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(72) Inventeurs/Inventors:
SCHWARZ-HARTMANN, ARMIN, DE;
LEPPER, JOACHIM, DE;
JUNG, PHILIPP, DE;
STOLPER, MICHAEL, DE;
BORNHEIMER, HEIKO, DE;
TRAWINSKI, PETER, DE

(73) Propriétaire/Owner:
BRAUN GMBH, DE

(74) Agent: DIMOCK STRATTON LLP

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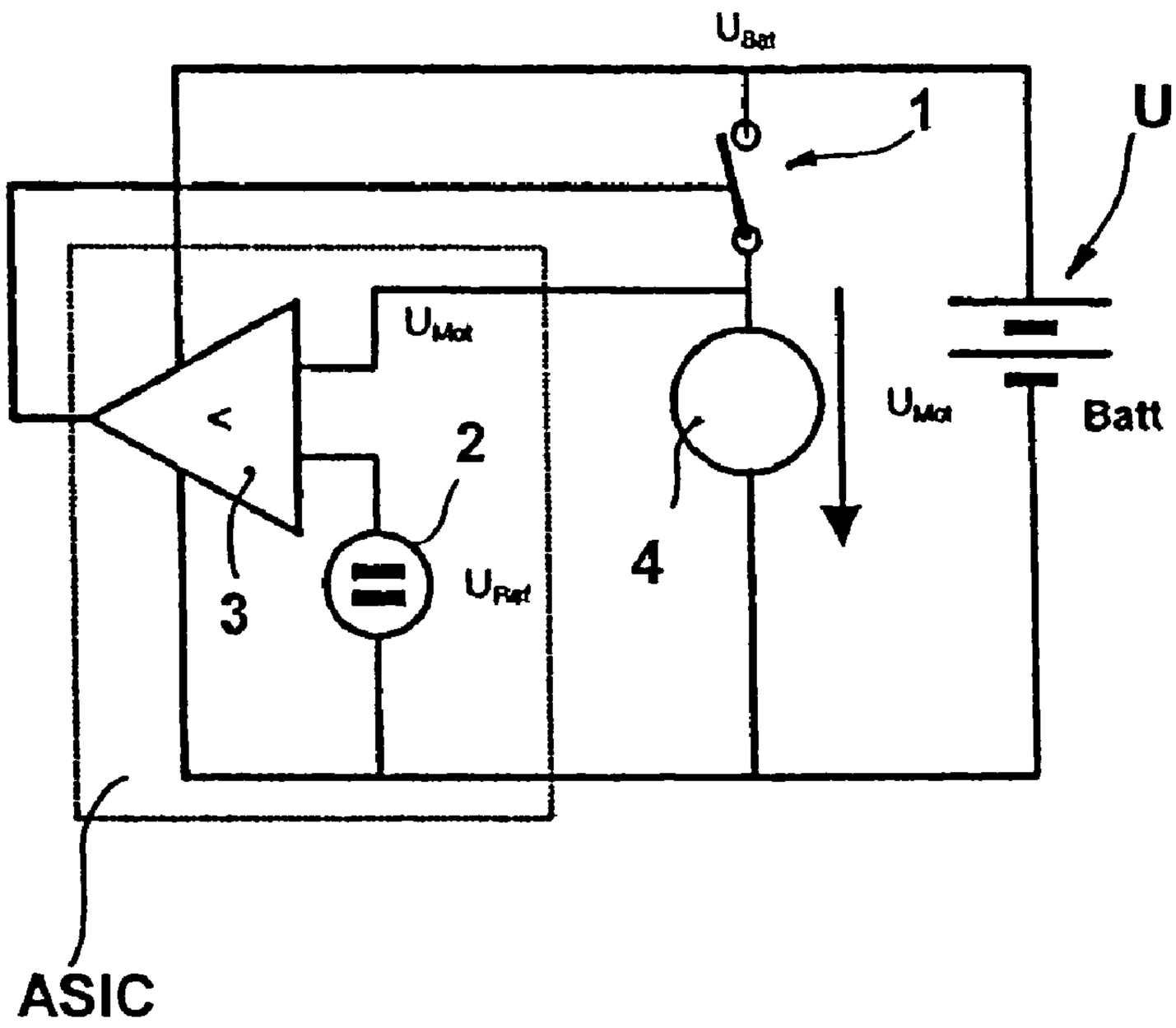

