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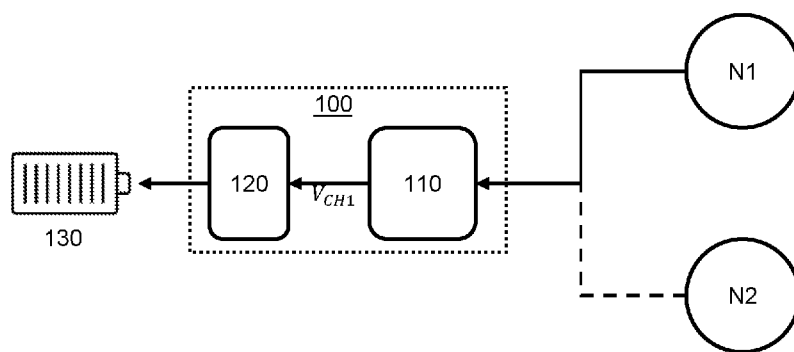


Fig. 1a

(57) Abstract: The disclosure relates to a charging station (100) for charging mining/construction vehicle batteries. The charging station (100) comprises at least one converter (110) configured to be connected to a first voltage network (N1) or a second voltage network (N2) and convert a voltage of the first voltage network (N1) to a first charging voltage (V_{CH1}) or convert a voltage of the second voltage network (N2) to a second charging voltage (V_{CH2}). The charging station (100) further comprises at least one battery charger (120) connected to the converter (110) and being configured to charge at least one battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) based on a measurement of the first voltage network (N1) and/or a measurement of the battery (130). Furthermore, the disclosure also relates to a corresponding method for charging mining/construction vehicle batteries.



CHARGING STATION FOR CHARGING MINING/CONSTRUCTION VEHICLE BATTERIES

Technical Field

- 5 The disclosure relates to a charging station for charging mining/construction vehicle batteries. Furthermore, the disclosure also relates to a charging system and corresponding methods.

Background

- 10 Electrified mining/construction vehicles provide an opportunity to reduce the environmental footprint and create a healthier work environment in mining/construction environments. The electrified mining/construction vehicle is driven by one or more electric motors which in turn may be powered by an electric grid system and/or an on-board electrical storage system (ESS) comprising e.g., one or more batteries or battery
15 packs. Compared to diesel vehicles, the electrified mining/construction vehicles are emission free and can hence bring considerable savings, especially for ventilation and cooling in the mining/construction environments.

- As the electrified mining/construction vehicle travels around the mining/construction
20 site performing one or more tasks, the charge level of the on-board ESS decreases, and the electrified mining/construction needs to be re-charged at regular intervals. The charging may be performed at a charging station and the mining/construction site typically comprises a number of charging stations in different locations for this purpose.

25 Summary

An objective of embodiments of the disclosure is to provide a solution which mitigates or solves the drawbacks of conventional solutions.

- Another objective of embodiments of the disclosure is to provide a charging station
30 which provides an efficient charging of mining/construction vehicles batteries.

The above and further objectives are solved by the subject matter of the appended independent claims.

According to a first aspect of the disclosure, the above mentioned and other objectives are achieved with a charging station for charging mining/construction vehicle batteries, the charging station comprising:

5 at least one converter configured to be connected to a first voltage network or a second voltage network and convert a voltage of the first voltage network to a first charging voltage or convert a voltage of the second voltage network to a second charging voltage; and

10 at least one battery charger connected to the converter and being configured to charge at least one battery with the first charging voltage or the second charging voltage based on a measurement of the first voltage network and/or a measurement of the battery.

15 An advantage of the control arrangement according to the first aspect is that the quality of the charging power and grid strength can be maintained due to the consideration of the measurement of the first voltage network and the measurement of the battery. Further, the impact of the charging current on the grid voltage may also be reduced. Thereby, improved charging is provided compared to conventional solutions.

20 In an embodiment of a charging station according to the first aspect, the charging station is configured to:

 charge the battery with the first charging voltage or the second charging voltage further based on a measurement of the second voltage network.

25 An advantage with this embodiment form is that yet another relevant parameter is considered for determining whether to charge the battery with the first charging voltage or the second charging voltage for improved charging.

 In an embodiment of a charging station according to the first aspect, the charging station is configured to:

30 charge the battery with the first charging voltage or the second charging voltage further based on at least one voltage threshold value or a charging current threshold value.

An advantage with this embodiment form is that a threshold value is used for determining whether to charge the battery with the first charging voltage or the second charging voltage for improved charging.

- 5 In an embodiment of a charging station according to the first aspect, the at least one voltage threshold value comprises zero voltage.

An advantage with this embodiment form is that it may be detected if there exists a voltage in the first voltage network or the second voltage network. Thus, the battery is
10 guaranteed to be charged. Correspondingly, the charging current threshold value is used to check if there is a current flow in the voltage networks.

In an embodiment of a charging station according to the first aspect, the measurement of the battery is a state-of-charge measurement.

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In an embodiment of a charging station according to the first aspect, the charging station is configured to:

charge the battery with the first charging voltage or the second charging voltage further based on any of a grid tariff, a grid service requirement and a change in
20 renewable power generation of the first voltage network and/or the second voltage network.

An advantage with this embodiment form is that further relevant parameters are considered for determining whether to charge the battery with the first charging voltage
25 or the second charging voltage for improved charging and grid operation.

In an embodiment of a charging station according to the first aspect, the charging station comprises:

at least two converters, wherein a first converter is configured to be connected to
30 the first voltage network and provide the first charging voltage and a second converter is configured to be connected to the second voltage network and provide the second charging voltage.

An advantage with this embodiment form is that the circuit topology of the charging station may be adapted to different charging requirements and/or voltage network configurations.

- 5 In an embodiment of a charging station according to the first aspect, the first converter is configured to be connected between the first voltage network and the battery charger and the second converter is configured to be connected between the second voltage network and the battery charger.
- 10 In an embodiment of a charging station according to the first aspect, the charging station comprises:
at least two battery chargers, wherein a first battery charger is configured to be connected to the first converter and charge the battery with the first charging voltage and a second battery charger is configured to be connected to the second converter
15 and charge the battery with the second charging voltage.

An advantage with this embodiment form is that the circuit topology of the charging station may be adapted to different charging requirements and/or voltage network configurations.

- 20 In an embodiment of a charging station according to the first aspect, the first battery charger is configured to charge a first battery temporary stored at the charging station and the second battery charger is configured to charge a second battery arranged in a mining/construction vehicle.

