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(54) Benævnelse: **Elektrokøretøjsladestation og fremgangsmåde til styring af en elektrokøretøjsladestation**

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Description

The present invention concerns an electric vehicle charging station an a method of controlling an electric vehicle charging station.

Charging stations for electric vehicles have long been known and typically have a cable with a plug which is fitted into a socket in or on the electric vehicle in order to charge up an energy storage means in or on the electric vehicle.

Efficient and rapid charging of the energy storage means in the electric vehicles is an essential factor for success with electric vehicles.

On the patent application from which priority is claimed the German Patent and Trade Mark Office searched the following documents: EP 2 875 985 A1, EP 2 647 522 A1, EP 2 875 986 A1, US 2013/0057211 A1, DE 10 2009 046 422 A1 and DE 10 2010 062 362 A1.

Therefore an object of the present invention is to provide a charging station for electric vehicles, which permits efficient and rapid charging of the electric vehicles.

That object is attained by an electric vehicle charging station according to claim 1 and by a method of controlling an electric vehicle charging station according to claim 3.

Thus there is provided an electric vehicle charging station comprising an interface, by way of which the charging station receives energy from an electrical energy supply grid, an energy intermediate storage device for intermediate storage of energy received or transmitted by way of the interface from the electrical energy supply grid, a plurality of output connections for charging electric vehicles and a control unit for controlling the energy intermediate storage in the energy intermediate storage device and for controlling the delivery of energy by way of the output connections. The control unit is adapted to pass energy from the energy intermediate storage device to the output connections when the energy required at the output connections cannot be made available completely by way of the interface by the electrical energy supply grid.

According to an aspect of the present invention the control unit is adapted in dependence on a fault in the energy supply grid to initiate energy intake from the energy supply grid by the intermediate storage device or energy delivery from the intermediate storage device into the energy supply grid.

The electric vehicle charging station has an energy intermediate storage device. That intermediate storage device can be charged up with energy from an energy supply grid. If for example no charging or only very little charging of electric vehicles takes place the intermediate storage device can be charged up. The

charging station can be provided for example in the form of a container or smart container and can be coupled to an energy supply grid. In addition the charging station/the container can have a plurality of cables with corresponding plugs so that a plurality of electric vehicles can be charged up at the same time. In particular if many electric vehicles are to be charged up at the same time it can then happen that the required amount of energy cannot be delivered by way of the energy supply grid to which the container or the charging station is connected. In such cases it is possible to have recourse to the energy intermediate storage device which is disposed in the container or coupled thereto. In that case the energy in the energy intermediate storage device can be used to at least partially charge up the electric vehicles connected to the charging station.

The invention comes in useful in particular when the amount of energy required by the electric vehicles connected to the charging station cannot be transmitted by way of the interface between the energy supply grid and the charging station. If for example an electric vehicle requires between 50 and 70 kW then ten electric vehicles already require between 500 and 700 kW for fast charging.

The energy storage device disposed in the charging station or in the charging container can also be used for the intermediate storage of energy from the electrical energy supply grid so that the charging station or the charging container can become operative in grid-supporting relationship. That is necessary or advantageous in particular in a fault situation in the electrical energy supply grid.

According to an aspect of the present invention the intermediate storage device in the charging station according to the invention can be used for supporting the electrical supply grid. The intermediate storage device can thus be fixedly operated as a buffer in the event of a grid fault between the electric vehicle and the energy supply grid. In addition the intermediate storage device or the energy stored therein can be used for grid protection for example in the event of an overfrequency or an underfrequency, that is to say if a fault occurs in the energy supply grid and the grid frequency is above or below the nominal frequency. An overfrequency represents a grid frequency which is higher than a reference grid frequency. An underfrequency represents a grid frequency which is lower than the reference grid frequency.

Further configurations of the invention are subject-matter of the appendant claims.

Advantages and embodiments by way of example of the invention are described in greater detail hereinafter with reference to the drawing.

Figure 1 shows a diagrammatic view of a charging station according to the invention, and

Figure 2 shows a block circuit diagram of an environment involving a plurality of charging stations according to the invention.

Figure 1 shows a diagrammatic view of an electric vehicle charging station according to the invention. A charging station or a charging container 100 for electric vehicles 200 is connected to an electrical energy supply grid 1000 by way of an interface I. A power P_I can be transmitted by way of the interface I from the electrical energy supply grid to the charging station. The charging station 100 has an energy intermediate storage device 110 and a control unit 120. The charging station 100 also has a plurality of charging connections 101-106. The number of charging connections can vary. An electrical power $P_{01} – P_{06}$ can be transmitted by way of each of the charging connections 101-106. A respective electric vehicle 200 can optionally be connected to the connections 101-106. The electric vehicles 200 have a rechargeable energy storage means 210 (for example an accumulator), a control unit 220 and an interface 230. The electric vehicle 200 can be connected to one of the connections 101-106 by way of the interface 230 in order to transmit electrical energy from the charging station 100 into the storage means 210.