(57) Abrégé/Abstract:
The invention relates to an electric toothbrush with a housing, a brush, a drive, e.g., an electric motor, for driving the brush, a power supply and a switch mechanism for turning the drive on and off. The toothbrush contains an electronic circuit for adjusting the

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(57) Abrégé(suite)/Abstract(continued):
effective voltage applied to the electric motor, so that during operation of the toothbrush in the range of high voltages supplied by the power supply, the effective voltage applied to the electric motor is reduced to a level at which the electric motor reaches a rotational speed which corresponds essentially to the rotational speed of the electric motor at a medium voltage, whereby at the same time the electric motor is designed in particular so that it still reaches a required minimum rotational speed in the range of low allowed voltages.

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(71) Applicant *(for all designated States except US)*: **BRAUN GMBH** [DE/DE]; Frankfurter Strasse 145, 61476 Kronberg im Taunus (DE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **SCHWARZ-HARTMANN, Armin** [DE/DE]; Bahnhof Street 46, 55234 Wendelsheim (DE). **LEPPER, Joachim** [DE/DE]; Waldstrasse 16, 61250 Usingen (DE). **JUNG, Philipp** [DE/DE]; Friedrich-Ebert-Strasse 166, 64347 Griesheim (DE). **STOLPER, Michael** [DE/DE]; Neugasse 9a, 65760 Eschborn (DE). **BORNHEIMER, Heiko** [DE/DE]; Im Hasengarten 3, 65205 Wiesbaden (DE). **TRAWINSKI, Peter** [DE/DE]; In der Wolfskaute 35, 64331 Weiterstadt (DE).

(74) Agent: **BRAUN GMBH**; Frankfurter Straße 145, 61476 Kronberg/Taunus (DE).

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[Continued on next page]

(54) Title: ELECTRIC TOOTHBRUSH

(57) Abstract: The invention relates to an electric toothbrush with a housing, a brush, a drive, e.g., an electric motor, for driving the brush, a power supply and a switch mechanism for turning the drive on and off. The toothbrush contains an electronic circuit for adjusting the effective voltage applied to the electric motor, so that during operation of the toothbrush in the range of high voltages supplied by the power supply, the effective voltage applied to the electric motor is reduced to a level at which the electric motor reaches a rotational speed which corresponds essentially to the rotational speed of the electric motor at a medium voltage, whereby at the same time the electric motor is designed in particular so that it still reaches a required minimum rotational speed in the range of low allowed voltages.

