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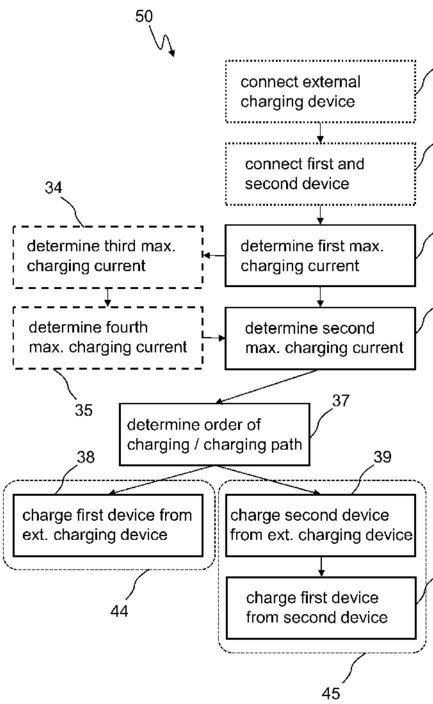

Fig. 4

(57) Abstract: A computer-implemented method for managing a charging of an aerosol-generating system with electrical energy by an external charging device, wherein the aerosol-generating system comprises a first device and a second device, wherein each device includes an energy storage for storing electrical energy, wherein the second device is removably electrically interconnected to the external charging device, and wherein the first device and the second device are removably electrically interconnected to each other, the method comprising: determining a first maximum charging current providable by the external charging device, determining a second maximum charging current providable from the energy storage of the second device to the energy storage of the first device, determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents, and, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, selecting either a first charging path, including charging the first device from the external charging device via the second device, or a second charging path, including charging the second device from the external charging device and then charging the first device from the second device.

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IMPROVED MANAGING OF A CHARGING OF AN AEROSOL-GENERATING SYSTEM

The present disclosure relates to a computer-implemented method for managing a charging of an aerosol-generating system with electrical energy by an external charging device. The present disclosure further relates to an aerosol-generating system, an aerosol-generating device, a companion device configured to charge an aerosol-generating device with electrical energy, a computer program and a non-transitory computer-readable medium having computer instructions recorded thereon to execute the method.

Aerosol-generating devices are typically designed as handheld devices that can be used by a user for consuming or experiencing, for instance in one or more usage sessions, aerosol generated from an aerosol-generating substrate or an aerosol-generating article, for example by heating. The aerosol-generating devices the present disclosure pertains to are commonly referred to as heated tobacco products (HTP), heat-not-burn devices, electronic cigarettes and/or vaporisers.

Exemplary aerosol-generating substrates can comprise solid substrate material, such as tobacco material or tobacco cast leaves (TCL) material. The substrate material can, for example, be assembled, often with other elements or components, to form a substantially stick-shaped aerosol-generating article. Such a stick or aerosol-generating article can be configured in shape and size to be inserted at least partially into the aerosol-generating device. The aerosol-generating device may comprise a heating element or heater device for heating the aerosol-generating article and/or the aerosol-generating substrate. The heating element or heater device may be part of the aerosol-generating article and/or the aerosol-generating device. Alternatively or additionally, aerosol-generating substrates can comprise one or more liquids and/or solids, which can, for example, be supplied to the aerosol-generating device in the form of a capsule, cartridge or container. Corresponding exemplary aerosol-generating articles can, for example, comprise a cartridge containing or fillable with the liquid and/or solid substrate, which can be vaporized during aerosol consumption by the user based on heating the substrate and/or liquid. Usually, such cartridge or container can be coupled to, attached to or at least partially inserted into the aerosol-generating device. Alternatively, the cartridge may be fixedly mounted to the aerosol-generating device and refilled by inserting liquid and/or solid into the cartridge. The aerosol generated from the aerosol-generating substrate or article may comprise or include one or more of nicotine, aroma, sugar, moisturising agent, preservative, flavouring, for example cocoa, liquorice, botanicals, menthol and lactic acid or other additives.

For generating the aerosol during use or consumption, heat can be supplied by a heating element, heater device or heat source to heat at least a portion or part of the aerosol-generating substrate. The heating element, heater device or heat source can be arranged in the handheld device or a handheld part of the aerosol-generating device. Alternatively or additionally, at least a part of or the entire heating element or heater device or heat source can be fixedly associated with or arranged within an aerosol-generating article, for instance in the form of a stick or cartridge, which can be attached to and/or powered by the handheld device or handheld part of the aerosol-generating device.

Exemplary heating elements or heater devices can be based on one or more of resistive heating, inductive heating, dielectric heating and microwave heating using electrical energy supplied via, drawn from or stored in a battery of the aerosol-generating device. As used herein, a battery of the aerosol-generating device can generally refer to an energy storage of the aerosol-generating device configured to store electrical energy. Accordingly, the term energy storage can include one or more batteries, one or more capacitors, one or more accumulators or other types of energy storage. Also, any reference to a battery herein can include a plurality of batteries or a battery pack.

Typically, aerosol-generating devices comprise an energy storage, for example a battery, providing the electrical energy needed to operate the aerosol-generating device and especially for heating the aerosol-generating substrate and/or article, for example to generate aerosol in one or more usage sessions using one or more aerosol-generating articles. The battery may, for example, be a lithium-ion battery.

As used herein, a usage session may refer to a period of time, during which a user may use the device to generate, consume, experience or inhale aerosol using the aerosol-generating device. Therein, a usage session may be finite. In other words, a usage session may have a start, an end and a duration. The duration of the usage session as measured by time may be influenced by use during the usage session. The duration of the usage session may have a maximum duration determined by a maximum time from the start of the usage session. The duration of the usage session may be less than the maximum time if one or more monitored parameters reaches a predetermined threshold before the maximum time from the start of the usage session. By way of example, the one or more monitored parameters may comprise one or more of: i) a cumulative puff count of a series of puffs drawn by a user since the start of the usage session, and ii) a cumulative volume of aerosol evolved from the aerosol-forming substrate since the start of the usage session. Typically, the heating of the aerosol-forming substrate or article during usage sessions may consume the most part of the energy that is provided by the energy storage or battery of the aerosol-generating device. Therefore, the activity of the heater and/or the usage sessions, for example the length, frequency and intensity of the usage sessions, may be monitored and considered in energy storage management or battery management to increase the number of usage sessions that can be provided before a recharging of the energy storage or battery is necessary.

An aerosol-generating system may comprise two devices, for example one aerosol-generating device and a companion device configured to charge the aerosol-generating device with electrical energy. When not in use, the aerosol-generating device may be stored in and/or in electrical connection to the companion device, so that the aerosol-generating device may be charged with electrical energy by the companion device. Additionally, the companion device may be connected to an external power source, which may be used to charge the aerosol-generating device and/or the companion device.