- 25 An advantage with this embodiment form is the possibility of both charging the battery stored at the charging station and the battery arranged in the mining/construction vehicle.

- 30 In an embodiment of a charging station according to the first aspect, the first voltage network and the second voltage network are connected to the same power source or to different power sources.

An advantage with this embodiment form is that grid flexibility is provided. In the case with the same power source, it is possible to charge with lower grid capacity. In the case with different power sources the charger is connected to the desired voltage network during capacity limits.

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In an embodiment of a charging station according to the first aspect, the first voltage network and the second voltage network are AC networks or DC networks.

According to a second aspect of the disclosure, the above mentioned and other objectives are achieved with a charging system comprising at least one charging station according to any one of the preceding claims, a first voltage network, a second voltage network, and at least one battery.

In an embodiment of a charging system according to the second aspect, the battery is a vehicle battery for a mining/construction vehicle.

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According to a third aspect of the disclosure, the above mentioned and other objectives are achieved with a method for charging mining/construction vehicle batteries, the method comprises:

converting a voltage of a first voltage network to a first charging voltage or converting a voltage of a second voltage network to a second charging voltage; and charging at least one battery with the first charging voltage or the second charging voltage based on a measurement of the first voltage network and/or a measurement of the battery.

20

The method may be adapted in accordance with the above-mentioned embodiments of the control arrangement. The advantages of the method are the same as the advantages of the corresponding embodiments of the control arrangement.

According to an aspect of the disclosure, the above mentioned and other objectives are achieved with one or more control units arranged to control the control arrangement and/or the first electrified mining/construction vehicle to carry out the methods according to any embodiment of the method aspects.

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According to further aspects of the present disclosure, the herein described methods are implemented by use of computer program products comprising instructions which, when the programs are executed by a computer, such as e.g., a herein mentioned control unit, cause the computer to carry out the steps of the methods according to any
5 one of the herein described embodiments.

Further applications and advantages of embodiments of the disclosure will be apparent from the following detailed description.

10 **Brief Description of the Drawings**

The appended drawings are intended to clarify and explain different embodiments of the disclosure, in which:

- Figs. 1a-b show a charging station according to an embodiment of the disclosure;
- 15 – Fig. 2 shows a charging station with a controller according to an embodiment of the disclosure;
- Figs. 3a-b show a charging station and power sources according to an embodiment of the disclosure;
- Fig. 4 shows a charging station with one battery charger and two converters
20 according to an embodiment of the disclosure;
- Fig. 5 shows a charging station with two battery chargers and two converters according to an embodiment of the disclosure;
- Fig. 6 shows a charging station for charging two batteries according to an embodiment of the disclosure;
- 25 – Fig. 7 shows a charging system according to an embodiment of the disclosure;
- Fig. 8 shows non-limiting examples of mining/construction vehicles according to an embodiment of the disclosure; and
- Fig. 9 shows a flow chart of a method according to an embodiment of the disclosure.

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Detailed Description

According to embodiments of the disclosure a charging station 100 for charging mining/construction vehicle batteries is provided. Figs. 1 to 6 shows the charging station 100 according to embodiments of the disclosure. The charging station 100 can

be used to charge a battery for a mining/construction vehicle. The battery may be a vehicle battery comprising one or more battery cells, battery units and/or battery packs and may, during the charging, be arranged in the mining/construction vehicle and/or arranged separate from the mining/construction vehicle, e.g., temporarily stored at the charging station 100. The charging station 100 can connect to two voltage networks and can thereby provide an improved and more reliable charging of the mining/construction vehicle battery.

With reference to Figs. 1a-b, the charging station 100 comprises at least one converter 110 configured to be connected to a first voltage network N1 or a second voltage network N2. The converter 110 may hence be switched between being connected to the first voltage network N1 or the second voltage network N2. The first voltage network N1 and the second voltage network N2 may be alternating current (AC) networks or direct current (DC) networks and may be connected to the same power source S or to different power sources S1, S2, as will be further described below with reference to Figs. 3a-b.

The converter 110 is configured to convert a voltage of the first voltage network N1 to a first charging voltage V_{CH1} or convert a voltage of the second voltage network N2 to a second charging voltage V_{CH2} . With reference to Fig. 1a, when the converter 110 is connected to the first voltage network N1, as indicated with a solid line, the converter 110 converts a voltage of the first voltage network N1 to the first charging voltage V_{CH1} . However, when the converter 110 is connected to the second voltage network N2, the converter 110 converts a voltage of the second voltage network N2 to the second charging voltage V_{CH2} , as shown in Fig. 1b. The charging voltage V_{CH1} , V_{CH2} provided by the charging station 100 may hence depend on which voltage network N1, N2 the converter 110 is connected to. The converter 110 may comprise power electronics configured to perform the conversion and may be an AC/DC converter or a DC/DC converter depending on the current type of the voltage network. Any suitable AC/DC converter and DC/DC converter may be employed in conjunction with the present charging station 100.

The first charging voltage V_{CH1} and the second charging voltage V_{CH2} provided by the converter 100 may have the same charging voltage level or different charging voltage

levels. For example, the converter 110 may provide the same charging voltage independent on whether the converter 110 is connected to the first voltage network N1 or the second voltage network N2. Alternatively, the converter 110 may provide a first charging voltage level when connected to the first voltage network N1 and provide a second charging voltage level different from the first charging voltage when connected to the second voltage network N2. Thus, $V_{CH1} = V_{CH2}$ or $V_{CH1} \neq V_{CH2}$ in embodiments.

The charging station 100 further comprises at least one battery charger 120 connected to the converter 110 and being configured to charge at least one battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} based on a measurement of the first voltage network N1 and a measurement of the battery 130. The measurement of the first voltage network N1 may be a measurement indicating available voltage/current, i.e., the voltage/current that the first voltage network N1 is able to provide for charging. The measurement of the first voltage network N1 may also reflect the characteristic of the available voltage/current. The measurement of the battery 130 on the other hand may be a state-of-charge measurement, i.e., a measurement indicating the current state-of-charge of the battery 130. However, also other battery measurements may be used such as rate-of-charge and charging current.