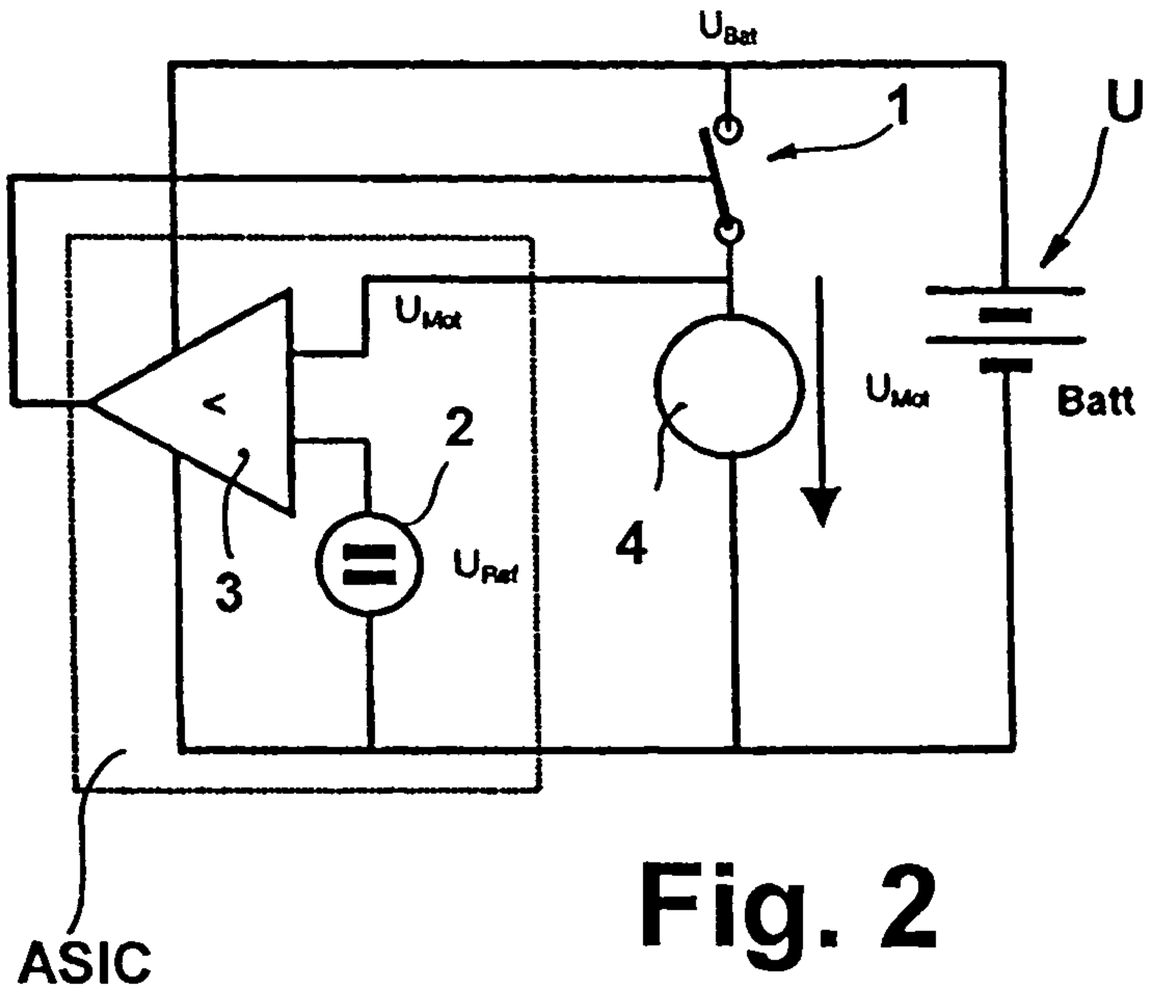

Fig. 2

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ELECTRIC TOOTHBRUSH

FIELD OF THE INVENTION

The invention relates to an electric toothbrush with a housing, a brush, a drive, for example an electric motor, for driving the brush, a power supply and a switch mechanism for turning the drive on and off by a user.

BACKGROUND OF THE INVENTION

DE 10 2006 004 146 A1 describes an electric toothbrush comprising a housing that functions as a handle and an electric motor that can move a bristle field carrier in the longitudinal direction of the housing as well as across its longitudinal direction with an oscillating action. The toothbrush is provided with a battery and a voltage stabilization circuit which supplies a stabilized power supply voltage to the electric motor.

DE 2 99 12 009 U1 describes an electric toothbrush having a drive with which the brush executes a rotating and reversing movement during tooth cleaning, whereby the rotational speed of the brush is either constant or is continuously variable.

DE 10 2005 063 045 A1 describes a discharge status display by means of which the almost discharged status of a battery can be recognized and displayed. The discharge status display comprises a display device designed as an LED, which lights up when the battery voltage drops below a certain threshold level.

With known battery-operated electric toothbrushes having a brush head that rotates with an oscillating action, the rotational speed of the drive motor changes with the voltage of the battery, i.e., when the battery is fully charged, the voltage and thus the rotational speed are much higher than when the battery has already supplied power for several tooth-brushing operations. The especially rapid brushing movements of the bristles with new batteries because of the higher rotational speed are perceived as unpleasant in particular by users who have previously been using a manual toothbrush.

OBJECT OF THE INVENTION

The object of the present invention is to create an electric toothbrush, which can be manufactured inexpensively and which is characterized by an operating performance that is perceived by the user as not requiring much adjustment.