An energy storage capacity or battery capacity may typically be chosen so that the aerosol-generating device may provide a user with at least a minimum number, for example at least two or more, consecutive usage sessions or experiences without having to recharge the battery or the aerosol-generating device in between. To improve user experience, aerosol-generating devices may usually be designed to only allow a user to start a usage session if the battery contains enough electrical energy to fully complete the usage session. When the energy storage of the aerosol-generating device is too empty to provide one full usage session to the user, the user may not be able to use the device again until the device has been recharged. The duration of this recharging of the device, for example the time it takes to recharge the device so that at least one usage session may be provided, may have a major impact on the downtime of the device and therefore can provide for a negative user experience where the user is forced to wait.

It may therefore be desirable to provide an improved energy storage management of an aerosol-generating system. For example, it may be desirable to minimize the time needed to recharge the aerosol-generating device until at least one or more usage session(s) may be provided to the user.

These advantages may be achieved by the features described herein.

According to an aspect of the present invention, there is provided a computer-implemented method for managing a charging of an aerosol-generating system with electrical energy by an external charging device, wherein the aerosol-generating system comprises a first device and a second device, wherein each device includes an energy storage for storing electrical energy, wherein the second device is removably electrically interconnected to the external charging device, and wherein the first device and the second device are removably electrically interconnected to each other, the method comprising: determining a first maximum charging current providable by the external charging device, determining a second maximum charging current providable from the energy storage of the second device to the energy storage of the first device, determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents, and, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, selecting either a first charging path, including charging the first device from the external charging device via the second device, or a second charging path, including charging the second device from the external charging device and then charging the first device from the second device.

The charging of the aerosol-generating system with electrical energy may pertain to recharging the energy storage of at least one or both of the first device and the second device.

Specifically, during this charging, electrical energy may be provided by the external charging device to at least one of the energy storage of the first device and the second device. Charging the first and or second device from the external charging device may be simultaneous or sequential. The first device and the second device may be an aerosol-generating device and a companion device configured to charge the aerosol-generating device with electrical energy. The first device and the second device may alternatively be two aerosol-generating devices or two companion devices. Each of the first and second devices may include an energy storage for storing electrical energy, for example a lithium-ion battery or battery pack.

That the second device is removably electrically interconnected to the external charging device may mean that the second device is connected to the external charging device, for example in a way to be able to receive electrical energy from the external charging device. For instance, the second device may be electrically connected to the external charging device through a wired or a wireless electrical connection, as described in more detail below. The second device may not have to be directly connected to the external charging device, however. For example, the second device may also be removably electrically interconnected to the external charging device via the first device. In this case, the first device may provide an electrical connection or an electrical link between the external charging device and the second device. However, the present disclosure also comprises the case in which the second device is directly removably electrically interconnected to the external charging device, for example without the first device acting as an intermediary. A removable electrical interconnection may mean that the connection or interconnection is non-permanent and may be established and detached, for example by a user. The second device may therefore be charged directly by the external charging device. However, also the first device may be directly charged by the external charging device, for example via the second device. In this case, the second device may simply act as an electrical connector between the external charging device and the first device. The second device may, in this case, be configured to simply pass through the electrical energy from the external charging device to the first device. Similarly, that the first device and the second device are removably electrically interconnected to each other may mean that the first device and the second device may be electrically connected in a way that allows transfer of electrical energy from one to the other, particularly at least from the second device to the first device. The method according to an aspect of the present disclosure may be performed on an aerosol-generating system configured as described above.

The method according to the present disclosure comprises the step of determining a first maximum charging current provided or providable by the external charging device. The first maximum charging current may represent the highest current available for charging the aerosol-generating system directly from the external charging device, meaning either the first device and/or the second device. Further, the method according to the present disclosure comprises the step of determining a second maximum charging current provided or providable from the energy storage of the second device to the energy storage of the first device. The second maximum charging current may represent the highest current available for charging the first device directly from the second device. The time necessary for recharging the energy storage of one of the first and the second devices may be indirectly proportional to the charging current. A higher charging current may lead to less time necessary for recharging the energy storage by a specific amount, for example by a specific capacity. The first maximum charging current and the second maximum charging current may depend on the type of external charging device and on the type of second device, respectively. The first and/or the second maximum charging current may vary over time, for example due to aging of the energy storage of the first and/or second device. Also, environmental factors such as temperature or humidity may influence the first and/or the second maximum charging current. Therefore, the method may include determining the present first and/or second maximum charging current. In this case, the method may use the value of the first and/or the second maximum charging current that is currently available. The method may alternatively include choosing a value of the first and/or the second maximum charging current from different values during a predetermined time window, for example, the maximal value, the maximal value minus a percentage, an average value, a median value, a lowest value, a lowest value plus a percentage or a randomly chosen value from the predetermined time window, or another representative value of the available charging currents from the predetermined time window. The predetermined time window may, for example, be between 1 to 60 minutes or between 1 to 24 hours or between 1 to 31 days or between 1 to 12 months. For example, the predetermined time window may be the entire lifetime of the device and/or the energy storage. The percentage mentioned above may, for example, be between 1 % to 5 % or between 5 % and 10 % or between 10 % and 20 % or between 20 % and 30 %. The percentage may refer to a percentage of the value in question.

Thus, the further step of the method according to the present disclosure of determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents may comprise comparing the first and second maximum charging currents, for example the magnitude of the first and second maximum charging currents. This step may therefore comprise determining which of the first and the second maximum charging current is higher or has the greater magnitude. The charging current which is higher or has the greater magnitude may be able to recharge an energy storage of the first and/or the second device faster than the charging current which is lower or has the smaller magnitude.

One of the aims of the present disclosure may be to recharge the first device at least so much that the first device is able to provide at least one or more usage session(s) to the user. In the case that the first device is an aerosol-generating device, this may mean that the energy storage of the aerosol-generating device as first device is recharged at least so much that the aerosol-generating device may be operated to generate aerosol from an aerosol-generating substrate or article in a usage session. In the case that the first device is a companion device configured to charge an aerosol-generating device with electrical energy, the first device being able to provide at least one usage session to the user may mean that the energy storage of the companion device has enough capacity to recharge the energy storage of an aerosol-generating device so that the aerosol-generating device may be operated to generate aerosol from an aerosol-generating substrate or article in the one or more usage session(s). Being able to provide at least one or more usage sessions to the user may therefore apply to both aerosol-generating devices and companion devices for their respective functions.

As mentioned, one of the aims of the present disclosure may be to recharge the first device at least so much that the first device is able to provide at least one or more usage sessions to the user. Depending on the first maximum charging current and the second maximum charging current, it may be quicker to recharge the first device directly from the external charging device or it may be quicker to first recharge the second device directly from the external charging device and then charge the first device from the second device.

