Title: ARRANGEMENT IN MINING VEHICLE

Abstract: The invention relates to a method for operating an unmanned mining vehicle and to an unmanned mining vehicle. When the mining vehicle (1) is not in operation, it is switched to a standby state. Thus, electric power supply to at least one electrically operated device is switched off so as to reduce electric energy consumption.
Declarations under Rule 4.17:


- of invention (Rule 4.17(iv)) for US only

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- with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
ARRANGEMENT IN MINING VEHICLE

FIELD OF THE INVENTION

[0001] The invention relates to a method for operating an unmanned mining vehicle, the mining vehicle comprising: a movable carrier; at least one electrically operated device; at least one battery; at least one electric power generation apparatus; and at least one first control unit that communicates over a data transfer connection with a second control unit outside the mining vehicle; and which method comprises: generating electric energy by means of the electric power generation apparatus for operating the electric actuators of the mining vehicle and for charging the battery; transmitting commands relating to the control of the mining vehicle over the data transfer connection from the second control unit to the first control unit.

[0002] The invention further relates to an unmanned mining vehicle, which comprises: a movable carrier; an electric system that includes at least one battery and at least one electric power generation apparatus for operating electrically operated devices of the mining vehicle and for charging said battery; a first control unit; and means for establishing a data transfer connection between said first control unit and a second control unit outside the mining vehicle for transmitting commands between the control units.

BACKGROUND OF THE INVENTION

[0003] At mining sites there are employed more and more unmanned mining vehicles, which are remote-controlled from a control room, or which may operate independently in the mine by means of their own navigation system and a predetermined plan. Generally, these mining vehicles are provided with a power source of their own in order that they can move more freely without limitations set by electric cables or corresponding power supply means. Typically the mining vehicle comprises a diesel engine, from which the operating power is transmitted to wheels and which engine is used, for instance, for operating apparatuses for generating the pressure of pressure medium and the electric energy needed by the mining vehicle. Electric energy is needed, for instance, for maintaining the data transfer connection between the vehicle and the control room and for operating the control devices. Electric energy is charged in batteries located in the vehicle so that the diesel engine or the like can be switched off when the vehicle is standing still, for instance, for shift changes and breaks of the operator, for rock blasting and for maintenance and
repair work. The mining vehicle consumes electric energy also when in standby, and consequently the battery runs down and the engine must be started to recharge it. To run the engine at short intervals just for charging the batteries consumes fuel and causes exhaust gas emissions in the mine. In addition, repeated switching on and off wears the engine and the electric generator.

BRIEF DESCRIPTION OF THE INVENTION

[0004] The object of the present invention is to provide a novel and improved arrangement for reducing the consumption of electric energy in a remote-controlled mining vehicle provided with own electric power generation system.

[0005] The method of the invention is characterized by switching the mining vehicle from a working state to a standby state when the vehicle is not actively employed; operating electrically operated devices of the mining vehicle by means of electric charge of a battery when in standby state; interrupting in the standby state electric power supply at least in part to at least one electrically operated device so as to reduce the energy consumption of the mining vehicle; and switching the mining vehicle back to the working state by switching on the electric power generation apparatus and by reinstating the normal electric power supply to the electrically operated devices.

[0006] The mining vehicle of the invention is characterized in that the mining vehicle is arranged to move over to a standby state if the mining vehicle is not in operation and that in said standby state the electric power generation apparatus is mainly switched off and a first control unit is arranged to interrupt at least in part the electric power supply to at least one electrically operated device.

[0007] The basic idea of the invention is that an unmanned mining vehicle can be switched to a standby state when it is not in active use. In standby state, the electric power generation system of the mining vehicle is mainly switched off and the electrically operated devices are driven by the charge in one or more batteries. Further, the electric energy consumption of the mining vehicle in standby state is reduced by switching off one or more electrically operated devices either completely or partly. When the mining vehicle is reactivated into normal working state, the electric power generation sys-
tem is started and electric power is fed again to the electrically operated devices that were switched off.