SOLUTION TO PROBLEM

The object defined above is achieved by an electric toothbrush having a housing, a brush, an electric motor 4 for driving the brush, a power supply for supplying the electric power required for operation of the toothbrush, whereby the voltage supplied by the power supply decreases with the discharge status of the power supply from a range H of high voltage to a range M of medium voltage and then to a range L of low voltage, a switch mechanism for turning the drive on and off and an electronic circuit for adjusting the effective voltage Umot applied to the electric motor 4, such that during operation of the toothbrush in the high-voltage range H, the effective voltage Umot applied to the electric motor 4 is lowered to a level at which the electric motor 4 reaches a rotational speed which corresponds essentially to the rotational speed of the electric motor 4 in the medium-voltage range M, whereby the electric motor 4 is designed so that it still reaches a required minimum rotational speed in the range L of low allowed voltages.

In this way an electric toothbrush in which the power supply may be provided by batteries, accumulators or capacitors is made possible. By limiting the motor voltage to a moderate level, brush movements with a high dynamic that is perceived as unpleasant for the user are prevented. Furthermore in a phase with a high charge status of the power supply, excessive power consumption is prevented and the operating time at a moderate speed is prolonged on the basis of the savings thereby achieved. Furthermore it is possible to design the drive motor so that its optimum efficiency is at a voltage which is dominant over time during operation.

The electronic circuit is preferably implemented by an ASIC (Application-Specific Integrated Circuit). This ASIC preferably has a reset controller with a reference voltage source, which has temperature and voltage compensation, and a comparator. An electronic switch, e.g., a transistor, is preferably triggered via the comparator output, thereby setting the effective motor voltage. The transistor is triggered, for example, by a pulse-width-modulated signal. The modulation frequency is preferably high enough so that the electric motor consumes a power

based on the effective motor voltage (i.e., the voltage averaged over time) and the current flowing through the motor. The motor is preferably designed as a d.c. motor.

The electric toothbrush contains a permanently installed capacitor or has a battery receptacle into which can be inserted preferably commercial 1.5 V primary batteries or 1.2 V secondary batteries, depending on the user's choice. For example, two such batteries may be inserted into the battery receptacle and connected in series. The voltage supplied by the power supply with new primary cells may then be in the range of 3 V and with fully charged accumulators in the range of 2.4 V. The electronic circuit is then designed to supply an effective voltage in the range of approx. 1.8 V-2.3 V in which the intended rotational speed is reached when using commercial primary batteries as well as accumulators. The voltage capacity is designed so that tooth-brushing operations can be performed with a brushing time of approx. 2 minutes each with an average brush contact pressure. The electric toothbrush preferably has a rotating or oscillating and rotating brush head.

BRIEF DESCRIPTION OF THE DRAWING

Additional details and features of the invention are derived from the following description in combination with the drawing, in which:

Fig. 1 shows a diagram to illustrate the rotational speed curve of an electric toothbrush with a rotating or oscillating and rotating brush head and with a voltage stabilizing circuit,

Fig. 2 shows a circuit diagram of a voltage stabilizing circuit.

DETAILED DESCRIPTION OF THE FIGURES

The diagram in Fig. 1 illustrates the relationship between a power supply voltage U supplied by a battery and the rotational speed n of a motor 4 (see Fig. 2). The high voltage supplied by the voltage supply in the area H drops over a period of time due to spontaneous discharge and due to use of the electric toothbrush, dropping to an average voltage level of approx. 2.3 V prevailing in the area M. After withdrawing approx. 75% of the electric power stored in the voltage supply, the voltage in the area L drops further to a voltage in the range of approx. 2.1 V. In the area L, the example shown here, it is also connected to a short sec-

tion F in which a tooth-brushing operation can be conducted with the lowest voltage that is still sufficient for the electric drive.

The electric toothbrush has an electronic circuit connected to the drive and the voltage supply, the circuit being designed to terminate operation of the toothbrush as soon as the power supply drops to inadmissibly low levels, so that in the event of use of accumulators, complete battery discharge is avoided. The electronic circuit may also be designed to comprise a voltage transformer circuit by means of which an increase in the voltage applied to the motor 2 to an adequate voltage is accomplished with a drop in the power supply below a predetermined voltage level. The electronic circuit is also designed to achieve a reduction in the effective voltage supplied to the motor when there is an especially high power supply voltage. At moderate power supply voltage levels and preferably also during the final phase L, however, the motor 4 may also be operated with the voltage supplied by the power supply.