Therefore, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, the method according to the present disclosure comprises selecting either a first charging path or a second charging path. The selection of either the first charging path or the second charging path may therefore depend on the result of the comparison between the magnitudes of the first and second maximum charging currents. The first charging path includes charging the first device from the external charging device via the second device. In the first charging path, the second device may be configured to pass through the electrical energy from the external charging device to the first device. In other words, in the first charging path, the first device may be charged directly from the external charging device, preferably the second device only providing the electrical connection or interconnection between the external charging device and the first device. In the first charging path, the first device may therefore be charged from the external charging device without first charging the second device. In contrast, the second charging path includes charging the second device from the external charging device and then charging the first device from the second device. The second charging path may therefore include a chronology or sequence of charging, in which the second device may be charged before the first device. Additionally, the second device may be charged directly from the external charging device, while the first device may be charged from the second device. The first device may be charged after the second device. The choice or selection between the first charging path and the second charging path may therefore determine which of the first device and the second device is charged or charged first by the external charging device. The first charging path may only or exclusively include the step of charging the first device from the external charging device. The first charging path, conversely, may include a step of charging the second device from the external charging device and may then include a further step of charging the first device from the second device. It is noted that in the present disclosure, selecting either the first charging path or the second charging path also means that the actual charging steps comprised in the first charging path and the second path, respectively, are also included as actual steps of the method according to the present disclosure. The method therefore does not end after a purely theoretical selecting step, but also includes the charging steps described by the respective first or second charging paths.

For example, it may be provided that the first charging path is chosen in case the first maximum charging current is greater than or equal to the second maximum charging current. When the first maximum charging current, meaning the maximum charging current providable by the external charging device, has a greater magnitude than the second maximum charging current, meaning the maximum charging current providable from the second device to the first device, it may always be the quickest way of recharging the first device so that the first device is able to provide at least one usage session to the user by directly recharging the first device from or by the external charging device. In other words, in this case, it may always be the quickest way of recharging the first device in this way by selecting the first charging path.

Typically, in the background art, when an external charging device is connected to an aerosol-generating system, the first charging path may be selected by default. In other words, in the background art, in a configuration of the aerosol-generating system as outlined above, there may only be the first charging path. The first device may therefore always be charged directly by the external charging device without considering the magnitudes of the first maximum charging current and the second maximum charging current. One aspect of the invention according to the present disclosure therefore lies in the fact that a second charging path may be provided and that a determination may be provided that objectively judges which of the first or the second charging paths may be the ideal charging path for the situation in question. Such a differentiation is not known in the background art.

In the case that the first maximum charging current is smaller than the second maximum charging current, the second charging path may be chosen. In this case, it may be quicker to first recharge the second device from or by the external charging device and then charge the first device from or by the second device. However, the present disclosure provides an even more refined differentiation, as there may be cases in which the first charging path may be more ideal than the second charging path even when the first maximum charging current is smaller than the second maximum charging current. This is explained in more detail below.

Apart from the first and second maximum charging currents, the method according to the present disclosure may also take the present or remaining capacities of the energy storages of the first and second devices into account. The present or remaining capacities of the energy storages of the first and second devices may pertain to the capacities in the respective energy storages at the start of the method, before the charging begins. In conjunction with a target capacity of the energy storage of the first device, this may result in an information about how much capacity has to be recharged in the first device to reach the target capacity. Simultaneously, this may result in information about how much capacity the second device may be able to provide to the first device or how much capacity the second device lacks to be able to recharge the first device to the target capacity.

The method according to the present disclosure may therefore comprise determining a capacity of the energy storage of the first device, determining a capacity of the energy storage of the second device and determining a target energy storage capacity of the first device. Methods for determining the capacity of an energy storage have been described by the applicant for example in International Patent Application No. PCT/CN2023/073320 and Armenian Patent Application No. AM20230047. These prior applications of the applicant are therefore incorporated into the present disclosure in their entirety. In particular, the methods described in the mentioned applications provide for an accurate determination of capacity taking the aging of the energy storage into account. They therefore lead to highly precise values increasing performance of the method according to the present disclosure. The capacities of the energy storages of the first and second devices may pertain to a current or present or remaining capacity of the respective energy storage, for example before being recharged according to the present disclosure. The capacities may, for example, be given in absolute values, for example in the unit ampere-hours (Ah). Alternatively, the capacities may also be given as a relative value, for example as a state of charge (SOC) of the respective energy storage, or by another value that expresses the capacity of the energy storage. The state of charge may be defined as the current or present capacity of the energy storage divided by the maximum or original or nominal capacity of the energy storage. The capacities of the energy storages of the first device and of the second device may be limited to a capacity that is actually available for use. For example, the energy storages of the first device and the second device may each be configured to stop discharging at a minimal capacity value, for example to avoid accelerated aging or damaging of the energy storage, or to preserve some basic functionality of the respective device, for example to allow a status indication or presentation of other information to the user. This may also be achieved by a corresponding configuration of the controller or processing circuitry of the respective device. Thus, the capacities of the energy storages may be limited to capacity values that are available for use or discharge.

The target energy storage capacity of the first device according to the present disclosure may represent the capacity value to which the first device is to be recharged as quickly as possible. The target energy storage capacity may therefore be an energy storage capacity necessary to provide a user with at least one usage session or at least two usage sessions or at least three usage sessions or more. As outlined previously, this may be a capacity of an aerosol-generating device necessary for generating aerosol in one or more usage session(s), or this may be a capacity of a companion device necessary for recharging an aerosol-generating device so that the aerosol-generating device has enough capacity for generating aerosol in one or more usage session(s).

When these capacity values are determined, the step of determining which one of the first charging path and the second charging path is chosen may include determining a time necessary to reach the target energy storage capacity in the first device by the first charging path and by the second charging path. As the mentioned time depends on a plurality of internal and external factors, for example environmental factors like the ambient temperature, an exact value may not be achievable. However, the method according to the present invention may be implemented with estimated values.

The time T_1 or an estimation of the time T_1 necessary to reach the target energy storage capacity in the first device by the first charging path may, for example, be calculated by the following formula:

$$T_1 = (Q_T - Q_1)/I_{E1} \qquad (1)$$

Wherein:

T_1 may be the time necessary to reach the target energy storage capacity in the first device by the first charging path;

Q_T may be the target energy storage capacity of the first device, for example in Ah;

Q_1 may be the present or current or remaining capacity of the energy storage of the first device, for example in Ah; and

I_{E1} may be the maximum charging current providable by the external charging device to the first device, for example the first maximum charging current as explained above or the third maximum charging current as explained below, for example in A.

Formula (1) may provide the time T_1 that is necessary to recharge the first device up to the target energy storage capacity Q_T by directly charging the first device from the external charging device. The remaining capacity Q_1 of the first device before charging may be taken into account.