Based on the measurement of the first voltage network N1 and the measurement of the battery 130, the charging station 100 may hence determine whether the first voltage network N1 has enough capacity to charge the battery 130 or not. For example, a low state-of-charge measurement means that a stronger voltage network is required to charge the battery 130. If the first voltage network N1 is not able to provide the required charging voltage/current, the charging station 100 may determine to switch to the second voltage network N2 such that the converter 110 provides the second charging voltage V_{CH2} .

Thus, in embodiments the input connection of the converter 110 may be configured to switch from the first voltage network N1 to the second voltage network N2, or switch from the second voltage network N2 to the first voltage network N1 based on the herein disclosed parameters. Yet further examples relate to the case when the input connection of the converter 110 is connected to the first voltage network N1 and remain connected to the first voltage network N1 based on the herein disclosed parameters,

or when the input connection of the converter 110 is connected to the second voltage network N2 and remain connected to the second voltage network N2 based on the herein disclosed parameters.

5 With reference to Fig. 2, the charging station 100 may comprise a controller 140 for controlling the converter 110 and the battery charger 120 to charge the battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} . The controller 140 may be configured to obtain measurements of the first voltage network N1 and measurements of the battery 130. The measurements of the first voltage network N1
10 may be provided to the controller 140 from the first voltage network N1 and the measurement of the battery 130 may be provided to the controller 140 from the battery 300, as indicated with dashed lines in Fig. 2. However, the measurement of the first voltage network N1 and/or the measurement of the battery 130 may in embodiments be provided in other ways such as e.g., from a central controller and or control nodes
15 distributed in a system (not shown). Based on the measurements of the first voltage network N1 and the measurements of the battery 130, the controller 140 may connect the converter 110 to the first voltage network N1 to charge the battery 130 with the first charging voltage V_{CH1} or connect the converter 110 to the second voltage network N2 to charge the battery 130 with the second charging voltage V_{CH2} . The controller 140
20 may e.g., control one or more switches of the charging station (not shown in Figs.) to connect the converter 110 to the first voltage network N1 or the second voltage network N2. In embodiments when communication is performed between the controller 140 and other parts/devices/components of the charging station and remote entities any suitable communication protocols and communication interfaces may be used. The
25 communication may be performed using wired and/or wireless communications and be based on standardised communication systems.

In embodiments, the charging station 100 may consider measurements of both the first voltage network N1 and the second voltage network N2 when determining from which
30 network to charge the battery 130. Thus, the charging station 100 may charge the battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} further based on a measurement of the second voltage network N2. In this way, the charging station 100 can ensure that the most suitable voltage network is selected and

that the converter 100 is not switched to a voltage network which is not able to provide the required charging voltage/current.

In embodiments, the charging station 100 may charge the battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} further based on at least one voltage threshold value or a current threshold value. The charging station 100 may e.g., compare a voltage measurement of the first voltage network N1 and/or a voltage measurement of the second voltage network N2 with the voltage threshold value. If the voltage of the first voltage network N1 is below the voltage threshold value and/or the voltage of the second voltage network N2 is equal to or above the voltage threshold value, the charging station 100 may determine to switch from the first voltage network N1 to the second voltage network N2. In a similar way, the current threshold value may be compared to a current measurement of the first voltage network N1 and/or a current measurement of the second voltage network N2.

In embodiments, the at least one voltage threshold value comprises or is equal to zero voltage. Thus, it may be determined whether the first voltage network N1 and/or the second voltage network N2 is energized or not. The charging station 100 may e.g., determine to connect to the second voltage network N2 and charge with the second charging voltage V_{CH2} , if the measurement of the first voltage network N1 indicates zero voltage, i.e., that the first voltage network N1 is not energized and hence cannot provide any charging voltage/current. Naturally, the voltage/current threshold value may be set to other values to suit different applications having different charging requirements. The voltage/current threshold value may also be dependent on the voltage network configuration.

In embodiments, the charging station 100 may charge the battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} further based on any of parameters: a grid tariff, a grid service requirement and a renewable power generation of the first voltage network N1 and/or the second voltage network N2. In other words, the charging station 100 may change from the first voltage network N1 to the second voltage network N2 or vice versa based on characteristics of the first voltage network N1 and/or the second voltage network N2 related to grid tariff, grid service requirement and/or renewable power generation. The grid tariff may indicate the cost of power from

a voltage network, and the charging station 100 may select to use the voltage network providing the lowest cost for charging. The grid service may be related to e.g., frequency support, reactive power etc. and the charging station 100 may select the voltage network supporting a specific grid service for charging. The renewable power generation may influence the stability, the environmental impact and/or the cost of the first voltage network N1 and/or the second voltage network N2. Depending on the renewable power generation, the charging station 100 may e.g., select the voltage network with the smallest or largest portion of renewable power generation.

With reference to Figs. 3a-b, the first voltage network N1 and the second voltage network N2 may be connected to the same power source S or to different power sources S1, S2. In Fig. 3a, the first voltage network N1 and the second voltage network N2 are connected to the same power source S1. The first voltage network N1 and the second voltage network N2 may be connected with an electrical line to the same power source S and/or with separate lines to the same power source S. In Fig. 3b, the first voltage network N1 and the second voltage network N2 are connected to different power sources S1, S2. The first voltage network N1 is thus connected to a first power source S1 and the second voltage network N2 is connected to a second power source S2 different from the first power source S1. The power sources S, S1, S2 may be AC power sources, DC power sources and/or renewable power sources such as e.g., wind or solar power.

In embodiments, the charging station 100 may comprise at least two converters 110, 110' and/or at least two battery chargers 120, 120'. In this way, a respective converter 110, 110' may be connected to a respective voltage network N1, N2. Furthermore, separate converters 110, 110' and/or battery chargers 120, 120' may be used for the first charging voltage V_{CH1} and the second charging voltage V_{CH2} .

Fig. 4 shows the charging station 100 according to an embodiment where the charging station 100 comprise two converters 110, 110' and one battery charger 120. A first converter 110 is configured to be connected to the first voltage network N1 and provide the first charging voltage V_{CH1} and a second converter 110' is configured to be connected to the second voltage network N2 and provide the second charging voltage V_{CH2} . With reference to Fig. 4, the first converter 110 may be configured to be

connected between the first voltage network N1 and the battery charger 120 and the second converter 110' may be configured to be connected between the second voltage network N2 and the battery charger 120. In the shown embodiment, it is assumed that the first converter 110 is connected to the first voltage network N1 and provides the first charging voltage V_{CH1} to the battery charger 120, as indicated with solid lines. The battery 130 is hence charged with the first charging voltage V_{CH1} .

