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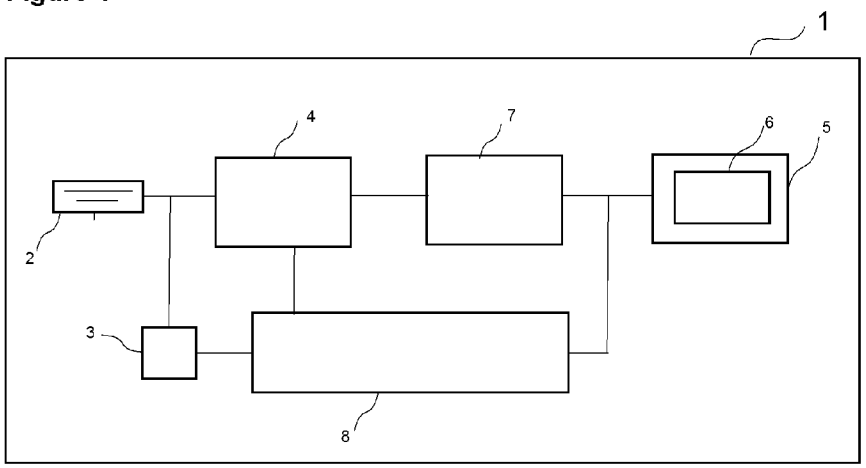
(54) **Title**: A COOLING DEVICE SUITABLE FOR USING IN MOTOR VEHICLES

Figure 1



(57) **Abstract**: The present invention relates to a cooling device (1) suitable for using in motor vehicles, comprising at least one accumulator (2), at least one compressor (5), at least one measuring circuit (3), at least one DC/DC converter (4) which serves as an amplifier that amplifies the accumulator (2) voltage ($V_{AKÜ}$), at least one motor (6) disposed in the compressor (5), at least one motor inverter (7) which is fed by the accumulator (2) that transforms the DC voltage to AC voltage and a control unit (8) which performs energy control for protecting the lifespan of the accumulator (2) and adjusts the motor (6) rotation speed so that the accumulator (2) is not damaged and the energy of the accumulator (2) is used for the longest period of time.

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Description

A COOLING DEVICE SUITABLE FOR USING IN MOTOR VEHICLES

[0001] The present invention relates to a cooling device suitable for using in motor vehicles.

[0002] Portable cooling devices are used in environments such as yachts, caravans where direct access to mains voltage is not possible. In these environments, the voltage to the cooling device is provided from the accumulator. However, the accumulator provides a limited amount of energy. At this point, it is vitally important to provide energy to be used for a long time, to use energy efficiently in the portable cooling devices and to provide optimum energy management.

[0003] In the state of the art United States of America Patent Application No. US 20070070771A1, a power source is described, wherein the voltage changes thereof are calculated at certain time intervals and the voltage trend is monitored for the control of the power level. Accordingly, the remaining operation time of the power source is estimated and the power of the power source is provided to be decreased depending on the remaining time.

[0004] The aim of the present invention is the realization of a cooling device suitable for using in motor vehicles, which provides the efficient usage of the accumulator and optimum energy management.

[0005] A portable cooling device, realized in order to attain the aim of the present invention, explicated in the first claim and the respective claims thereof, is explained in the claims.

[0006] A cooling device suitable for using in motor vehicles comprises at least one accumulator, at least one compressor, at least one motor disposed in the compressor and a control unit that measures the accumulator voltage.

[0007] A maximum voltage value acceptable for the accumulator not to be damaged and an upper limit voltage value which is lower than the maximum voltage value are recorded in the memory of the control unit by the producer. If the voltage value measured instantaneously is equal to or higher than the upper limit voltage value, the control unit evaluates that the said value is close to the maximum voltage level. Accordingly, the motor

rotation speed is increased. Depending on the amount the measured voltage value exceeds the upper limit voltage value, a gradual increase in speed is provided. Thus, the overcharging of the accumulator is prevented and/or delayed. Thus, the accumulator is prevented from being deactivated.