In order for the electronic circuit to be able to keep the rotational speed of the motor 4 as constant as possible, regardless of the charge state of the power supply, the motor 4 is preferably designed so that it still reaches the desired rotational speed at the lowest feasible power supply voltage. In a variant with two batteries, this range is between approx. 1.8 V and 2.3 V. During operation of the electric toothbrush in the high-voltage range H supplied on the part of the power supply as well as in the medium-voltage range M, the electric motor is operated in the range of its maximum efficiency. On depletion of the remaining approx. 25% of the energy stored by the power supply, there is only a slight discernable drop in the rotational speed of the electric toothbrush. The electronic circuit is preferably designed so that the rotational speed of the motor drops significantly only just before the battery is completely discharged and thereby signals the user the need for a battery replacement and/or recharging. This range between a significant drop in rotational speed and stoppage of the drive motor is of such dimensions that preferably at least the tooth-cleaning operation of the current moment can still be concluded to satisfaction.

Fig. 2 shows a preferred electronic circuit for operating the electric motor 4 in an electric toothbrush with which the typical drop in rotational speed over the lifetime of the battery is largely prevented. The electronic circuit is preferably implemented by an ASIC comprising essentially all the circuits required for implementation of voltage stabilization. For stabilization of rotational speed, the voltage Umot on motor 4 is measured via a measurement device, optionally filtered and compared with a setpoint value. The power supply U is connected to the motor 4 via a switch mechanism 1 which is triggered by a high-frequency

pulse-width-modulated signal, for example, such that when averaged over time, the rotational speed of the motor 4 and thus the frequency of movement of the driven brush carrier remains at an essentially constant level.

The electronic circuit can be implemented especially advantageously by a so-called reset controller, comprising a reference voltage source 2, which has temperature and voltage compensation, and a comparator 3. The comparator compares the motor voltage Umot with the voltage of the reference voltage source 2. If the motor voltage Umot is greater than the voltage of the reference voltage source 2, then the switch mechanism 1 triggered by the output of the comparator 3 is opened. If the motor voltage Umot is lower than the voltage of the reference voltage source 2, then the switch mechanism 1 triggered by the output of the comparator 3 is closed. The switch mechanism 1 is preferably implemented by an electronic switch, e.g., a transistor.

The electric toothbrush may be designed so that it comprises a structure component which comprises a receptacle space for the replaceable batteries or accumulators. The electronic circuit may be mounted on this structural component in such a way that the power supply may be designed as a preassembled module. The electronic circuit may be mounted on the structural component in such a way that it is protected from moisture or contaminants. It is also possible to implement the main device switch by means of the electronic circuit by the fact that an operating element mounted on the housing of the toothbrush in a manner that facilitates gripping by the user is connected to an input of the electronic circuit, which allows a corresponding switch signal to be supplied. The electronic circuit may also be provided with a charge status display, which displays the charge status of the power supply by means of optical or acoustic signals, for example.

1. An electric toothbrush, comprising

- a housing,
- a brush,
- an electric motor for driving the brush,
- a power supply for providing the electric power required for operation of the toothbrush, whereby a voltage supplied by the power supply declines with the discharge status of the power supply from a high-voltage range over a medium-voltage range to a low-voltage range,
- a switch mechanism for turning a drive on and off, and
- an electronic circuit for adjusting the effective voltage Umot applied to the electric motor , such that during operation of the toothbrush in the high-voltage range, the effective voltage Umot applied to the electric motor is lowered to a level at which the electric motor has reached a rotational speed corresponding essentially to the rotational speed of the electric motor in the medium-voltage range, whereby the electric motor is designed so that it still reaches a required minimum rotational speed in the range of low admissible voltages range, wherein the effective voltage Umot on the electric motor is measured via a measurement device and compared with a setpoint value URef.

2. The toothbrush according to Claim 1, wherein the motor is designed so that its maximum efficiency is achieved at a voltage in the range of a medium-voltage level.