Fig. 5 shows the charging station 100 according to an embodiment where the charging station 100 comprise two converters 110, 110' and two battery chargers 120, 120'. In the embodiment shown in Fig. 5, a first battery charger 120 is configured to be connected to the first converter 110 and charge the battery 130 with the first charging voltage V_{CH1} and a second battery charger 120' is configured to be connected to the second converter 110' and charge the battery 130 with the second charging voltage V_{CH2} . When the first converter 110 is connected to the first voltage network N1, the battery 130 is hence charged with the first charging voltage V_{CH1} by first battery charger 120. When the second converter 110' is connected to the second voltage network N2, the battery 130 is charged with the second charging voltage V_{CH2} by the second battery charger 120'.

Fig. 6 shows the charging station 100 according to an embodiment where the charging station 100 is configured to charge two batteries 130, 130'. In the embodiment shown in Fig. 6, the charging station 100 comprise two converters 110, 110' and two battery chargers 120, 120'. The first battery charger 120 is configured to charge a first battery 130 temporary stored at the charging station 100 and the second battery charger 120' is configured to charge a second battery 130' arranged in a mining/construction vehicle 400. The first battery charger 120 may be connected to the first converter 110 and charge the first battery 130 with the first charging voltage V_{CH1} or connected to the second converter 110' and charge the first battery 130 with the second charging voltage V_{CH2} . The second battery charger 120' may be connected to the first converter 110 and charge the second battery 130' with the first charging voltage V_{CH1} or connected to the second converter 110' and charge the second battery 130' with the second charging voltage V_{CH2} , as indicated in Fig. 6.

In other embodiments (not shown in Figs.), the first battery charger 120 may be connected to the first converter 110 and charge the first battery 130 with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} depending on whether the first converter 110 is connected to the first voltage network N1 or the second voltage network N2. In a similar way, the second battery charger 120' may be connected to the second converter 110' and charge the second battery 130' with the first charging voltage V_{CH1} or the second charging voltage V_{CH2} depending on whether the second converter 110' is connected to the first voltage network N1 or the second voltage network N2. Furthermore, the first battery charger 120 and the second battery charger 120' may be connected to the same converter 110 and each provide the first charging voltage V_{CH1} or the second charging voltage V_{CH2} depending on whether the converter 110 is connected to the first voltage network N1 or the second voltage network N2.

According to embodiments of the disclosure a charging system 300 comprising at least one charging station 100 according to any one of the herein described embodiments is provided. Fig. 7 shows the charging system 300 according to an embodiment where the charging system comprises two charging stations 100, 100', the first voltage network N1, the second voltage network N2, and two batteries 130, 130'. Each battery 130; 130' may be a vehicle battery for a mining/construction vehicle 400. In the shown embodiment, a first battery 130 is arranged stand-alone, i.e., currently not arranged in a mining/construction vehicle 400, and connected to the first charging station 100 for charging. A second battery 130' is arranged in a mining/construction vehicle 400 and is connected to a second charging station 100' for charging. The first battery 130 may e.g., be temporary stored at the first charging station 100 for charging of the first battery 130. When charged the first battery 130 may be swapped with an empty or near empty battery in a mining/construction vehicle 400.

The first charging station 100 and/or the second charging 110' may provide the first charging voltage V_{CH1} or the second charging voltage V_{CH2} based on at least a measurement of the first voltage network N1 and a measurement of the battery 130, 130', as described according to any one of the herein described embodiments.

The mining/construction vehicle 400 may be any type of vehicle used in a mining and/or construction environment/site such as e.g., a drill rig, a truck, a loader, a digging

machine, etc. With reference to Fig. 8, the mining/construction vehicle 400 may e.g., be a drill rig, a loading, hauling and dumping (LHD) machine or a mine truck but is not limited thereto. The mining/construction vehicle 400 may comprise a battery 130 which may be charge by the charging station 100 according to any of the herein described
5 embodiments. The mining/construction vehicle 400 may be an electrified mining/construction vehicle.

According to an aspect of the disclosure a method 200 for charging mining/construction vehicle batteries is provided. The method 200 may be performed by the charging
10 station 100 according to any of the herein described embodiments. Fig. 9 shows a flow chart of the method 200. The method 200 comprises converting 202 a voltage of the first voltage network N1 to a first charging voltage V_{CH1} or converting a voltage of the second voltage network N2 to a second charging voltage V_{CH2} . The method 200 further comprises charging 204 at least one battery 130 with the first charging voltage V_{CH1} or
15 the second charging voltage V_{CH2} based on a measurement of the first voltage network N1 and a measurement of the battery 130.

According to embodiments of the disclosure, the charging station 100 may comprise or be connected to a control unit arranged to control the charging station 100 to carry
20 out one or more of the steps of the method 200. The control unit may hence be arranged/configured/programmed with instruction to control the charging station 100 to perform the steps of any of the herein described embodiments. The control unit may be the same device as the previously mentioned controller 140 or a stand-alone device.

25 Finally, it should be understood that the disclosure is not limited to the embodiments described above, but also relates to and incorporates all embodiments within the scope of the appended independent claims.

CLAIMS

1. A charging station (100) for charging mining/construction vehicle batteries, the charging station (100) comprising:

5 at least one converter (110) configured to be connected to a first voltage network (N1) or a second voltage network (N2) and convert a voltage of the first voltage network (N1) to a first charging voltage (V_{CH1}) or convert a voltage of the second voltage network (N2) to a second charging voltage (V_{CH2}); and

10 at least one battery charger (120) connected to the converter (110) and being configured to charge at least one battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) based on a measurement of the first voltage network (N1) and/or a measurement of the battery (130).

2. The charging station (100) according to claim 1, configured to:

15 charge the battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) further based on a measurement of the second voltage network (N2).

3. The charging station (100) according to claim 1 or 2, configured to:

20 charge the battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) further based on at least one voltage threshold value or a charging current threshold value.

4. The charging station (100) according to claim, wherein the at least one voltage
25 threshold value comprises zero voltage.

5. The charging station (100) according to any one of the preceding claims, wherein the measurement of the battery (130) is a state-of-charge measurement.

30 6. The charging station (100) according to any one of the preceding claims, configured to:

 charge the battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) further based on any of a grid tariff, a grid service requirement

and a change in renewable power generation of the first voltage network (N1) and/or the second voltage network (N2).