[0008] Thanks to the invention the electric energy consumption of the mining vehicle in standby state can be reduced, whereby the electric power generation system and the power unit need not be started so often as before just for producing electric power. Hence, fuel will be saved, less exhaust gas emissions will be produced, and in addition, components and the power unit associated with electric power generation will wear less, because the number of start ups will be lower. On the other hand, reduced electric power consumption enables the mining vehicle being provided with a smaller and lighter battery than before, which allows freer constructional design of the vehicle.

[0009] The basic idea of one embodiment of the invention is that the mining vehicle is automatically switched to standby state after a predetermined period of time when the vehicle was last actively used. Either a control unit in the mining vehicle or a control unit outside the mining vehicle can perform the switching to standby.

[0010] The basic idea of one embodiment of the invention is that in standby state the ordinary data transfer connection between the control unit of the mining vehicle and the control unit of the control room is substantially completely switched off. So, electric energy is not wasted for maintaining the data transfer connection.

[0011] The basic idea of one embodiment of the invention is that in standby state the battery charge of the mining vehicle is monitored and as the charge is running down to a predetermined level the electric power generation system is automatically switched on to generate electric energy and to charge the battery. Thus, it is made sure that there is always a sufficient electric charge in the battery for the control and data transfer devices of the mining vehicle. Further, if the electric power generation apparatus is driven by an internal combustion engine, the arrangement of the invention can always ensure that the battery charge is sufficient for starting the engine. The solution makes it possible to avoid disturbances caused by a dead battery.

[0012] The basic idea of one embodiment of the invention is that in the standby state the battery charge of the mining vehicle is monitored and electrically operated devices of the mining vehicle will be switched off from operation according to a predetermined plan in proportion to the charge left in the battery. Electrically operated devices can be switched off from operation on the
basis of their electric energy consumption or the switching off can be prioritized in accordance with the use of the devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In the following the invention will be described in greater detail in the attached drawings, wherein

Figure 1 is a schematic side view of a mining vehicle in accordance with the invention, and

Figure 2 is a schematic view of another mining vehicle in accordance with the invention.

[0014] For the sake of clarity, the invention is presented in a simplified form in the figures. Like reference numerals refer to like parts in the figures.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Figure 1 shows a side view of a mining vehicle 1. In this case the vehicle is a loading vehicle, but the invention is also applicable to unmanned rock drilling rigs and other vehicles having a moveable carrier. The mining vehicle 1 is provided with an electric power generation system 2 of its own, which may comprise a power source 3 that is arranged to drive an electric generator 4 or a corresponding electric power generation apparatus. The power source 3 may be an internal combustion engine, such as a diesel engine, which can be arranged to drive hydraulic and pneumatic pumps, in addition to the electric generator 4, and to generate the mechanical power necessary for moving the vehicle. Further, it is possible to generate the electric energy required by the mining vehicle 1 by means of one or more fuel cells, for instance. The electricity produced by the electric power generation system is charged in at least one battery 5 in the mining vehicle 1. When the mining vehicle 1 is not in operational use, the electric devices and systems of the mining vehicle 1 can be operated by the charge in the battery 5. Thus, the electric power generation system 2 can be switched off in the standby state. The mining vehicle 1 also comprises a first control unit 6, which is arranged to control various control devices and actuators of the mining vehicle 1. The control system of the unmanned mining vehicle 1 may further comprise at least one external control unit 7, which is typically located in a control room 8 of the mine site, but which can, in principle, be located anywhere physically. Between the first control unit 6 and the second control unit 7 there can be a data transfer
connection 9 such that data and commands relating to the control of the mining vehicle 1 can be transmitted between the control units 6 and 7. The data transfer connection 9 can be based on the utilization of a radio transmitter/receiver, infrared waves or any wireless connection known per se. The control units 6 and 7 may comprise one or more computers or other corresponding control apparatuses suitable for controlling the mining vehicle 1.

[0016] The control system of the mining vehicle 1 comprises means, by which the mining vehicle 1 can be switched to standby state, for instance, when the operators in the control room 8 change shifts, when the operator has a break, for the duration of rock blasting and for the duration of maintenance and repair work of the mining vehicle 1 and the mine. In standby state the mining vehicle 1 is out of normal operational use and thus all its electric systems need not be active. Hence, the electric energy consumption of the mining vehicle 1 in standby can be reduced by switching off one or more electrically operated devices and systems in accordance with a predetermined plan. At the first stage it is possible to switch off the mining vehicle’s 1 headlights, sensor elements, electric motors and other actuators, etc. At the second stage it is possible to switch off at least in part the first control unit 6 and the data transfer connection 9.