The time T_2 or an estimation of the time T_2 necessary to reach a target energy storage capacity in the first device by the second charging path may, for example, be calculated by the following formula:

$$T_2 = (Q_T - Q_2)/I_{E2} + (Q_T - Q_1)/I_{21} \qquad (2)$$

Wherein:

T_2 may be the time necessary to reach a target energy storage capacity in the first device by the second charging path;

Q_2 may be the present or current or remaining capacity of the energy storage of the second device, for example in Ah;

I_{E2} may be the maximum charging current providable by the external charging device to the second device, for example the first maximum charging current as explained above or the fourth maximum charging current as explained below, for example in A;

I_{21} may be the maximum charging current providable from the energy storage of the second device to the energy storage of the first device, for example the second maximum charging current as explained herein, for example in A; and

Q_T and Q_1 may be defined as in formula (1).

The first summand in formula (2) may calculate the time that is necessary to recharge the second device up to the target energy storage capacity Q_T from the external charging device, taking the remaining capacity Q_2 of the second device into account. The second summand in formula (2) may calculate the time that is necessary to recharge the first device up to the target energy storage capacity Q_T by charging the first device from or by the second device. The second summand may also take the remaining capacity Q_1 of the energy storage of the first device into account. The time T_2 may then be calculated by adding the times resulting from the two summands.

Formula (2) may therefore provide the time that is necessary to first charge the second device up to the target energy storage capacity from the external charging device and then charging the first device up to the target energy storage capacity from the second device. Therefore, this result may represent the time necessary to reach the target energy storage capacity in the first device by the second charging path.

An alternative way of calculating time T_2 or an estimation of the time T_2 necessary to reach a target energy storage capacity in the first device by the second charging path may, for example, be given by the following formula:

$$T_2 = (Q_T - Q_2 - Q_1)/I_{E2} + (Q_T - Q_1)/I_{21} \qquad (3)$$

Wherein:

T_2, Q_2, I_{E2}, and I_{21} may be defined as in formula (2); and

Q_T and Q_1 may be defined as in formula (1).

The calculation according to formula (3) may be similar to the one in formula (2), with the exception that in the first summand, the present or current or remaining capacity Q_1 of the energy storage of the first device may also be taken into account. The first summand therefore may not represent the time necessary to recharge the second device up to the target energy storage capacity Q_T from the external charging device, but only the time that is necessary to recharge the second device up to a capacity level that is necessary to provide the first device with the amount of capacity that the first device lies below the target energy storage capacity Q_T. In other words, formula (3) may take into account that the second device may not need to be recharged to the full target energy storage capacity Q_T. Accordingly, additional time may be saved by only recharging the second device up to a capacity that is needed to bring the first device up to the target energy storage capacity Q_T. Therefore, the result of formula (3) may represent the time necessary to reach the target energy storage capacity in the first device by the second charging path.

Another alternative way of calculating time T_2 or an estimation of the time T_2 necessary to reach a target energy storage capacity in the first device by the second charging path may, for example, be given by the following formula:

$$T_2 = (Q_{T2} - Q_2 - Q_{21})/I_{E2} + (Q_{T1} - Q_1)/I_{21} \qquad (4)$$

Wherein:

Q_{T1} may be the target energy storage capacity of the first device, for example in Ah;

Q_{T2} may be the target energy storage capacity of the second device necessary to recharge the first device to the target energy storage capacity of the first device Q_{T1}, for example in Ah;

Q_{21} may be the capacity of the second device necessary to recharge the first device to a capacity that equals the current or present or remaining capacity Q_1 of the first device, for example in Ah;

T_2, Q_2, I_{E2}, and I_{21} may be defined as in formula (2); and

Q_1 may be defined as in formula (1).

The calculation according to formula (4) may be similar to the one in formula (3), with the exception that formula (4) may take into account that there may be losses when transferring electrical energy from the second device to the first device. Therefore, a capacity discharged from the energy storage of the second device may not be the same capacity as gained at the energy storage of the first device when charging the first device from or by the second device. In particular, the capacity discharged from the energy storage of the second device may be greater than the one gained at the first device. This may be taken into account in formula (4) by providing different target capacities for the second device and for the first device. The target energy storage capacity Q_{T1} of the first device may, for example, be the same as the target energy storage capacity Q_T as previously explained. The target energy storage capacity Q_{T2} of the second device, however, may be different, in particular greater, than the target energy storage capacity Q_T as previously explained. The magnitude of the losses when transferring capacity or electrical energy from the second device to the first device may be known or may be experimentally determined. The losses may be implemented in the calculation by multiplying the target energy storage capacity Q_T by an appropriate factor. The factor may represent a percentage of losses, to receive Q_{T2}. Losses may, for example, be 1% or 5% or 10%. The factor for multiplication with Q_T may then, for example, be 1.01 or 1.05 or 1.1. Therefore, the target energy storage capacity Q_{T2} of the second device represents the capacity necessary in the second device to charge the first device to the target energy storage capacity Q_{T1} or Q_T. The first summand of formula (4) may also take into account that because of the losses, the present or current or remaining capacity Q_1 of the energy storage of the first device may need to be replaced (in the first summand) by the capacity of the second device that would be needed to recharge the first device up to the present or current or remaining capacity Q_1 of the energy storage of the first device. This capacity of the second device may be represented by Q_{21}, which may also be calculated from Q_1 by the factor mentioned above. Therefore, the result of formula (4) may represent the time necessary to reach the target energy storage capacity in the first device by the second charging path.

Another alternative way of calculating time T_2 or an estimation of the time T_2 necessary to reach a target energy storage capacity in the first device by the second charging path may, for example, be given by the following formula:

$$T_2 = ([Q_{T1} - Q_1]/n - Q_2)/I_{E2} + (Q_{T1} - Q_1)/I_{21} \qquad (5)$$

Wherein:

n may be a coefficient which may be related to the charging efficiency from the second device to the first device and may, in particular, satisfy $0 < n \leq 1$;

Q_{T1} may be defined as in formula (4);

T_2, Q_2, I_{E2}, and I_{21} may be defined as in formula (2); and

Q_1 may be defined as in formula (1).

By using the coefficient n, formula (5) may be a combination of formulas (3) and (4). For example, if n = 1 and because $Q_{T1} = Q_T$, formula (5) may become formula (3). As another example, in cases in which $0 < n < 1$, formula (5) may become formula (4), with $Q_{T1}/n = Q_{T2}$ and $Q_1/n = Q_{21}$. In other words, n may be the factor representing a percentage of losses as explained for formula (4) above. The value of n, in particular in the given range of $0 < n \leq 1$, may be predetermined. In other words, the value of n may be fixed in advance so that the method always uses this value of n, for example n = 1 or a value of $0 < n < 1$, the latter being chosen with regard to actual losses of energy when recharging the first device from the second device. In another example, the value of n may be dynamically determined during the method according to the present invention. For example, the actual losses of energy when recharging the first device from the second device may be determined or estimated and the value of n chosen accordingly. For example, n may be determined from the values of Q_1, Q_2, I_{21}, and optionally also at least one temperature value. The temperature value may refer to the ambient temperature, the temperature of the first device, particularly the energy storage of the first device, or the temperature of the second device, particularly the energy storage of the second device. The temperature value may also refer to a mean or median value of the mentioned temperatures. In one example, therefore, n may be a funtion of Q_1, Q_2, I_{21}, and a temperature value: n = f (Q_1, Q_2, I_{21}, temperature).Although four different formulas (formulas (2), (3), (4) and (5)) are given to calculate the time necessary to reach the target energy storage capacity in the first device by the second charging path T_2 and although the formulas may give different results, all of the given formulas and others may be used to calculate T_2 or an estimation of T_2 according to the present disclosure. The choice of the specific way of calculating T_2 may depend on the use case and on data availability. However, as the exact time depends on a plurality of factors including environmental factors, an exact calculation may not be possible. All of the given possibilities of calculation may result in useful estimations of the actual time value. As explained further below, additional parameters may be used to increase the accuracy of the estimation even more.