7. The charging station (100) according to any one of the preceding claims, comprising:

5 at least two converters (110, 110'), wherein a first converter (110) is configured to be connected to the first voltage network (N1) and provide the first charging voltage (V_{CH1}) and a second converter (110') is configured to be connected to the second voltage network (N2) and provide the second charging voltage (V_{CH2}).

10 8. The charging station (100) according to claim 7, wherein the first converter (110) is configured to be connected between the first voltage network (N1) and the battery charger (120) and the second converter (110') is configured to be connected between the second voltage network (N2) and the battery charger (120).

15 9. The charging station (100) according to claim 7, comprising:

at least two battery chargers (120, 120'), wherein a first battery charger (120) is configured to be connected to the first converter (110) and charge the battery (130) with the first charging voltage (V_{CH1}) and a second battery charger (120') is configured to be connected to the second converter (110') and charge the battery (130) with the
20 second charging voltage (V_{CH2}).

10. The charging station (100) according to claim 9, wherein the first battery charger (120) is configured to charge a first battery (130) temporarily stored at the charging station (100) and the second battery charger (120') is configured to charge a second
25 battery (130') arranged in a mining/construction vehicle (400).

11. The charging station (100) according to any one of the preceding claims, wherein the first voltage network (N1) and the second voltage network (N2) are connected to the same power source (S1) or to different power sources (S1, S2).

30 12. The charging station (100) according to any one of the preceding claims, wherein the first voltage network (N1) and the second voltage network (N2) are AC networks or DC networks.

13. A charging system (300) comprising at least one charging station (100) according to any one of the preceding claims, a first voltage network (N1), a second voltage network (N2), and at least one battery (130).

5 14. The charging system (300) according to claim 13, wherein the battery (130) is a vehicle battery for a mining/construction vehicle.

15. A method (200) for charging mining/construction vehicle batteries, the method (200) comprising:

10 converting (202) a voltage of the first voltage network (N1) to a first charging voltage (V_{CH1}) or converting a voltage of the second voltage network (N2) to a second charging voltage (V_{CH2}); and

charging (204) at least one battery (130) with the first charging voltage (V_{CH1}) or the second charging voltage (V_{CH2}) based on a measurement of the first voltage
15 network (N1) and/or a measurement of the battery (130).

16. A computer program with a program code for performing a method according to claim 15 when the computer program runs on a computer.