[0008] The deactivation voltage value of the accumulator, the minimum voltage value required for activating the accumulator after the accumulator is deactivated and for operating the compressor again and a lower limit voltage value higher than the deactivation voltage are recorded in the memory of the control unit by the producer. The lower limit value recorded in the memory of the control unit is at a level higher than the deactivation voltage.

[0009] If the measured voltage value is equal to or lower than the lower limit voltage value, the control unit, which evaluates that the measured voltage value is close to the deactivation voltage value of the accumulator, decreases the motor rotation speed. Depending on the amount the measured voltage value decreases with respect to the lower limit voltage value, a gradual decrease in speed is provided. Thus, the usage of energy which remains low for a long time by means of cooling at lower speeds is provided.

[0010] In an embodiment of the present invention, the control unit raises the motor rotation speed to the maximum level by increasing the motor rotation speed if the measured voltage value is equal to the upper limit voltage value or higher than the upper limit voltage value. Thus, the overcharging of the accumulator is prevented. Thus, it is possible to prolong the efficiency of the accumulator.

[0011] In an embodiment of the present invention, the control unit reduces the motor rotation speed to the minimum level by decreasing the motor rotation speed if the measured voltage value is equal to the lower limit voltage value or lower than the lower limit voltage value. Thus, the accumulator is provided to be used for a longer period of time.

[0012] In an embodiment of the present invention, the cooling device comprises a control unit which raises the motor rotation speed to the next upper level

by increasing the motor rotation speed if the measured voltage value is between the upper limit voltage value and the minimum voltage value. Thus, the overcharging of the accumulator is prevented and/or delayed by preventing the accumulator voltage from rising to the maximum level.

[0013] In an embodiment of the present invention, the control unit reduces the motor rotation speed to the next lower level by decreasing the motor rotation speed if the measured voltage value is between the lower limit voltage value and the minimum voltage value. Thus, the accumulator is provided to be used for a longer period of time.

[0014] According to the measured voltage value of the accumulator, the control unit provides the compressor motor to operate at the maximum speed or the minimum speed when necessary, independently of the refrigeration requirement of the cooling device. Thus, the lifespan of the accumulator is extended and the situations wherein the accumulator is deactivated are minimized as well. The control unit provides the motor speed depending on the accumulator voltage such that the accumulator is provided to remain active for a long period of time.

[0015] A cooling device realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

1. Figure 1 – is the flow chart of the system of measuring the accumulator voltage.

[0016] The elements illustrated in the figures are numbered as follows:

1. Cooling device
2. Accumulator
3. Measuring circuit
4. DC/DC converter
5. Compressor
6. Motor
7. Motor inverter
8. Control unit

[0017] A cooling device (1) suitable for using in motor vehicles comprises at least one accumulator (2), at least one measuring circuit (3) that measures the accumulator (2) voltage ($V_{AKÜ}$), at least one DC/DC converter (4) which

serves as an amplifier that amplifies the accumulator (2) voltage ($V_{AKÜ}$), at least one compressor (5), a motor (6) disposed in the compressor (5), at least one motor inverter (7) which is fed by the accumulator (2) that transforms the DC voltage to AC voltage and a control unit (8) (Figure 1).

[0018] The control unit (8) comprises storage components, an A/D converter and a microprocessor for processing the measured voltage information. The accumulator (2) voltage information is transmitted to the microprocessor by decreasing the accumulator (2) voltage ($V_{AKÜ}$) by the measuring circuit (3) by means of the voltage divider resistor or voltage sensor. The measuring is completed in the microprocessor by converting the voltage information to digital information by means of the A/D converter. The measured voltage ($V_{AKÜ}$) is amplified by means of the DC/DC converter (4) and raised to higher voltage values. The current passing through the DC/DC converter (4) provides the voltage value, which is increased by means of the motor inverter (7) circuit, to operate the motor (6) at the desired frequency. The control unit (8) instantaneously measures the voltage ($V_{AKÜ}$). The control unit (8) controls and adjusts the motor (6) rotation speed by evaluating the measured voltage value ($V_{AKÜ}$) (Figure 1).

