catalyst immediately after their discharge and can be subsequently converted.

In another preferred embodiment, the catalytic surface is detachably connected to the housing. The catalyst can be removed from the housing if it does not function optimally any more, and may be replaced, for example, with a new catalyst or one that functions better. If the appliance is not used for a certain time, the catalyst may be uncoupled from the housing and may be placed in another electrical appliance. In an embodiment, the catalyst is shaped such that it can be placed in several types of electrical appliances.

Batteries are in existence with an internal catalyst for converting hydrogen, the presence of said battery being necessary for the operation of the appliance. Thus the international patent application WO 00/36684 describes a catalyst arrangement whereby oxygen and hydrogen gases produced by a so-called valve regulated lead acid (VRLA) battery can be recombined into water. The conversion of oxygen and hydrogen takes place inside the VRLA battery. The catalyst arrangement comprises a substantially airtight housing provided with an opening. An internal chamber is positioned in the housing, in which chamber the catalyst is provided. A microporous disc is positioned in said opening. An excessive generation of oxygen and hydrogen in the battery, such that the capacity of the catalyst arrangement is insufficient for converting the total quantity of evolved gases, will

open a pressure relief valve forming part of the battery owing to a rising pressure in the battery. An excessive gas generation in the VRLA battery may arise from a malfunctioning of the battery owing to, for example, heat and wear, such as a capacity reduction of the catalyst. Hazardous situations can arise because the opening of the pressure relief valve will allow combustible hydrogen gases to enter the atmosphere surrounding the battery. Besides VRLA batteries, rechargeable batteries of other types, such as the aqueous nickel-cadmium (NiCd) and nickel-metal hydride (NiMH) batteries, are capable of generating oxygen and hydrogen gases. If such batteries no longer operate optimally during recharging and over-discharging, for example owing to a reduction in their capacity, the pressure inside the battery may rise substantially. The moment the internal pressure in the battery exceeds a critical battery valve pressure, the (combustible) gases present in the battery will be discharged through the pressure relief valve to the atmosphere surrounding the battery. Such a discharge of gases may lead to hazardous situations if, for example, spark-generating electrical or mechanical components are present in the atmosphere surrounding the battery.

The invention also has for its object to provide a battery of the kind mentioned in the opening paragraph by means of which hazardous situations caused by the release of hydrogen gas owing to malfunctioning of the battery can be prevented, while the advantages of the prior art are retained.

The invention for this purpose provides a battery of the kind mentioned in the opening paragraph which is characterized in that the battery is provided with a catalytic surface designed for converting hydrogen gas produced by the assembly at the side of the housing facing away from the assembly. If an excessive (hydrogen) gas production takes place in the battery owing to malfunctioning of the battery or at least of parts of the battery, as described above, the evolved gases will be discharged through the pressure relief valve the moment the internal gas pressure exceeds a critical battery valve pressure. The advantages of a timely neutralization were described above with reference to the electrical appliance according to the present invention. The catalyst may be provided at an outer surface of the battery, preferably adjacent the pressure relief valve.

The catalyst preferably comprises at least one metal. Suitable metals for hydrogen conversion are, for example, Ni, Pd, Pt, Rh, and Ir. In a preferred embodiment, the catalyst is made from an alloy. Examples of suitable alloys are PtPd, PtW, ZrPd, $MoNi_3$, $MoCo_3$, etc. Preferably, the catalytic surface is formed by a catalytic material layer. Among the properties of a catalytic material layer is that it forms an extended planar surface on which a catalytic reaction can take place. The material layer may be constructed as a foil.

Alternatively, the material layer may be provided as a thin layer on a side of the housing facing away from the assembly. The thin material layer may be provided by known techniques such as painting, spraying, sputtering, vapor deposition, laser ablation, adhesion, etc. Research has shown that the hydrogen is not absorbed by a catalyst in the form of a hydride, but that it is captured by an electrochemical oxidation reaction in which oxygen acts as the combustion agent. Water is required for a satisfactory conversion of the hydrogen. This, however, will always be the case under normal ambient operational conditions. A large catalytic surface, such as a catalytic material layer, is essential. The required water may form part of the electrolyte and may be carried along with the ventilated gas during ventilation of the battery. The electrochemical conversion may be written as follows as partial reactions and a subsequent total reaction:

$$2\,H_2 + 4\,OH^- \rightarrow 4\,H_2O + 4e^-$$

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

$$2H_2 + O_2 \rightarrow 2H_2O$$

The total reaction is exothermic and produces a considerable quantity of heat. To facilitate the above conversion, it is important to provide as large a catalytic surface as possible. Besides the material layer described above, the catalyst may be manufactured from a porous material and/or be present as a material layer provided on a porous material. The catalytic surface is preferably provided with a specific surface area of at least 1 m^2/g of catalyst material.