3. The toothbrush according to Claim 1 or 2, wherein the electronic circuit has a reset controller.

4. The toothbrush according to Claim 3, wherein the reset controller comprises a temperature- and voltage-compensated reference voltage source and a comparator.

5. The toothbrush according to Claim 4, wherein the motor voltage Umot is adjusted via an output of the comparator.

6. The toothbrush according to any one of Claims 1 to 5, wherein the power supply comprises at least one primary or secondary battery or a capacitor.

7. The toothbrush according to any one of Claims 1 to 6, wherein the electronic circuit is designed so that the rotational speed provided for operation in the medium-voltage range is reached when using primary batteries as well as when using secondary batteries.

8. The toothbrush according to claim 1, wherein the drive is designed so that the brush executes a rotating or an oscillating and rotating movement.

9. The toothbrush according to claim 1, wherein the electronic circuit is an application specific integrated circuit.

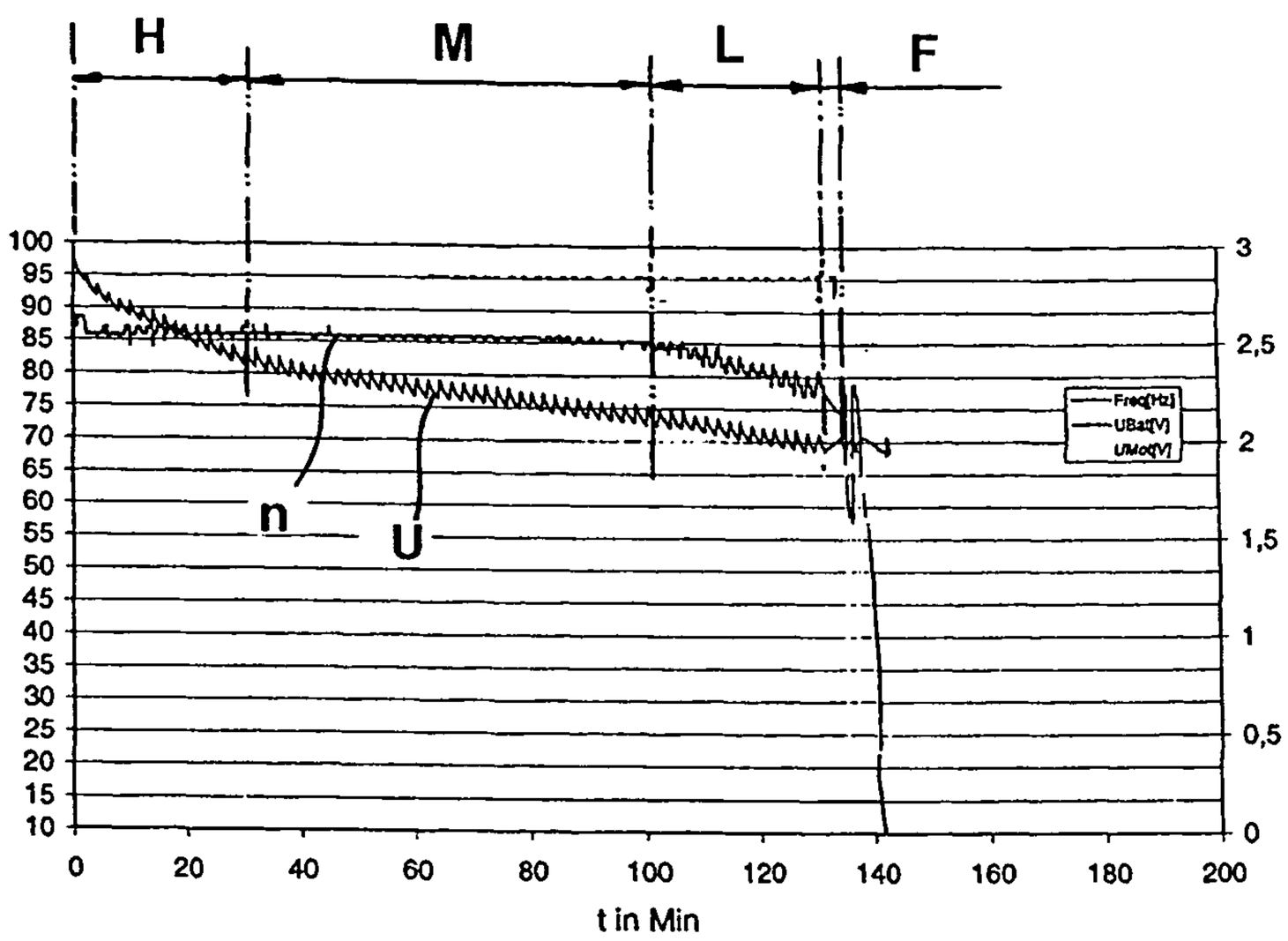
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Fig. 1