As previously mentioned, the times necessary to reach the target energy storage capacity in the first device by the first charging path T_1 and by the second charging path T_2 are compared. It may then be provided that the first charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the first charging path (T_1) is shorter than the time necessary to reach the target energy storage capacity in the first device by the second charging path (T_2). Conversely, it may be provided that the second charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the second charging path (T_2) is shorter than the time necessary to reach the target energy storage capacity in the first device by the first charging path (T_1).

Purely for explanatory purposes, two exemplary situations are described below. The examples are given only to illustrate the present disclosure and not to limit it in any way. In both examples, the first maximum charging current is smaller than the second maximum charging current, but the method according to the present disclosure still differentiates which charging path would be ideal in the respective situation:

For example, in a first situation, the capacity of the energy storage of the first device may be 100 mAh, with the target energy storage capacity of the first device being 105 mAh. The state of charge (SOC) of the second device may be 3%, with the target energy storage capacity of the second device given as an SOC value being 7%. The first maximum charging current providable by the external charging device may be 1.5 A and the second maximum charging current providable between the first and second devices may be 1.6 A. In this situation, the first charging path, meaning charging the first device directly from the external charging device, may be the quicker option to attain the target energy storage capacity in the first device. This may be despite the first maximum charging current being smaller than the second maximum charging current.

As another example, in a second situation, the capacity of the energy storage of the first device may be 30 mAh, with the target energy storage capacity of the first device again being 105 mAh. The state of charge (SOC) of the second device may be 6%, with the target energy storage capacity of the second device given as an SOC value again being 7%. The first maximum charging current providable by the external charging device may be 500 mA and the second maximum charging current providable between the first and second devices may again be 1.6 A. In this situation, the second charging path, meaning first charging the second device from the external charging device and then charging the first device from the second device, may be the quicker option to attain the target energy storage capacity in the first device. The reason for this may be that the second maximum charging current is higher than the first maximum charging current and that the SOC of the second device is very close to the target energy storage capacity of the second device.

As already mentioned, the target energy storage capacity may be an energy storage capacity necessary to provide a user with at least one usage session or at least two usage sessions or at least three usage sessions and may pertain to both the aerosol-generating device and the companion device. However, the amount of energy that a user actually uses up in a usage session may be different from user to user. For example, some users may prefer short but quick usage sessions that do not require keeping the aerosol-generating substrate or article at a higher temperature for extended periods. For other uses, it may be the opposite. Besides this, there may be many other factors that may influence how much energy or capacity is actually necessary per usage session for a specific user. The method according to the present disclosure may therefore comprise adjusting the energy storage capacity necessary to provide the user with at least one usage session or at least two usage sessions or at least three usage sessions to usage patterns or user habits of the user of the aerosol-generating system. Such an adjustment may be based on historic usage data of the first and/or second device, for example based on a statistic analysis of historic user data, or may be based on a setting of the first and/or second device, for example a user profile or a user setting of the energy usage or intensity or duration of the user session. In other words, the target energy storage capacity may be adjusted to an individual user value. Ways to determine the actual amount of energy or capacity necessary for a usage session of an individual user may be, for example, disclosed in the applicant's international patent applications PCT/CN2023/080445, PCT/CN2022/116794, and PCT/CN2022/116690 which are hereby incorporated herein by reference in their entirety. By taking individual energy consumption per usage session of a specific user into account, the present disclosure may improve user experience even further.

As explained above, the first device and the second device may be any combination of aerosol-generating device and companion device. In other words, the first device may be at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy. Similarly, the second device may be at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy. One typical case for the present disclosure may be that the first device is an aerosol-generating device and that the second device is a companion device. However, the present disclosure explicitly also comprises the case that the first device is a companion device and the second device is an aerosol-generating device. Also, the present disclosure comprises the case in which both the first and the second device are aerosol-generating devices as well as the case in which both the first and the second device are companion devices.

The above-mentioned cases may all be useful for specific users and their individual usage of aerosol-generating systems. For example, a user may possess more than one aerosol-generating device and/or more than one companion device. Depending on which combination of devices the user has and which of them they plan to use in a specific situation, a user may want to recharge any one of the devices to the target energy storage capacity as quickly as possible. The method may therefore comprise receiving a control signal from a user, wherein the control signal determines which one of the devices of the aerosol-generating system is to be charged by the external charging device. In other words, the user may control, through a control signal, which of the devices of the aerosol-generating system acts as the first device and which of the devices of the aerosol-generating system acts as the second device. In this way, the user may control which of their devices is charged up to the target energy storage capacity as quickly as possible.

It may be that the maximum charging current that can be provided by the external charging device to the energy storage of the first device is different than the maximum charging current that can be provided by the external charging device to the energy storage of the second device. For example, this may depend on the charging circuits used in the first and the second device. Other factors or parameters may also influence the current that may be provided to the respective energy storages. In other words, the first maximum charging current may not be uniform for the first device and the second device. In the method according to the present disclosure, determining the first maximum charging current providable by the external charging device may therefore include at least one of: determining a third maximum charging current providable by the external charging device to the energy storage of the first device, and determining a fourth maximum charging current providable by the external charging device to the energy storage of the second device. In the entire present disclosure, the first maximum charging current may therefore be substituted by the third maximum charging current when the current in question pertains to the current providable to the first device. Additionally, in the entire present disclosure, the first maximum charging current may be substituted by the fourth maximum charging current when the current in question pertains to the current providable to the second device. Adjusting the current values for these differences may improve the accuracy of the method.