[0017] Switching to standby can be carried out in a variety of ways. One option is that using any suitable user interface the operator enters a standby command manually into the second control unit 7. The second control unit 7 transmits the command via a data transfer connection 9 to the first control unit 6, which switches off electric devices and systems as required. When there is a need to return from the standby state back to the working state, a relating command is entered into the second control unit 7, which forwards again the command to the mining vehicle 1. Alternatively, the operator may determine for the second control unit 7 a first time, after which the mining vehicle 1 moves over from the working state to the standby state, and further a second time, which determines how long the mining vehicle 1 remains switched to standby. As the second time expires the mining vehicle automatically returns from the standby state to the working state. The operator can be notified when the mining vehicle 1 is ready for normal use. It is possible to determine yet a third time, in the course of which the transfer back to the working state must be acknowledged or the mining vehicle 1 must start re-operating, or otherwise the vehicle will automatically return to standby state. The operations
of the second and the third times may alternate automatically as long as the operator takes control of the vehicle.

[0018] At a desired moment the mining vehicle in standby state can be activated using a second wireless data transfer connection 11, for instance an emergency stop system, which is different from the ordinary data transfer connection 9. Data transmission capacity of the second data transfer connection 11 can be substantially lower than that of the data transfer connection 9 intended for operational use, whereby considerably less electric energy is consumed for maintaining the second data transfer connection 11. It is sufficient that the second data transfer connection 11 allows transmission of a simple command to the vehicle for switching on the ordinary data transfer connection 9. The second data transfer connection 11 may also be arranged to activate automatically, when the ordinary data transfer connection is switched off. The second data transfer connection 11 may also comprise a battery of its own.

[0019] One option to activate the mining vehicle from the standby state to the working state is to go to the mining vehicle and manually acknowledge the termination of the standby state. When necessary, the mining vehicle can be controlled to standby state of this kind, for instance, when the mining vehicle is broken down or its use could cause a dangerous situation.

[0020] Figure 2 shows an unmanned rock drilling rig provided with an electric energy saving system in accordance with the invention. The drilling machine can be mainly electrically operated, whereby electric motors generate the powers required by the operating power transmission and drive the pressure medium pumps. The rock drilling rigs 10 can also be electrically operated. The rock drilling rig can comprise sensors 12 or the like, which allow the charge, i.e. current and voltage, of the battery 5 to be monitored. The measurement results are conveyed to the first control unit, in which there can be set a limit value for the charge, below which the control unit 6 is arranged to start the electric power generation apparatus 2.

[0021] The first control unit 6 and the second control unit 7 can be computers, in the processors of which it is possible to execute a computer program, which makes the rock drilling rig move over from the working state to the standby state in accordance with the invention. The program code can be loaded from a memory in the control units or it can be transferred from a separate external memory means, such as a CD-ROM. The program code can also be transferred over a data network, for instance, by connecting the device to
the Internet. It is also possible to use a hardware implementation or a combination of hardware and software solutions.

[0022] The drawings and the relating specification are only intended to illustrate the inventive idea. The details of the invention may vary within the scope of the claims.
CLAIMS

1. A method for operating an unmanned mining vehicle, the mining vehicle (1) comprising: a movable carrier; at least one electrically operated device; at least one battery (5); at least one electric power generation apparatus (2); and at least one first control unit (6) that communicates over a data transfer connection (9) with a second control unit (7) outside the mining vehicle (1); and which method comprises:

   generating electric energy by means of the electric power generation apparatus (2) for operating the electric actuators of the mining vehicle (1) and for charging the battery (5);

   transmitting commands relating to the control of the mining vehicle (1) over the data transfer connection (9) from the second control unit (7) to the first control unit (6), characterized by

   switching the mining vehicle (1) from a working state to a standby state when the vehicle (1) is not actively employed;

   operating electrically operated devices of the mining vehicle (1) by means of electric charge of a battery (5) when in standby state;

   interrupting in standby state electric power supply at least in part to at least one electrically operated device of the mining vehicle (1) so as to reduce the energy consumption of the mining vehicle (1); and

   switching the mining vehicle (1) back to the working state by switching on the electric power generation apparatus (2) and by reinstating the ordinary electric power supply to the electrically operated devices.