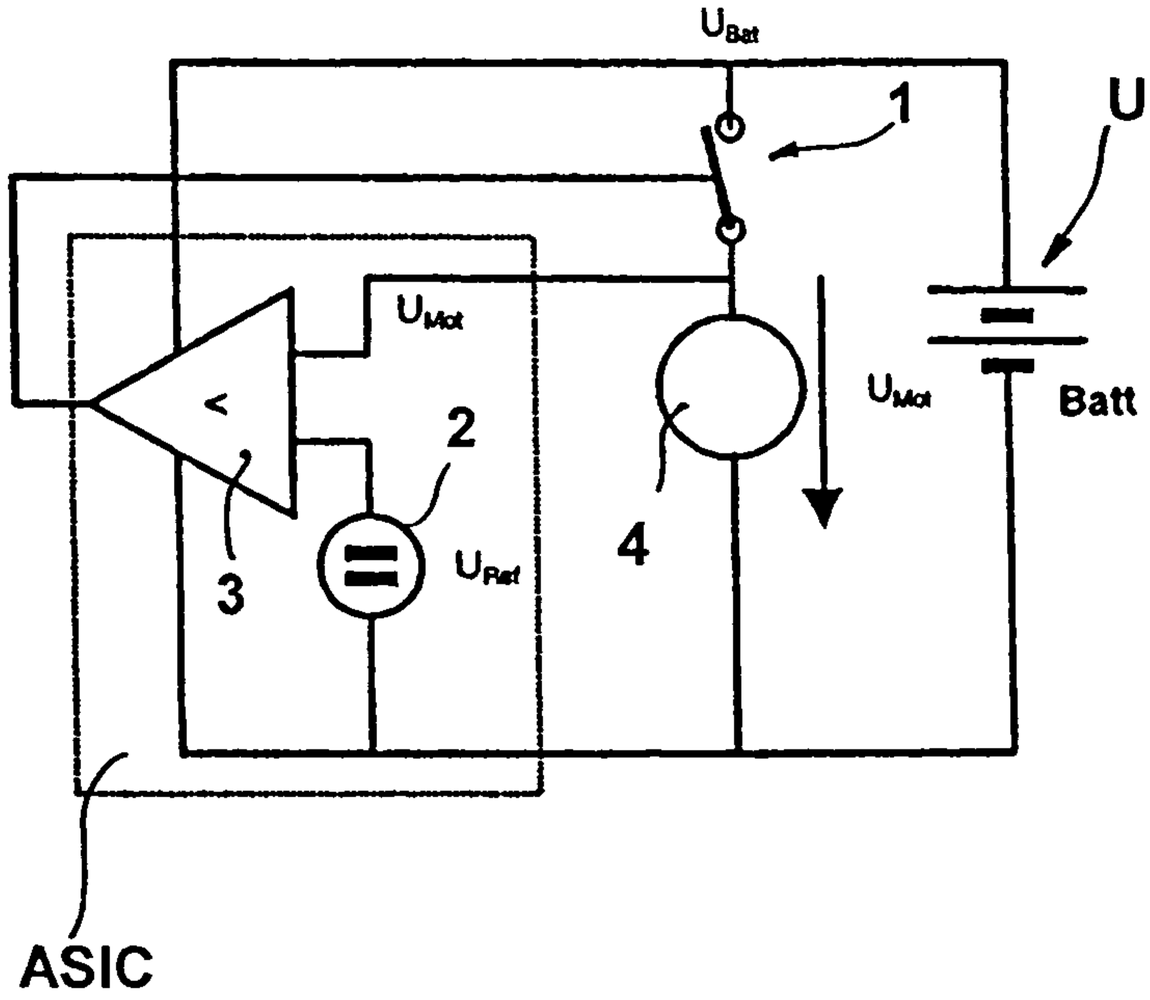
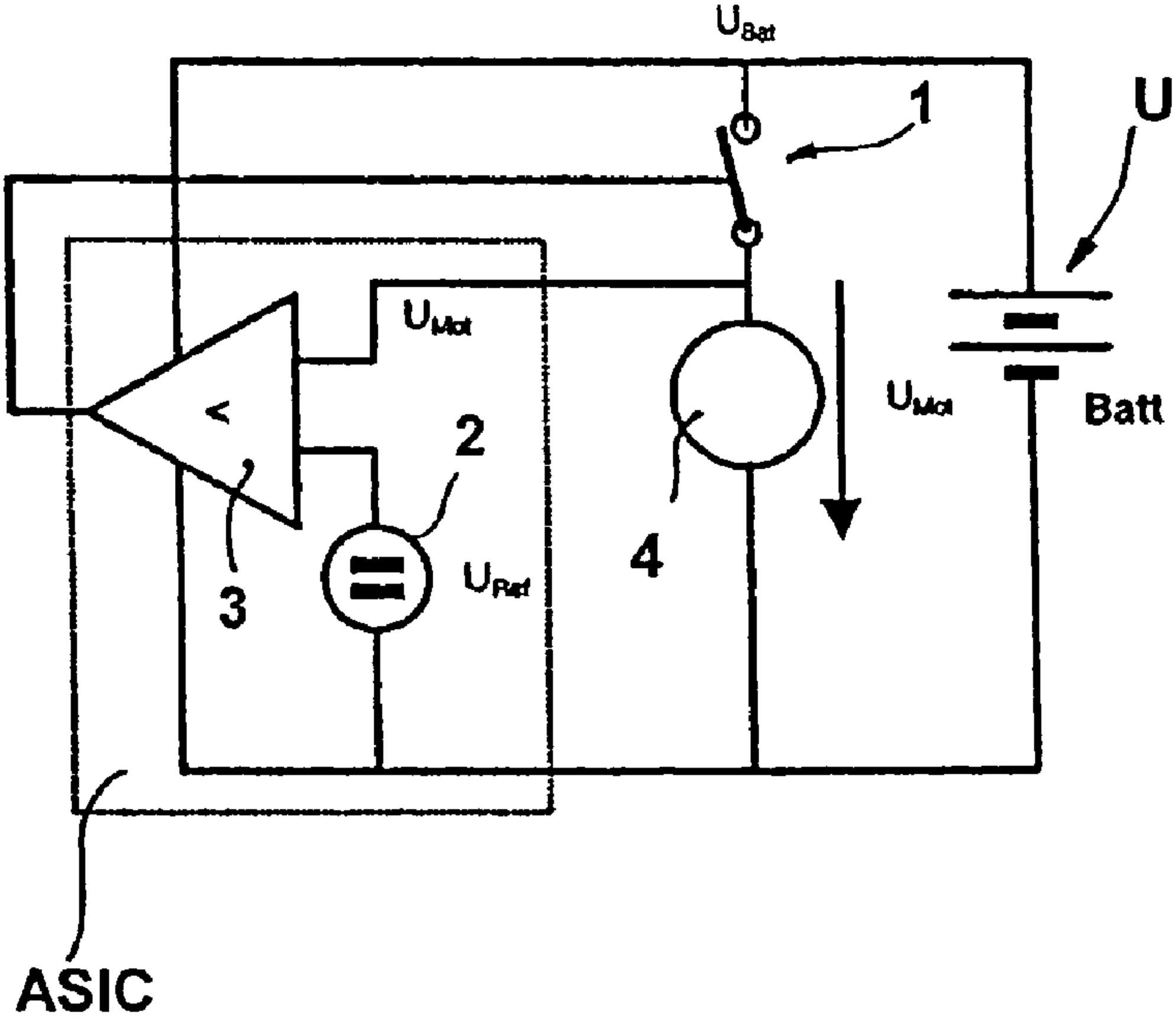


Fig. 2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