The first device and the second device may have at least one or more auxiliary functions that may drain or use energy from the energy storage during charging. An auxiliary function may comprise or may be any component of the first device or the second device that drains or uses energy from the energy storage, especially during charging. The auxiliary function may thus be any electrical component or element of the first and/or second device that uses electrical energy during charging. For example, the at least one auxiliary function may comprise or may be a wireless communications arrangement, for example at least one of Wi-Fi, WLAN, RFID, and Bluetooth, a positioning system, for example GPS or any other GNSS, a display device, for example one or more LEDs or a screen, for example a touchscreen, a loudspeaker or a heating element, a haptic device for vibratory or other type of mechanical feedback, data processing of different types of user and parameter data of the device, running of the firmware or other operational software of the device for basic operation and standby. The energy or current used or drained from the energy storage during charging by the at least one auxiliary function may therefore reduce the current provided to the energy storage for charging. To take this into account, the method according to the present disclosure may include reducing the first maximum charging current and/or the second maximum charging current by a portion used to power at least one auxiliary function of at least one of the first device and the second device. For example, determining at least one of the third and fourth maximum charging currents may include reducing the maximum charging current providable by the external charging device by a portion used to power at least one auxiliary function of at least one of the first device and the second device. Determining the third maximum charging current may include reducing the maximum charging current providable by the external charging device by a portion used to power at least one auxiliary function of the first device. Similarly, determining the fourth maximum charging current may include reducing the maximum charging current providable by the external charging device by a portion used to power at least one auxiliary function of the second device. Determining the second maximum charging current providable from the energy storage of the second device to the energy storage of the first device may include reducing the maximum charging current providable by the second device by a portion used to power at least one auxiliary function of the first device.

The first device and/or the second device may therefore be configured to determine the amount of electrical energy or current drained or used by the one or more auxiliary functions. These values may, for example, also be read from the charging circuit of the energy storage of the respective device. The first device and/or the second device may also be configured to detect a change in the load on the respective energy storage caused by activating or deactivating one or more auxiliary functions. Whenever an activation or a deactivation of one or more of the auxiliary functions is detected, the method may comprise newly determining at least one or all of the first, the second, the third and the fourth maximum charging current.

Another parameter that may affect the maximum charging currents is the temperature, for example the temperature of the first device, of the second device, of the charging circuits of the first and/or second devices or of the energy storages of the first and/or second devices. The method may therefore comprise determining a temperature of at least one of the first device and the second device or any of the mentioned components of these devices, wherein at least one of determining the first maximum charging current and determining the second maximum charging current and determining the third maximum charging current and determining the fourth maximum charging current may include adjusting the current for the determined temperature. For this purpose, the first device and/or the second device may comprise at least one temperature sensor or other type of sensor that is configured to determine the temperature of the first device, the second device or one of the mentioned components of these devices. The energy storage capacity necessary to provide the user with at least one or more usage sessions may be dependent on the temperature of the heater or the cavity for the aerosol-generating substrate or article. For example, when the heater and/or the cavity is at a high temperature, for example 30 °C or 35 °C or more in warm climates, the energy necessary in a usage session may be lower than when the heater and/or the cavity is at a low temperature, for example 0 °C or -5 °C or less in cool climates. Therefore, the at least one temperature sensor may also be used to provide a temperature value to adjust the energy storage capacity necessary to provide the user with at least one or more usage sessions. The method may therefore include adjusting the energy storage capacity necessary to provide the user with at least one or more usage sessions to the temperature value or values provided by the at least one temperature sensor.

There may be many possible ways to determine the first maximum charging current or the second maximum charging current or the third or fourth maximum charging current, respectively. For example, these values may be provided by the charging circuits of the energy storages of the first and second devices. The processing circuitry or the controller of the first and second devices may therefore read these values from the charging circuits, which may be configured as integrated circuits (IC) and which may communicate, for example with the processing circuitry or the controller, through a data bus configured as an inter-integrated circuit (I2C). Determining the first maximum charging current providable by the external charging device may therefore include determining the first maximum charging current or the third maximum charging current or the fourth maximum charging current from a charging circuit of at least one of the first device and the second device. For example, the method may comprise exclusively charging the first and/or the second device from the external charging device and reading the respective currents from the charging circuits. Determining the second maximum charging current providable by the second device may include determining the second maximum charging current from a charging circuit of at least one of the first device and the second device, preferably the first device. For example, the method may comprise exclusively charging the first device from the second device and reading the second maximum charging current from the charging circuit of the first device or the second device.

It may also be provided that determining the first maximum charging current or the third maximum charging current or the fourth maximum charging current providable by the external charging device includes identifying the external charging device and retrieving prestored information pertaining to the identified external charging device. For example, the external charging device may be identified using a wired or wireless communication, for example by using a handshake protocol or radiofrequency identification (RFID). The processing circuitry or the controller of the first device or the second device may comprise a data storage in which information about a plurality of external charging devices may be stored. After identifying the external charging device, this information pertaining to the identified external charging device may be retrieved from data storage and may be used in determining at least one of the first, the third or the fourth maximum charging currents. Similarly, the second maximum charging current may be determined by identifying the second device and retrieving prestored information pertaining to the identified second device. The second device may also be identified using wired or wireless communication, for example by a handshake protocol or radiofrequency identification (RFID). After identifying the second device, this information pertaining to the identified second device may be retrieved from data storage and may be used in determining the second maximum charging current.

The maximum charging current for the energy storages of the first device and the second device, meaning the first, third and fourth maximum charging currents, may also be estimated by a calculation. For example, determining the first maximum charging current or the third maximum charging current or the fourth maximum charging current providable by the external charging device may include determining the respective maximum charging current from an output voltage and an output current of the external charging device, a charging efficiency of a charging circuit of at least one of the first device and the second device and an energy storage regulation voltage of the energy storage of at least one of the first device and the second device. For example, the following formula may be used:

$$I_{max} = U_{ex} \cdot I_{ex} \cdot \eta \, / \, U_{reg} \qquad (6)$$

Wherein:

I_{max} may be the maximum charging current, for example the first or the third or the fourth maximum charging current;

U_{ex} may be the output voltage of the external charging device;

I_{ex} may be the output current of the external charging device;

η may be the charging efficiency of a charging circuit of at least one of the first device and the second device; and

U_{reg} may be the energy storage regulation voltage of the energy storage of at least one of the first device and the second device.

The output voltage U_{ex} and the output current I_{ex} of the external charging device may be taken from prestored information, for example from the data storage of the first device or the second device, when the external charging device has been identified as explained above. The charging efficiency η of the charging circuit may typically be known from the specifications of the respective circuit and may therefore, for example, be taken from a datasheet and/or also stored in the data storage of the respective device. Similarly, the energy storage regulation voltage U_{reg} may typically also be known from the specifications of the respective energy storage and may therefore, for example, be taken from a datasheet and/or also stored in the data storage of the respective device. Therefore, all of the values necessary to implement formula (6) may be available.