[0019] A maximum voltage value (V_{max}) acceptable for the accumulator (2) not to be damaged and an upper limit voltage value (V_{UL}), which is lower than the maximum voltage value (V_{max}) are recorded in the memory of the control unit (8) by the producer. When the voltage ($V_{AKÜ}$) value measured while the compressor (5) operates rises over the maximum voltage value (V_{max}), the compressor (5) is stopped for the accumulator (2) not to be damaged. The stopping of the compressor (5) means the stopping of the refrigeration system and this unwanted situation causes a decrease in lifespan of the accumulator (2).

[0020] In the cooling device (1) of the present invention, if the voltage ($V_{AKÜ}$) value measured instantaneously is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}), the motor (6) rotation speed is increased by the control unit (8). The control unit (8) evaluates that the said value is close to the maximum voltage level (V_{max}).

The control unit (8) prevents and/or delays the overcharging of the accumulator (2) by increasing the motor (6) rotation speed. Thus, the accumulator (2) is prevented from being deactivated. The accumulator (2) is provided to remain active for a longer period of time by controlling the power of the accumulator (2) and providing optimum energy management with controlled energy consumption.

[0021] Furthermore, the deactivation voltage (V_{pasif}) value of the accumulator (2), the minimum accumulator (2) voltage (V_{aktif}) required for activating the accumulator (2) and a lower limit voltage (V_{AL}) value higher than the deactivation voltage (V_{pasif}) are recorded in the memory of the control unit (8) by the producer.

[0022] If the measured voltage ($V_{AKÜ}$) falls below the deactivation voltage (V_{pasif}) value, the compressor (5) is stopped by deactivating the accumulator (2) since the energy of the accumulator (2) is reduced and insufficient. The minimum accumulator (2) voltage (V_{aktif}) is at the minimum accumulator (2) voltage (V_{aktif}) level required for activating the accumulator (2) after the accumulator (2) is deactivated and for operating the compressor (5) again. The lower limit value (V_{AL}) recorded in the memory of the control unit (8) is a value higher than the deactivation voltage (V_{pasif}).

[0023] If the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}), the control unit (8) evaluates that the said voltage is close to the deactivation voltage value (V_{pasif}) and decreases the motor (6) rotation speed. Thus, the accumulator (2) is provided to be used for a longer period of time. Moreover, the usage of energy which remains low for a long time by means of cooling at a lower speed is provided.

[0024] In an embodiment of the present invention, the control unit (8) raises the motor (6) rotation speed to the next upper speed level by increasing the motor (6) rotation speed if the measured voltage ($V_{AKÜ}$) value is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}). According to the measured voltage value ($V_{AKÜ}$), speed is gradually increased. Thus, the energy of the accumulator (2) is effectively used.

[0025] In an embodiment of the present invention, the control unit (8) reduces the motor (6) rotation speed to the next lower level by decreasing the motor (6) rotation speed if the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}). According to the measured voltage value ($V_{AKÜ}$), speed is gradually decreased.

[0026] In an embodiment of the present invention, the motor (6) rotation speed is raised to the maximum level by the control unit (8) if the measured voltage ($V_{AKÜ}$) value is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}). Thus, the problem of the overcharging of the accumulator (2) is prevented.

[0027] In an embodiment of the present invention, the control unit (8) provides the energy of the accumulator (2), which remains low, to be used efficiently by reducing the motor (6) rotation speed to the minimum level if the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}).

[0028] In an embodiment of the present invention, the control unit (8) raises the motor (6) rotation speed to the next upper level if the measured voltage value ($V_{AKÜ}$) is lower than the upper limit voltage value (V_{UL}) and higher than the minimum voltage value (V_{aktif}), in other words, if the measured voltage value ($V_{AKÜ}$) remains between the upper limit voltage value (V_{UL}) and the minimum voltage value (V_{aktif}). In this embodiment, the motor (6) rotation speed is raised to the maximum level by the control unit (8), if the measured voltage value ($V_{AKÜ}$) is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}). Thus, the accumulator (2) is provided to be used for a longer period of time and early prevention of the overcharging situation becomes possible.