According to the invention the charging station or the charging container 100 has an energy intermediate storage device 110. That intermediate storage device 110 can optionally be of such dimensions that the energy stored therein can be sufficient to charge up a plurality of electric vehicles 200. The electric vehicles 200 can thus be charged up by way of the energy stored in the energy intermediate storage device 110. As an alternative thereto the energy required for charging up the electric vehicles 200 can be made available directly from the electrical energy supply grid 1000 by means of the charging station 100.

If however the number of electric vehicles 200 which are to be charged up simultaneously at the charging station 100 is too high and the energy made available by the electrical energy supply grid 1000 is not sufficient for all electric vehicles 200 it is then possible to have access to the energy stored in the intermediate storage device 110 to charge up the electric vehicles.

Thus effective fast charging even of a multiplicity of electric vehicles can be ensured at the same time at the charging station or the charging container.

The control unit 120 can also be connected to the electrical energy supply grid 1000 in order to obtain information from the electrical energy supply grid 1000. Particularly in a fault situation in the energy supply grid 1000 the control unit 120 can control charging of the energy intermediate storage device 110. If for example there is too much energy in the energy supply grid 1000 then energy from the electrical energy supply grid 1000 can be stored in the energy intermediate storage device 110. If for example there is not sufficient energy in the electrical energy

supply grid 1000 then energy can be transmitted from the energy intermediate storage device 110 to the electrical energy supply grid.

Electric vehicles can represent motor vehicles (like automobiles and trucks), motor cycles, bicycles, aircraft and so forth.

A fault in the energy supply grid 1000 can represent an over/under-voltage or an over/under-frequency.

According to the invention the charging station can be used with the energy intermediate storage device 110 for grid support.

Figure 2 shows a block circuit diagram of an environment involving a plurality of charging stations according to the invention. A plurality of charging stations 100 is coupled both to the energy supply grid 1000 and also to a central control unit 300. The central control unit 300 can monitor the grid voltage and/or grid frequency in the energy supply grid 1000. If a fault occurs in the energy supply grid, that is to say if the detected voltage differs from the reference grid voltage and/or if the grid frequency differs from the reference nominal grid frequency by a tolerance range then the central control unit 300 can intervene in operation of the charging stations 100. That can occur in particular to contribute to grid support.

If the grid frequency exceeds above a first limit value then the central control unit 300 can operate the charging stations 100 in such a way that energy is delivered from the supply grid into the intermediate storage devices of the charging stations. The charging stations therefore receive excessive energy from the supply grid, for example to be able to stabilise the grid frequency. If the grid frequency drops below a second limit value then energy can be taken from the intermediate storage devices of the charging stations and delivered to the electrical energy supply grid.

According to the invention the electric charging stations can have a charging mode and a discharging mode. During the charging mode for example energy can be taken from the energy supply grid and output to the connected electric vehicles. In a discharging mode energy can be delivered from the intermediate storage device to the electrical energy supply grid.

According to an aspect of the present invention there can be provided a minimum charging of the intermediate storage device, below which it is not to fall in the discharging mode in order to ensure that the intermediate storage device can deliver energy to the connected charging stations if it is not possible to provide sufficient energy by way of the connection to the electric grid for charging the connected electric vehicles.

According to the invention the intermediate storage device can be connected on the low-voltage level (between 1 and 20 kV).

The charging stations according to the invention can thus actively intervene in support for the grid. If there are a plurality of charging stations which are geographically distributed then the accumulated storage capability of the intermediate storage devices can be sufficiently great to make itself felt positively in terms of grid support.

Patentkrav

1. Elektrokøretøjsladestation med
en grænseflade (I), som ladestationen modtager energi gennem fra et elektrisk energiforsyningsnet (1000),
et energimellemlager (110) til mellemlagring af energi, der sendes eller modtages fra det elektriske energiforsyningsnet (1000) via grænsefladen (I),
en flerhed af udgangstilslutninger (101 - 106) til opladning af elektrokøretøjer,
og
en styreenhed (120) til styring af energimellemlagringen i energimellemlageret (110) og til styring af afgivelsen af energi via udgangstilslutningerne (101 - 106),
hvor styreenheden (120) i en første driftsmodus er beregnet til at oplade elektrokøretøjer, der er tilsluttet til en flerhed af udgangstilslutninger, ved hjælp af energi, der modtages via grænsefladen (I),
hvor styreenheden (120) i en anden driftsmodus er udformet til yderligere at videresende energi fra energimellemlageret (110) til udgangstilslutningerne (101 - 106), når den energi, der er nødvendig ved udgangstilslutningerne (101 - 106), ikke kan stilles fuldstændig til rådighed af det elektriske energiforsyningsnet (1000) via grænsefladen (I), og
styreenheden (120) i en tredje driftsmodus er udformet til afhængigt af en første fejl i energiforsyningsnettet (1000), nemlig når der er for meget energi i energiforsyningsnettet (1000), at initiere en energioptagelse fra energiforsyningsnettet (1000) via energimellemlageret (110),
hvor styreenheden (120) i en fjerde driftsmodus er udformet til afhængigt af en anden fejl i energiforsyningsnettet (1000), nemlig der ikke er tilstrækkeligt energi i energiforsyningsnettet (1000), at initiere en energiafgivelse fra energimellemlageret (110) til energiforsyningsnettet (1000).