In a preferred embodiment, the catalytic surface is provided on a chamber which merges into the housing and which surrounds the pressure relief valve. In a special preferred embodiment, said chamber closely adjoins the pressure relief valve so that the ventilated gas is forcedly conducted along the catalytic surface. The catalyst may be provided in the chamber in the form of a porous material. Alternatively, it may be positioned as a foil against an inside of the chamber. In an alternative embodiment, the catalyst is formed by particles of a granulate surrounded by the chamber. The chamber is preferably provided with an exhaust opening for gases and/or liquids.

The invention will be explained in more detail with reference to embodiments which are shown by way of example in the appended drawing and to which the invention is by no means limited. In the drawing:

Fig. 1 is a cross-sectional view of a first preferred embodiment of a rechargeable battery according to the invention,

Fig. 2 is a cross-sectional view of a second preferred embodiment of a rechargeable battery according to the invention, and

Fig. 3 is a perspective view of a hair trimmer provided with a catalyst according to the invention.

Fig. 1 is a cross-sectional view of a first preferred embodiment of a rechargeable battery 1 according to the invention. The battery 1 comprises a housing 2 in which an assembly (not shown) of an anode, a cathode, and a separator is accommodated, and a pressure relief valve 3. The pressure relief valve 3 may at the same time act as the positive pole of the battery 1. The battery is provided with a catalytic material layer 4 at the outside of the housing 2. If a gas produced by the battery 1, including hydrogen, exceeds a critical battery valve pressure, the pressure relief valve 3 will open and the gases present in the battery will be discharged through an opening in the pressure relief valve 3 to the atmosphere surrounding the battery 1. There at least a portion of the discharged hydrogen gas can come into contact with the catalytic material layer 4. The contact between the hydrogen gas and the catalytic material layer 4 stimulates the conversion of combustible hydrogen gas to (non-combustible) water. The catalytic material layer 4 shown in Fig. 1 is provided around the outside of the housing 2 in the form of a foil layer. The catalyst has a high surface/volume ratio so as to achieve a satisfactory operation; the hydrogen conversion taking place at the surface of a catalyst can thus be effective.

Fig. 2 is a cross-sectional view of a second preferred embodiment of a rechargeable battery 5 according to the invention. The battery 5 again comprises a housing 6 in which an assembly (not shown) of an anode, a cathode, and a separator is accommodated, and a pressure relief valve 7. The battery 5 is also provided with a recombination chamber 8, which recombination chamber 8 narrowly adjoins the housing 6 and also surrounds the pressure relief valve 7. The recombination chamber 8 is provided with at least one opening 9 for discharging any excess gases and/or liquids present in the recombination chamber 8. The recombination chamber 8 is at least partly filled with a catalyst 10 in the form of granulate

particles which may or may not be porous. An alternative option is that a porous material (not shown in the Figure) is provided with an active component which acts as a catalyst 10. The catalyst 10 is designed so as to facilitate the conversion of hydrogen to water. A microporous disc 11 is provided between the opening 9 and the catalyst 10. The disc 11 prevents a (too) easy escape of hydrogen gas from the recombination chamber 8 to the atmosphere surrounding the battery 5. A construction of the battery 5 as shown in Fig. 2 has the advantage that the gases discharged through the pressure relief valve 7 come into contact with the catalyst 10 for a major portion, so that the hydrogen conversion rate will be high. The disc 11 in a preferred embodiment may at the same time have the property that it is substantially non-permeable to hydrogen gas, such that the hydrogen gas discharged from the housing 6 remains trapped in the recombination chamber 8 until it has been converted into water.

Fig. 3 is a perspective view of a hair trimmer 12 provided with a catalyst 13 according to the invention. The catalyst 13 is positioned in an accommodation space 14 for a battery (not shown). The accommodation space 14 may be closed by a cover element (not shown). The battery may be placed on the catalyst 13 and is preferably designed such that it applies itself to contact elements 15. The catalyst 13 is detachably connected to the accommodation space 14 for the battery by means of coupling elements 16. In alternative embodiments, however, it is possible to provide the catalyst 13 in other locations of the trimmer 12.

CLAIMS:

1. An electrical appliance provided with a substantially gastight housing, characterized in that the appliance is provided with a catalytic surface at the inside of its housing for converting hydrogen evolved by a hydrogen source present in the electrical appliance.