[0029] In an embodiment of the present invention, the control unit (8) raises the motor (6) rotation speed to the next lower level if the measured voltage value ($V_{AKÜ}$) is lower than the upper limit voltage value (V_{UL}) and higher than the minimum voltage value (V_{aktif}), in other words, if the measured voltage value ($V_{AKÜ}$) remains between the upper limit voltage value (V_{UL}) and the minimum voltage value (V_{aktif}) thus, the cooling device (1) is

provided to be operated for a longer period of time. In this embodiment, if the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}), the control unit (8) reduces the motor (6) rotation speed to the minimum level. Consequently, the accumulator (2) is provided to be used for a longer period of time and the deactivation of the accumulator (2) is delayed.

[0030] In an embodiment of the present invention, the cooling device (1) comprises the control unit (8) which gradually increases the motor (6) rotation speed depending on the amount of the upper limit voltage value (V_{UL}) exceeds the measured voltage value ($V_{AKÜ}$). Thus, the deactivation of the accumulator (2) due to overcharging is delayed by consuming the energy of the accumulator (2) in a more controlled manner.

[0031] In an embodiment of the present invention, the cooling device (1) comprises the control unit (8) which gradually decreases the motor (6) rotation speed depending on the amount the measured voltage value ($V_{AKÜ}$) decreases with respect to the lower limit value (V_{AL}). Thus, the cooling device (1) is provided to cool for a longer period of time by cooling at lower speeds.

[0032] In an embodiment of the present invention, the accumulator (2) voltage ($V_{AKÜ}$) detected by means of the measuring circuit (3) is transmitted to the control unit (8) by being passed through the filter. Thus an accurate measurement is provided by suppressing electrical noise. Accurate measurement is important in terms of adjusting the motor (6) rotation speed.

[0033] In an embodiment of the present invention, a voltage sensor (3) is used as the measuring circuit (3). In cases wherein the voltage coming from the voltage sensor (3) is undesirably low, the accumulator (2) voltage ($V_{AKÜ}$) is transmitted to the control unit (8) by being passed through the amplifier circuit. Thus a more accurate measurement is provided.

[0034] By means of the present invention, a cooling device (1) is realized, that is suitable for using in motor vehicles and that provides the energy to be used for a long time and the energy of a cooling device suitable for using in motor vehicles to be used efficiently and which also provides optimum

energy management.

[0035] It is to be understood that the present invention is not limited by the embodiments disclosed above and a person skilled in the art can easily introduce different embodiments. These should be considered within the scope of the protection postulated by the claims of the present invention.