In general, the charging of the aerosol-generating system according to the present disclosure pertains to the fast charging phase of the energy storage of the first device or the second device. For example, the charging of the aerosol-generating system may pertain to the constant current regulation mode or phase and the constant voltage regulation mode or phase of the respective energy storages. However, a situation may arise in which the energy storage of the first device and/or the energy storage of the second device has been discharged below a capacity threshold or a voltage threshold that is necessary for charging the energy storage in the mentioned modes or phases. In other words, it may be necessary to pre-charge the energy storage of the first device or the energy storage of the second device before the actual charging or the fast charging of the energy storage may commence. To be sure that these cases are taken into account, the method according to the present disclosure may comprise determining a voltage of the energy storage of the first device, comparing the determined voltage of the energy storage of the first device to a first pre-charge threshold, and pre-charging the energy storage of the first device when the determined voltage of the energy storage of the first device is below the first pre-charge threshold. The method may additionally or alternatively comprise determining a voltage of the energy storage of the second device, comparing the determined voltage of the energy storage of the second device to a second pre-charge threshold, and pre-charging the energy storage of the second device when the determined voltage of the energy storage of the second device is below the second pre-charge threshold. The first and/or the second pre-charge threshold may be different or similar values. Particularly, the first and/or the second pre-charge threshold may be between 2.5 V to 3.2 V, preferably from 2.8 V to 3.0 V. For example, the first pre-charge threshold and/or the second pre-charge threshold may be 2.9 V. Pre-charging the respective energy storage may comprise charging the energy storage until the respective pre-charge threshold is reached or exceeded, for example with a reduced current. After this is achieved, normal charging may be performed as explained herein.

Another parameter or factor that may influence the charging order charging times of the aerosol-generating system may be the voltage providable by the external charging device. Typical external charging devices may provide, for example, a voltage of 5 V. However, other values may be employed. The method according to the present disclosure may therefore comprise determining a voltage providable by the external charging device and determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents and the voltage providable by the external charging device. In other words, the voltage providable by the external charging device may also be taken into account when selecting either the first charging path or the second charging path.

The method according to the present disclosure may also take into account or cover specific circumstances that may arise in charging the aerosol-generating system. For example, in cases that the capacity of the first device is below the target energy storage capacity, but the second device has enough capacity to recharge the first device at least up to the target energy storage capacity, the method may comprise directly charging the first device from the second device. In cases in which the capacity of the first device is above the target energy storage capacity and the energy storage of the second device is not completely full, the method may comprise directly charging both the first device and the second device from the external charging device. In cases in which the energy storage of the first device is full, the method may comprise charging the second device directly from the external charging device. In cases in which the energy storage of the second device is full, the method may comprise charging the first device directly from the external charging device, except in cases in which the first maximum charging current is smaller than the second maximum charging current. In those cases, the method may comprise charging the first device from the second device until the first device is full and then charging the second device from the external charging device. When the capacities of the energy storages of the first device and the second device are determined and one of the above-mentioned situations is detected, the method may comprise controlling or managing the charging of the aerosol-generating system by implementing one of the charging regimes or charging paths as outlined above.

According to another aspect of the present invention, there is provided an aerosol-generating system, comprising a first device and a second device, wherein the first device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy, and wherein the second device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy, wherein each device includes an energy storage for storing electrical energy, wherein at least one of the devices includes an electrical connection interface for receiving electrical energy from an external charging device, wherein at least one of the devices includes processing circuitry comprising at least one processor, and wherein the processing circuitry is configured to perform steps, preferably all of the steps, of the method according to the present disclosure. All of the features, functions and advantages of the method according to the present disclosure are also applicable to the aerosol-generating system and vice versa.

In the aerosol-generating system, each of the first and the second device may include a fuel gauge for determining the capacity of the energy storage of the respective device. For example, any aerosol-generating device and/or any companion device comprised in the aerosol-generating system may include such a fuel gauge. In particular, a companion device comprised in the aerosol-generating system may include such a fuel gauge. The fuel gauge may be configured as an integrated circuit (IC) that may be electrically connected to the processing circuitry and the charging circuit of the respective device, for example through a data bus configured as inter-integrated circuit (I2C). A sampling resistor may be arranged in an electrical connection between the charging circuit and the energy storage. The fuel gauge may comprise or may be connected to the sampling resistor. Particularly, the fuel gauge may be connected to the electrical connection between the charging circuit and the energy storage both upstream and downstream of the sampling resistor.

The electrical interconnection interface arranged on at least one of the devices may be configured to establish a removable electrical interconnection between the device and the external charging device. The electrical interconnection interface may also be configured to establish a removable electrical interconnection between the first device and the second device. For instance, the electrical interconnection interface may be one of a wireless interconnection interface or a wired connector, for example a USB or USB C connector. The wireless interconnection interface may be configured to use inductive coupling or capacitive coupling to wirelessly transfer power. The external charging device may be configured to provide a corresponding electrical interconnection interface, for example also a wireless interconnection interface or a wired connector, so that the external charging interface may be removably interconnected to the first device and/or the second device.

According to another aspect of the present invention, there is provided an aerosol-generating device, comprising an energy storage for storing electrical energy, an electrical interconnection interface for receiving electrical energy at the aerosol-generating device from at least one of an external charging device and a companion device configured to charge the aerosol-generating device with the electrical energy, and processing circuitry comprising at least one processor, wherein the processing circuitry is configured to perform steps, preferably all of the steps, of the method according to the present disclosure. All of the features, functions and advantages of the method and the aerosol-generating system according to the present disclosure are also applicable to the aerosol-generating device and vice versa.

The aerosol-generating device may comprise an aerosol-generating substrate or article, preferably an aerosol-generating substrate or article as previously described. The aerosol-generating device may be configured to generate or produce aerosol from the aerosol-generating substrate or article.

According to another aspect of the present disclosure, there is provided a companion device configured to charge an aerosol-generating device with electrical energy, comprising an energy storage for storing electrical energy, an electrical interconnection interface for receiving electrical energy at the companion device from at least one of an external charging device and the aerosol-generating device, and processing circuitry comprising at least one processor, wherein the processing circuitry is configured to perform steps, preferably all of the steps, of the method according to the present disclosure. All of the features, functions and advantages of the method as well as the aerosol-generating system and the aerosol-generating device according to the present disclosure are also applicable to the companion device and vice versa.

As already mentioned, both the aerosol-generating device and the companion device may each include a fuel gauge for determining the capacity of the energy storage of the device. Also, the electrical interconnection interface of the first device or the second device may be one of a wireless interconnection interface or a wired connector as explained above.

According to another aspect of the present invention, there is provided a computer program, which when executed by an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy, causes the device to perform steps, preferably all of the steps, of the method according to the present disclosure. All of the features, functions and advantages of the method as well as the aerosol-generating system and the aerosol-generating device and the companion device according to the present disclosure are also applicable to the computer program and vice versa.

According to another aspect of the present invention, there is provided a non-transitory computer-readable medium storing a computer program according to the present disclosure, the computer program being configured to execute the charging method when executed on an aerosol-generating device or a companion device. All of the features, functions and advantages of the method as well as the aerosol-generating system and the aerosol-generating device and the companion device and the computer program according to the present disclosure are also applicable to the computer-readable medium and vice versa.