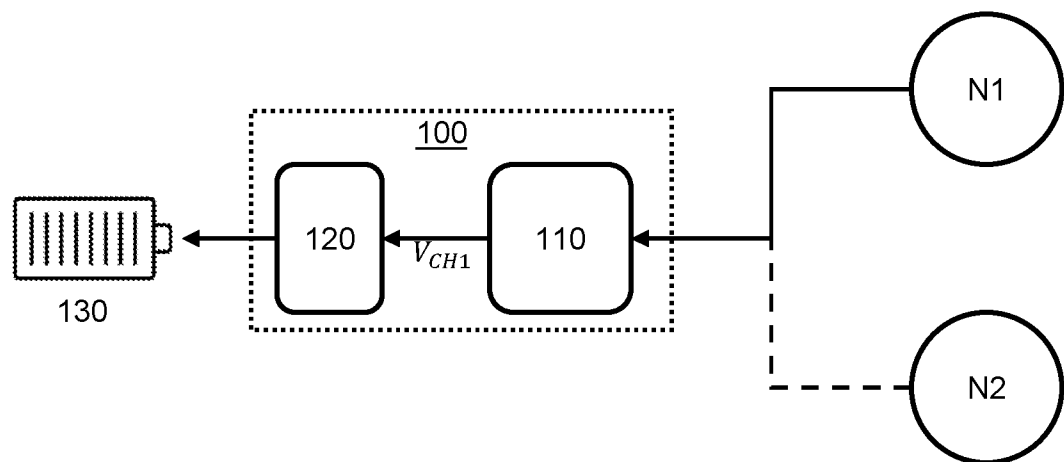


Fig. 1a

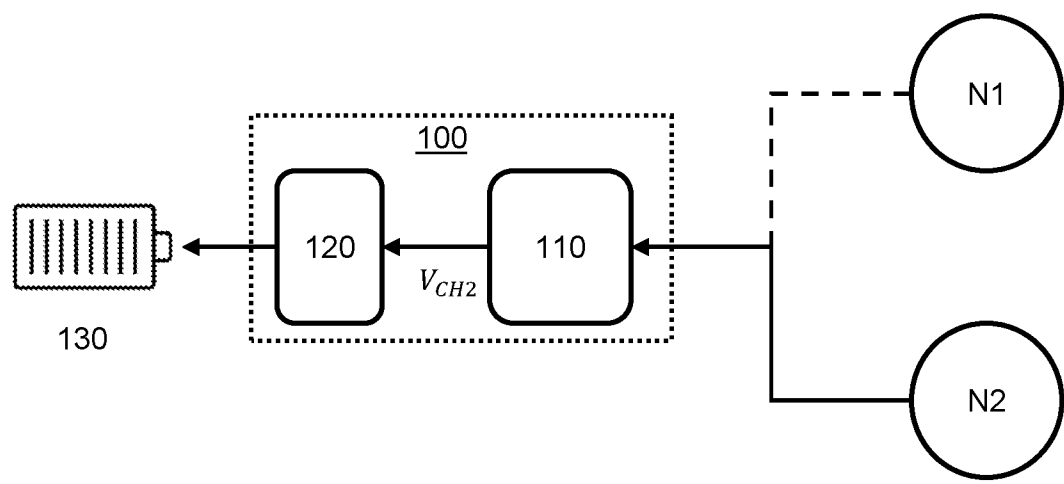


Fig. 1b

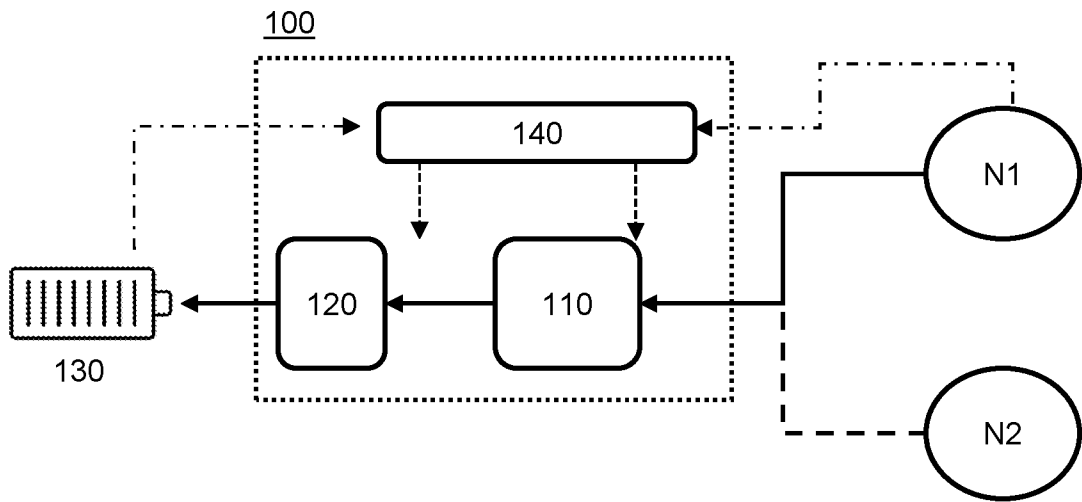


Fig. 2

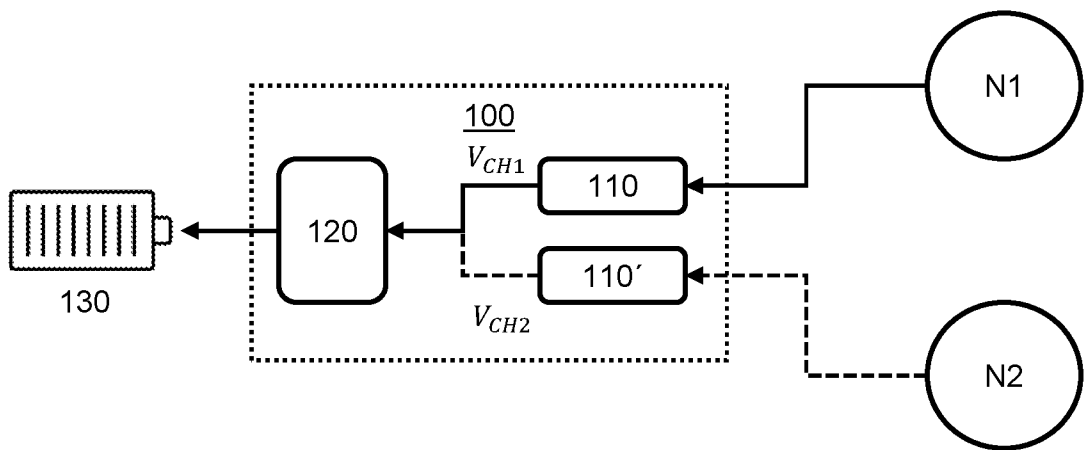


Fig. 4

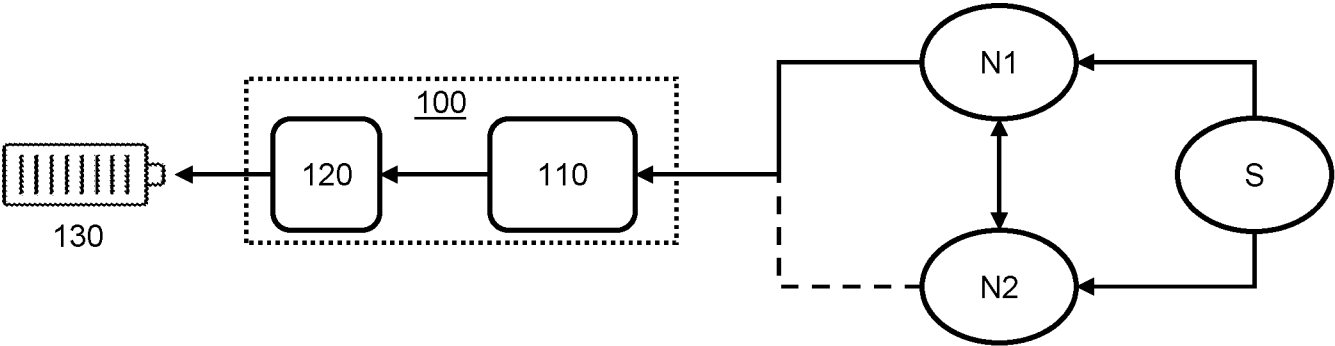


Fig. 3a

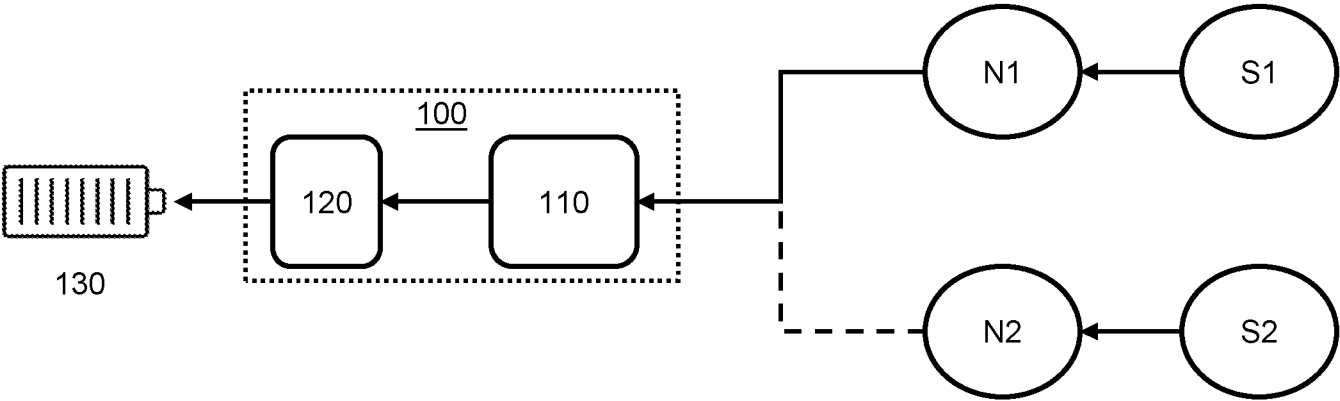


Fig. 3b

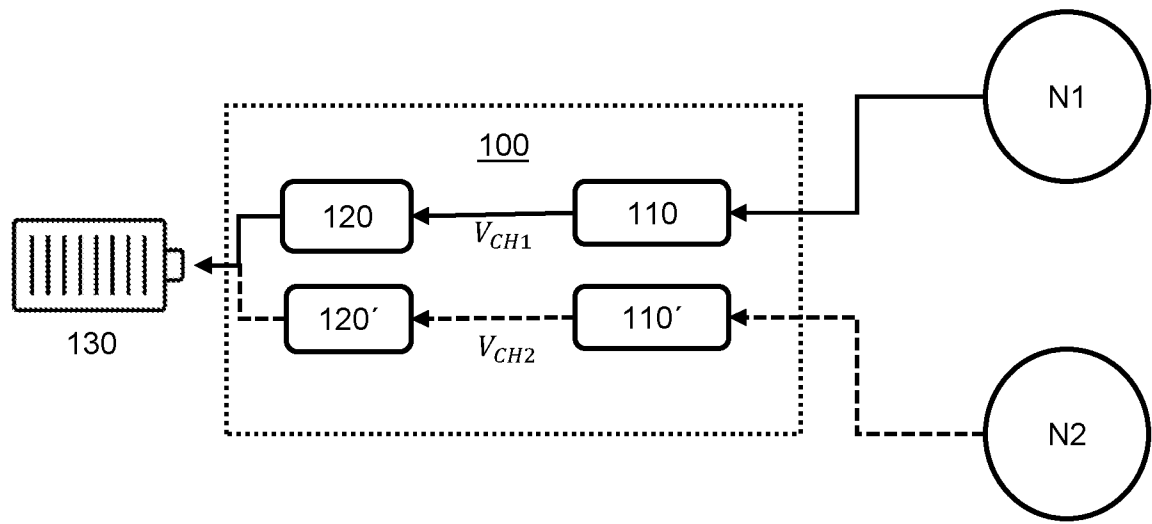


Fig. 5

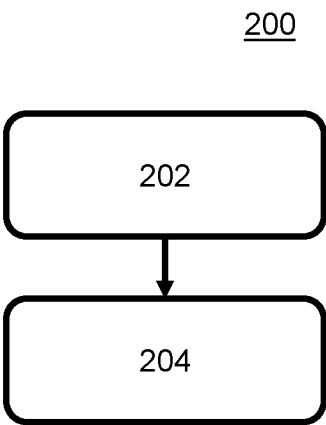


Fig. 9

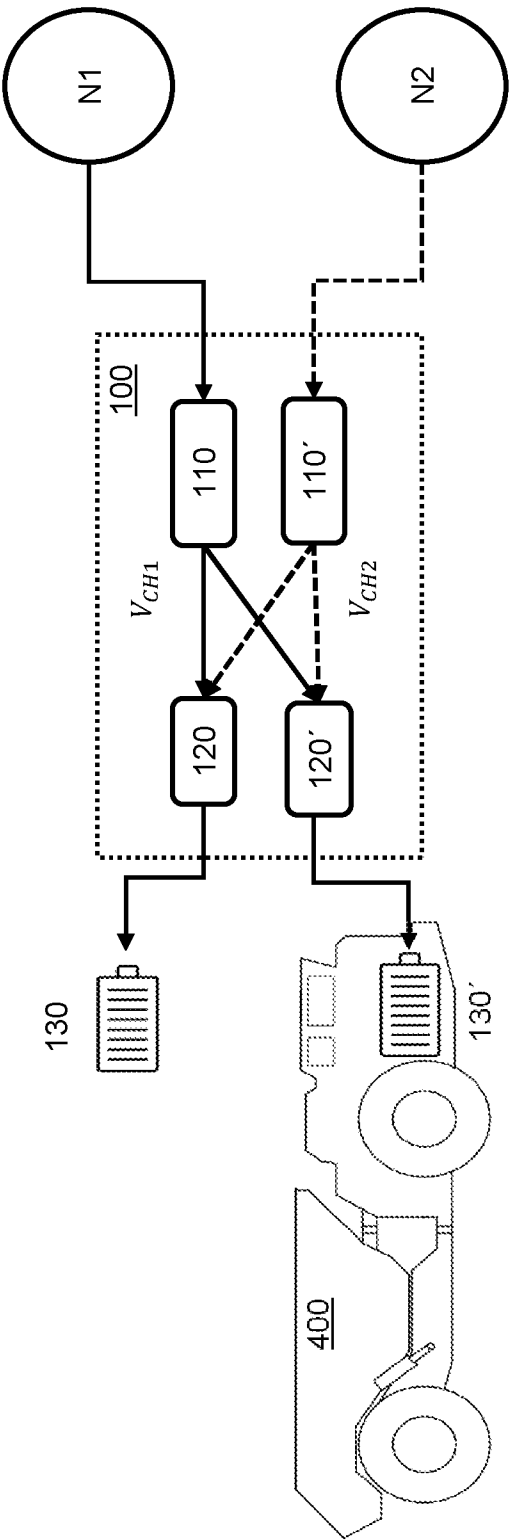


Fig. 6

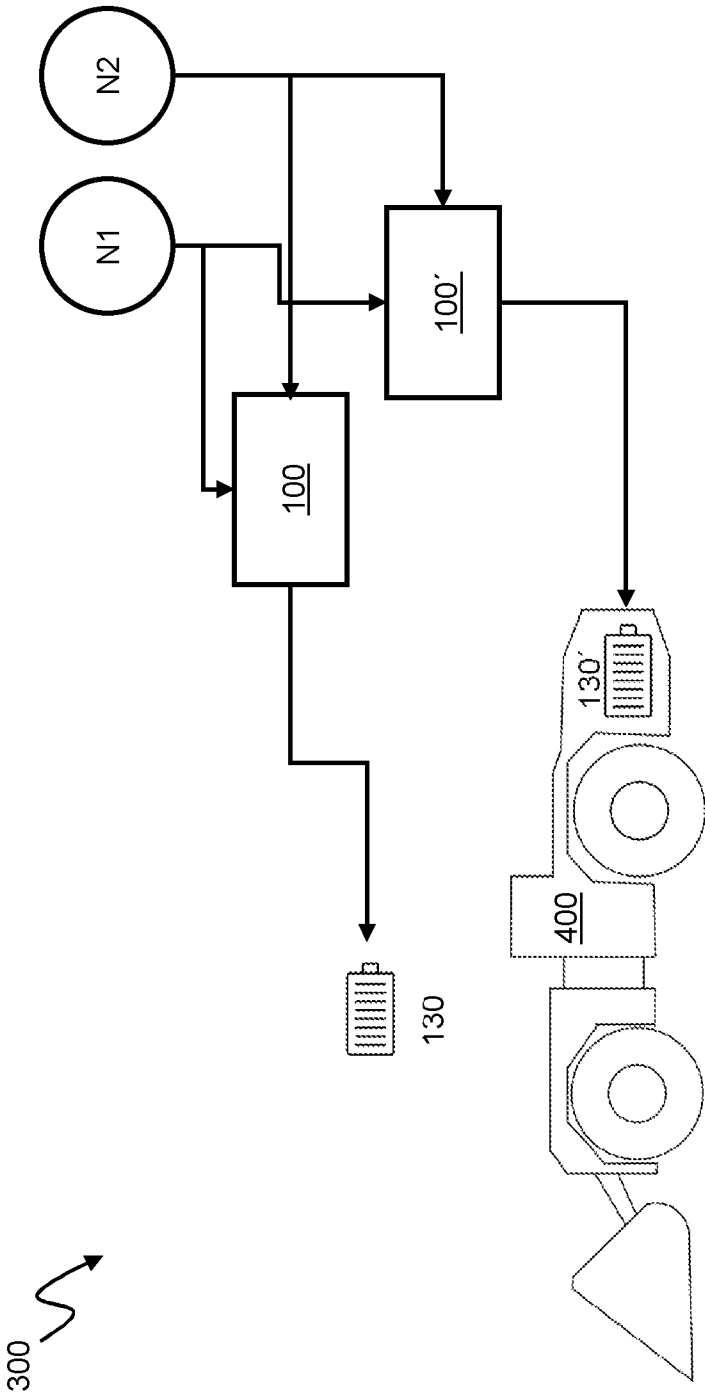


Fig. 7

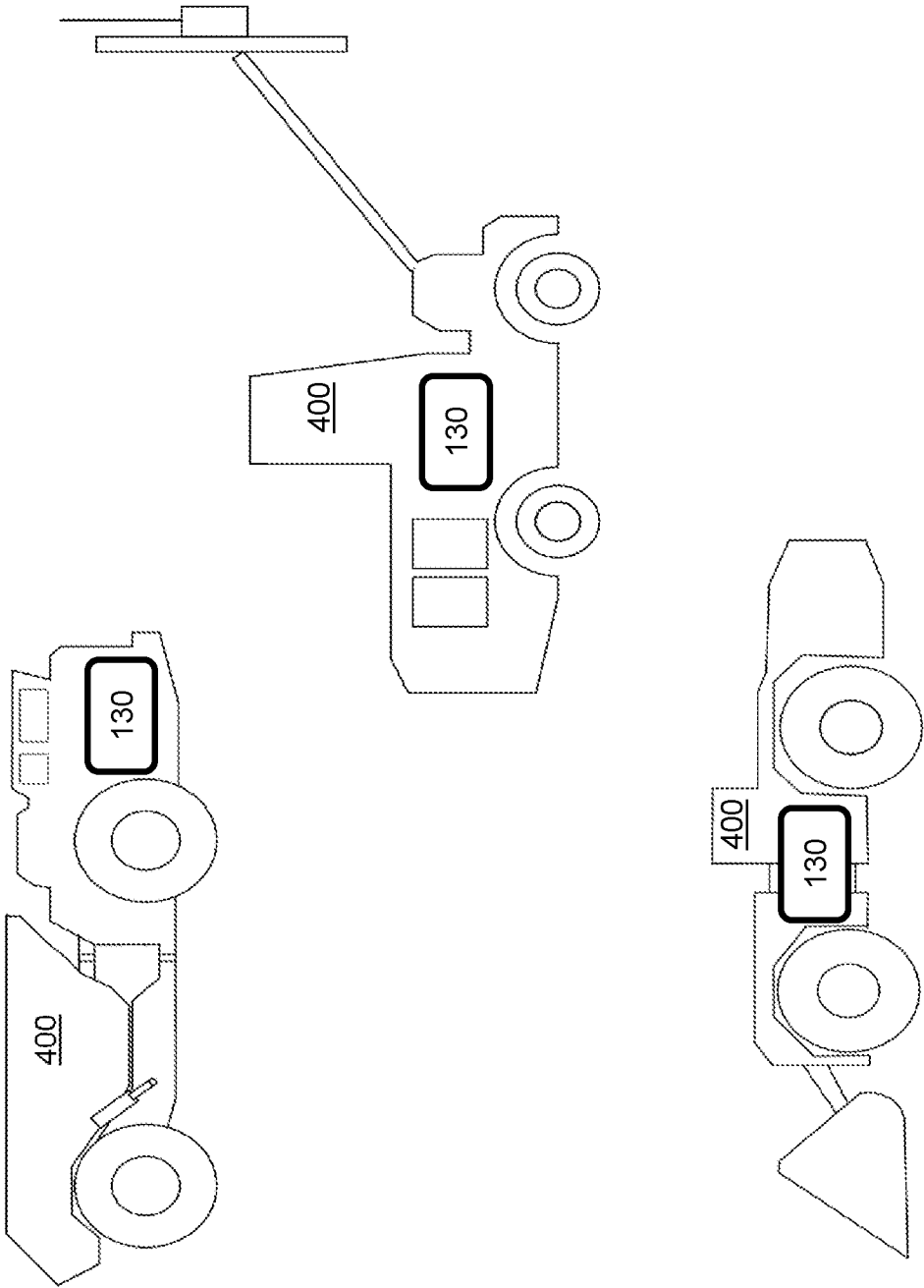


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2024/050002

A. CLASSIFICATION OF SUBJECT MATTER INV. H02J7/00 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) 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 practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 2022 224 574 A1 (AMPLY POWER INC [US]) 5 October 2023 (2023-10-05) paragraph [0003] paragraph [0021] - paragraph [0054] figures 1-5 -----	1-16
X	US 2023/033955 A1 (SEROFF NICHOLAS [US] ET AL) 2 February 2023 (2023-02-02) paragraph [0023] - paragraph [0057]; figures 1-5 -----	1,4-11, 15,16
A	US 2023/356607 A1 (MCALWEE GERALD STEVEN [US] ET AL) 9 November 2023 (2023-11-09) paragraph [0041] - paragraph [0083]; figures 1-12 ----- -/-	1-16
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 25 June 2024		Date of mailing of the international search report 09/07/2024
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Dudoignon, David

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2024/050002

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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