2. Elektrokøretøjsladestation ifølge krav 1, hvor energimellemlageret (110) er dimensioneret således, at energien, der kan lagres deri, rækker til at oplade en flerhed af elektrokøretøjer (200).

3. Elektrokøretøjsladestation ifølge krav 1 eller 2, hvor der er tilvejebragt en minimumsopladning af energimellemlageret (110), der ikke underskrides i den fjerde driftsmodus.

4. Fremgangsmåde til styring af mindst en elektrokøretøjsladestation, med trinnene:
- at modtage energi fra et elektrisk energiforsyningsnet (1000) via en grænseflade (I),
- at mellemlagre energi, der sendes eller modtages via grænsefladen (I) fra det elektriske energiforsyningsnet (1000), i et energimellemlager (110),
- at oplade elektrokøretøjer ved en flerhed af udgangstilslutninger (101-106) i en første driftsmodus ved hjælp af energi, der modtages via grænsefladen (I),
- at styre energimellemlagringen ind i energimellemlageret (110) ved hjælp af en styreenhed (120),
- at styre afgivelsen af energi via udgangstilslutningerne (101-106) ved hjælp af styreenheden (120),
- yderligere at videresende energi fra energimellemlageret (110) i en anden driftsmodus til udgangstilslutningerne (101-106), når den energi, der er nødvendig ved udgangstilslutningerne (101-106), ikke kan stilles fuldstændig til rådighed af det elektriske energiforsyningsnet (1000) via grænsefladen (I),
- at initiere en energioptagelse fra energiforsyningsnettet (1000) via mellemlageret (110) i en tredje driftsmodus afhængigt af en første fejl i energiforsyningsnettet (1000), nemlig når der er for meget energi i energiforsyningsnettet, og
at initiere en energiafgivelse fra mellemlageret (110) til energiforsyningsnettet (1000) i en fjerde driftsmodus afhængigt af en anden fejl, nemlig når der ikke er tilstrækkeligt energi i energiforsyningsnettet.

5. Fremgangsmåde ifølge krav 4,
hvor energimellemlageret (110) er dimensioneret således, at energien, der kan lagres deri, rækker til at oplade en flerhed af elektrokøretøjer (200).

6. Fremgangsmåde ifølge krav 4 eller 5,
hvor der er tilvejebragt en minimumsopladning af energimellemlageret (110),
der ikke underskrides i den fjerde driftsmodus.