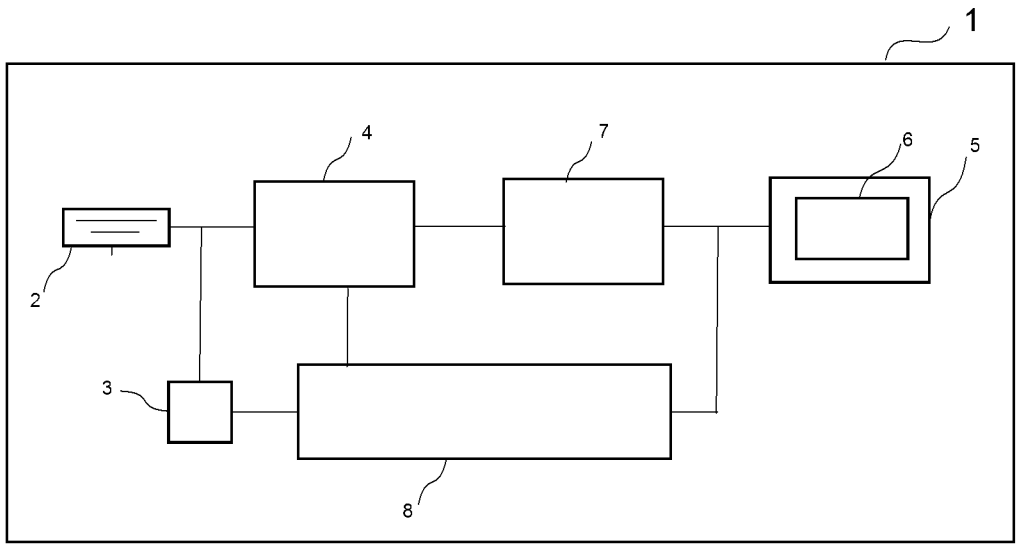
Claims

1. A cooling device (1) suitable for using in motor vehicles, comprising
   at least one accumulator (2),
   at least one compressor (5),
   at least one measuring circuit (3) which measures the accumulator (2) voltage ($V_{AKÜ}$),
   at least one DC/DC converter (4) which serves as an amplifier that amplifies the accumulator (2) voltage ($V_{AKÜ}$),
   at least one motor (6) disposed in the compressor (5),
   at least one motor inverter (7) which is fed by the accumulator (2) that transforms the DC voltage to AC voltage and a control unit (8),
   characterized by the control unit (8)
   - in the memory of which a maximum voltage value (V_{max}) acceptable for the accumulator (2) not to be damaged and an upper limit voltage value (V_{UL}), which is lower than the maximum voltage (V_{max}) value are recorded by the producer
   - that instantaneously measures the voltage ($V_{AKÜ}$) of the accumulator (2) and increases the motor (6) rotation speed if the measured voltage ($V_{AKÜ}$) value is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}).
2. A cooling device (1) as in Claim 1, **characterized by** the control unit (8) in the memory of which the deactivation voltage (V_{pasif}) value of the accumulator (2) and a lower limit voltage (V_{AL}) value higher than the deactivation voltage (V_{pasif}) are recorded by the producer and that decreases the motor (6) rotation speed if the voltage value ($V_{AKÜ}$) measured instantaneously is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}).
3. A cooling device (1) as in Claim 1 or 2, **characterized by** the control unit (8) which raises the motor (6) rotation speed to the next upper level by increasing the motor (6) rotation speed if the measured voltage ($V_{AKÜ}$) value is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}).
4. A cooling device (1) as in Claim 1 or 2, **characterized by** the control unit (8) which raises the motor (6) rotation speed to the maximum level by increasing

the motor (6) rotation speed if the measured voltage ($V_{AKÜ}$) value is equal to the upper limit voltage value (V_{UL}) or higher than the upper limit voltage value (V_{UL}).

5. A cooling device (1) as in any one of the Claims 1 to 4, **characterized by** the control unit (8) which reduces the motor (6) rotation speed to the next lower level by decreasing the motor (6) rotation speed if the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}).
6. A cooling device (1) as in any one of the Claims 1 to 4, **characterized by** the control unit (8) which reduces the motor (6) rotation speed to the minimum level by decreasing the motor (6) rotation speed if the measured voltage value ($V_{AKÜ}$) is equal to the lower limit voltage value (V_{AL}) or lower than the lower limit voltage value (V_{AL}).
7. A cooling device (1) as in any one of the above claims, **characterized by** the control unit (8) which raises the motor (6) rotation speed to the next upper level by increasing the motor (6) rotation speed if the measured voltage ($V_{AKÜ}$) value is between the upper limit voltage value (V_{UL}) and the minimum voltage value (V_{aktif}).
8. A cooling device (1) as in any one of the above claims, **characterized by** the control unit (8) which reduces the motor (6) rotation speed to the next lower level by decreasing the motor (6) rotation speed if the measured voltage value ($V_{AKÜ}$) is between the lower limit voltage value (V_{AL}) and the minimum voltage value (V_{aktif}).

Figure 1



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B60H1/00 B60H1/32 B60L11/18 H02H3/20 H02H3/24
H02J7/00 H02J7/14
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)
B60H B60L H02H H02J

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/070771 A1 (JOERGENSEN HENRIK [DK] ET AL) 29 March 2007 (2007-03-29) cited in the application paragraph [0050] - paragraph [0054]; figures 1,2,4	1-8
X	US 2003/201097 A1 (ZEIGLER TERRY [US] ET AL) 30 October 2003 (2003-10-30) paragraphs [0011], [0012], [0037]; figures 1,4	1
X	EP 1 985 481 A2 (BERGSTROM INC [US]) 29 October 2008 (2008-10-29) paragraph [0030]; figures 1,4	1
A	US 6 028 406 A (BIRK JENS [DK]) 22 February 2000 (2000-02-22) figure 1	1

☐ Further documents are listed in the continuation of Box C.

☒ 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
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/072842

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