2. An electrical appliance as claimed in claim 1, characterized in that the appliance is powered by a battery arranged inside the appliance.

3. An electrical appliance as claimed in claim 1 or 2, characterized in that the catalytic surface is provided on a housing which forms part of the electrical appliance.

4. An electrical appliance as claimed in any one the preceding claims, characterized in that the catalytic surface is provided at least adjacent to a source which is capable of generating sparks and which is present inside the electrical appliance.

5. An electrical appliance as claimed in any one of the claims 2 to 4, characterized in that the catalytic surface is provided at least adjacent an accommodation space for a battery which forms part of the electrical appliance.

6. An electrical appliance as claimed in any one of the preceding claims, characterized in that the catalytic surface is detachably connected to the housing.

7. A battery comprising:

- a housing which is substantially impermeable to mediums and which is provided with a pressure relief valve, and
- an assembly of an anode, a cathode, and a separator layer positioned between the anode and the cathode, which assembly is positioned in the housing and is at least partly surrounded by an electrolytic solution,

characterized in that the battery is provided with a catalytic surface designed for converting hydrogen gas produced by the assembly at the side of the housing facing away from the assembly.

8. A battery as claimed in claim 7, characterized in that the catalyst comprises at least one metal.

9. A battery as claimed in claim 7 or 8, characterized in that the catalytic surface is formed by a layer of catalytic material.

10. A battery as claimed in any one of the claims 7 to 9, characterized in that the catalytic surface has a specific surface area of at least 1 m^2/g of catalyst material.

11. A battery as claimed in any one of the claims 7 to 10, characterized in that the catalytic surface is provided on a chamber which merges into the housing and which surrounds the pressure relief valve.

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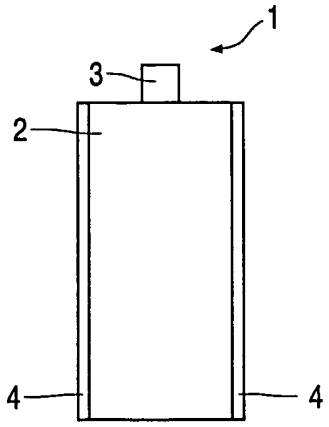

FIG. 1

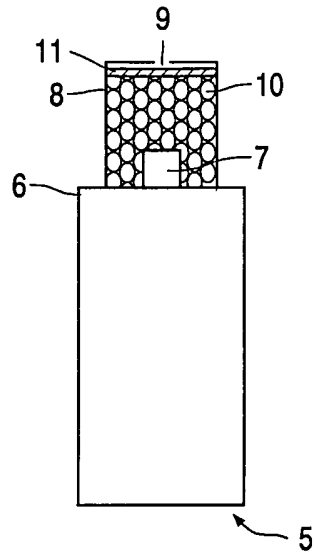

FIG. 2

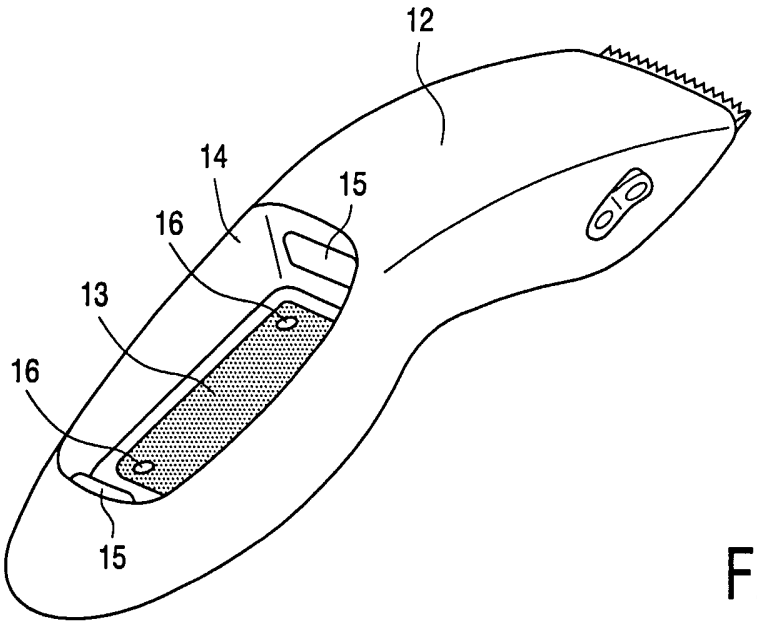

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M10/52 H01M2/10 H01M2/02 F21V33/00 H02K5/136

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)
IPC 7 H01M F21L F21V H05K H02K

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
10 January 2003	17/01/2003

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