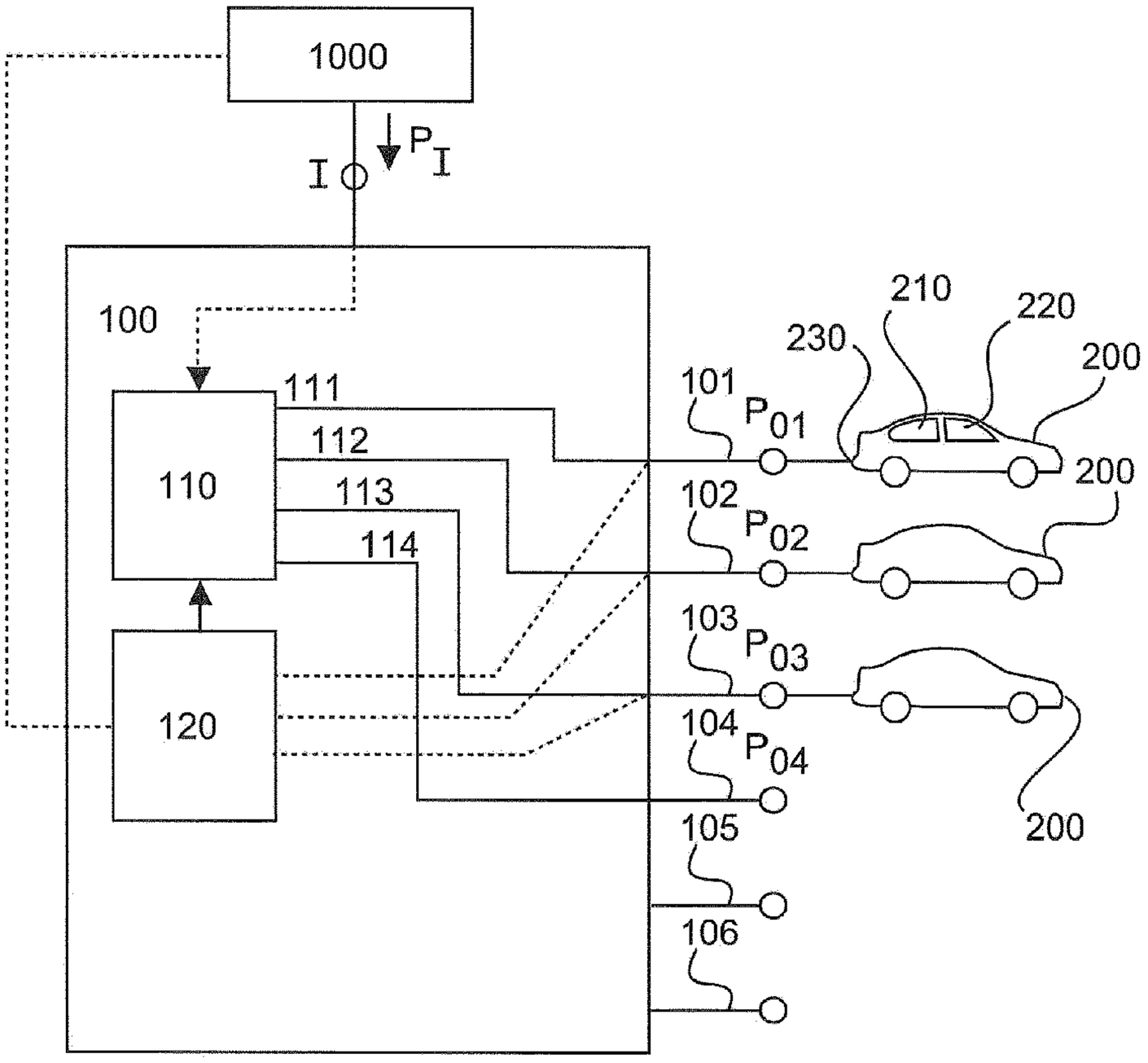

1000
I
P_I
100
110
120
111
112
113
114
101
P_{01}
102
P_{02}
103
P_{03}
104
P_{04}
105
106
210
220
230
200
200
200

Fig. 1

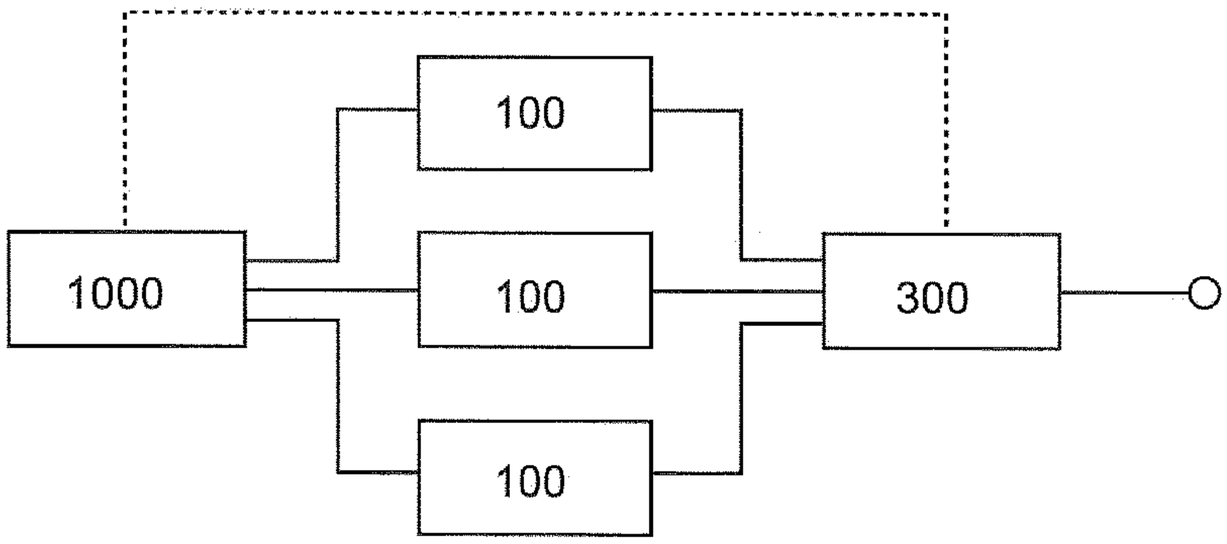

100
1000
100
300
100

Fig. 2