2. A method as claimed in claim 1, characterized in that from the second control unit (7) a command is given to the first control unit (6) for switching the mining vehicle (1) to standby state.

3. A method as claimed in claim 1, characterized in that the mining vehicle (1) is automatically switched to standby state after a predetermined time from the moment when the vehicle (1) was last used.

4. A method as claimed in any one of the preceding claims, characterized by monitoring the charge of the battery (5) of the mining vehicle (1) in the standby state, and by starting automatically the electric power generation apparatus (2) of the mining vehicle (1) to generate electric energy, when the charge of the battery (5) is below a predetermined limit value.
5. A method as claimed in any one of the preceding claims, characterized by monitoring the charge of the battery (5) of the mining vehicle (1) in the standby state, and by switching off one or more electrically operated devices of the mining vehicle (1) in accordance with a predetermined plan in proportion to the charge left in the battery (5).

6. An unmanned mining vehicle, which comprises:
   a movable carrier; an electric system that includes at least one battery (5) and at least one electric power generation apparatus (2) for operating electrically operated devices of the mining vehicle (1) and for charging said battery (5);
   a first control unit (6); and
   means for establishing a data transfer connection (9) between said first control unit (6) and a second control unit (7) outside the mining vehicle (1) for transmitting control commands between the control units (6, 7), characterized in
   that the mining vehicle (1) is arranged to move over to a standby state if the mining vehicle (1) is not in operation; and
   that in said standby state the electric power generation apparatus (2) is mainly switched off and the first control unit (6) is arranged to interrupt at least in part the electric power supply to at least one electrically operated device.

7. A mining vehicle as claimed in claim 6, characterized in that the mining vehicle (1) is arranged to move over automatically to the standby state after a predetermined time from the moment when the mining vehicle (1) was last used.

8. A mining vehicle as claimed in claim 6, characterized in that the mining vehicle (1) is arranged to move over to the standby state controlled by a command entered in the second control unit (7).

9. A mining vehicle as claimed in any one of claims 6 to 8, characterized in that the mining vehicle (1) comprises means for monitoring the charge of the battery (5) and that the electric power generation apparatus (2) of the mining vehicle (1) is arranged to start automatically as the charge of the battery (5) is below a predetermined value.

10. A mining vehicle as claimed in any one of claims 6 to 9, characterized in that the mining vehicle (1) comprises at least one in-
ternal combustion engine (3), which is arranged to drive the electric power generation apparatus (2).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60K 6/04, E02F 9/20, E21F 13/02
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)

IPC7: B60K, E02F, E21F

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ, INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 02061515 A2 (AINSWORTH INC.), 8 August 2002 (08.08.2002), page 4, line 8 - line 15; page 24, line 30 - page 28, line 24; page 41, line 14 - page 43, line 24</td>
<td>1-3,6-8,10</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search: 1 July 2004

Date of mailing of the international search report: 05-07-2004

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<td>A</td>
<td>EP 1177928 A2 (TOYOTA JIDOSHA KABUSHIKI KAISHA), 6 February 2002 (06.02.2002), column 1, line 15 - column 3, line 39</td>
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<td>US</td>
<td>6491121 B</td>
<td>10/12/2002</td>
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<tr>
<td>US</td>
<td>2003052650 A1</td>
<td>20/03/2003</td>
<td>JP</td>
<td>2003092804 A</td>
<td>28/03/2003</td>
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<tr>
<td>EP</td>
<td>1177928 A2</td>
<td>06/02/2002</td>
<td>CN</td>
<td>1401515 A</td>
<td>12/03/2003</td>
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<td>JP</td>
<td>2002047963 A</td>
<td>15/02/2002</td>
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<td>US</td>
<td>6687580 B</td>
<td>03/02/2004</td>
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<td>2002019687 A</td>
<td>14/02/2002</td>
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