The present disclosure is explained herein with respect to a method for managing a charging of an aerosol-generating system with electrical energy by an external charging device. However, the method according to the present disclosure may always be advantageously applicable whenever there are two or more electronic devices that may be connected to each other electrically and at least one of the devices needs to be recharged to be able to provide the user with a specific task. The specific task may be, in the example explained herein, the usage session of an aerosol-generating device, but may be any task providable by the electronic device. Therefore, the present disclosure also pertains to a method for managing a charging of an electronic system with electrical energy by an external charging device, wherein the electronic system comprises a first device and a second device. The first and second device may be, for example, an electronic device and a companion device configured to charge the electronic device with electrical energy. The present disclosure may be regarded as a specific example of this method applied to an aerosol-generating system. Thus, all of the features, functions and advantages of the method applied to an aerosol-generating system as explained herein are also applicable to the method for managing a charging of an electronic system, which may also be claimed without reference to the aerosol-generating system. For example, the electronic system may comprise a plurality of different or similar devices as first and/or second device, for example any kind of portable electronic devices, such as smartphones, tablet computers, laptops, gaming devices, for example gaming consoles or gaming controllers, powerbanks, loudspeakers, cameras, pedelecs, e-bikes, headphones, in-ear headphones and so on. The first and/or second device may also be a portable medical device, for example an inhaler, which may be configured to deliver a vapour or an aerosol, which may comprise a pharmaceutical agent, into the lungs of a user by inhalation. The task providable by the device may, for example, be the possibility of using the device in its intended function for a specific amount of time.

The invention is defined in the claims. However, below there is provided a non-exhaustive list of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example 1. A computer-implemented method for managing a charging of an aerosol-generating system with electrical energy by an external charging device,

wherein the aerosol-generating system comprises a first device and a second device,

wherein each device includes an energy storage for storing electrical energy,

wherein the second device is removably electrically interconnected to the external charging device, and

wherein the first device and the second device are removably electrically interconnected to each other,

the method comprising:

determining a first maximum charging current providable by the external charging device,

determining a second maximum charging current providable from the energy storage of the second device to the energy storage of the first device,

determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents,

and, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, selecting

either a first charging path, including charging the first device from the external charging device via the second device,

or a second charging path, including charging the second device from the external charging device and then charging the first device from the second device.

Example 2. The method according to Example 1,

wherein the first charging path is chosen in case the first maximum charging current is greater than or equal to the second maximum charging current.

Example 3. The method according to any one of the previous Examples, comprising:

determining a capacity of the energy storage of the first device,

determining a capacity of the energy storage of the second device,

determining a target energy storage capacity of the first device,

wherein determining which one of the first charging path and the second charging path is chosen includes determining a time necessary to reach the target energy storage capacity in the first device by the first charging path and by the second charging path, and

wherein the first charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the first charging path is shorter than the time necessary to reach the target energy storage capacity in the first device by the second charging path, and wherein the second charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the second charging path is shorter than the time necessary to reach the target energy storage capacity in the first device by the first charging path.

Example 4. The method according to the previous Example, wherein the target energy storage capacity is an energy storage capacity necessary to provide a user with at least one usage session or at least two usage sessions or at least three usage sessions.

Example 5. The method according to the previous Example, comprising adjusting the energy storage capacity necessary to provide the user with at least one usage session or at least two usage sessions or at least three usage sessions to usage patterns or user habits of the user of the aerosol-generating system.

Example 6. The method according to any one of the previous Examples, wherein the first device is at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy.

Example 7. The method according to any one of the previous Examples, wherein the second device is at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy.

Example 8. The method according to any one of the previous Examples, comprising receiving a control signal from a user, wherein the control signal determines which one of the devices of the aerosol-generating system is to be charged by the external charging device.

Example 9. The method according to any one of the previous Examples, wherein determining the first maximum charging current providable by the external charging device includes at least one of:

determining a third maximum charging current providable by the external charging device to the energy storage of the first device, and

determining a fourth maximum charging current providable by the external charging device to the energy storage of the second device.

Example 10. The method according to the previous Example, wherein determining at least one of the third and fourth maximum charging currents includes reducing the maximum charging current providable by the external charging device by a portion used to power at least one auxiliary function of at least one of the first device and the second device.

Example 11. The method according to the previous Example, wherein the at least one auxiliary function comprises a wireless communications arrangement, for example at least one of Wi-Fi, WLAN, and Bluetooth, a positioning system, for example GPS, a display device, a loudspeaker or a heating element.

Example 12. The method according to any one of the previous Examples, comprising determining a temperature of at least one of the first device and the second device, wherein at least one of determining the first maximum charging current and determining the second maximum charging current includes adjusting the current for the determined temperature.

Example 13. The method according to any one of the previous Examples, wherein determining the first maximum charging current providable by the external charging device includes determining the first maximum charging current from a charging circuit of at least one of the first device and the second device.

Example 14. The method according to any one of the previous Examples, wherein determining the first maximum charging current providable by the external charging device includes identifying the external charging device and retrieving prestored information pertaining to the identified external charging device.

Example 15. The method according to any one of the previous Examples, wherein determining the first maximum charging current providable by the external charging device includes determining the first maximum charging current from an output voltage and an output current of the external charging device, a charging efficiency of a charging circuit of at least one of the first device and the second device and an energy storage regulation voltage of the energy storage of at least one of the first device and the second device.

Example 16. The method according to any one of the previous Examples, comprising:

determining a voltage of the energy storage of the first device,

comparing the determined voltage of the energy storage of the first device to a first pre-charge threshold, and

pre-charging the energy storage of the first device when the determined voltage of the energy storage of the first device is below the first pre-charge threshold.

Example 17. The method according to any one of the previous Examples, comprising:

determining a voltage of the energy storage of the second device,

comparing the determined voltage of the energy storage of the second device to a second pre-charge threshold, and

pre-charging the energy storage of the second device when the determined voltage of the energy storage of the second device is below the second pre-charge threshold.

Example 18. The method according to any one of the previous Examples, comprising determining a voltage providable by the external charging device and determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents and the voltage providable by the external charging device.

Example 19. An aerosol-generating system, comprising a first device and a second device,

wherein the first device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy, and

wherein the second device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy,

wherein each device includes an energy storage for storing electrical energy, wherein at least one of the devices includes an electrical interconnection interface for receiving electrical energy from an external charging device,

wherein at least one of the devices includes processing circuitry comprising at least one processor, and

wherein the processing circuitry is configured to perform steps of the method according to any of the previous Examples.

Example 20. The system according to the previous Example, wherein each of the first and the second device includes a fuel gauge for determining a capacity of the energy storage of the respective device.

Example 21. The system according to any one of previous Examples 19-20, wherein the electrical interconnection interface is one of a wireless interconnection interface or a wired connector, for example a USB connector.

Example 22. An aerosol-generating device, comprising

an energy storage for storing electrical energy,

an electrical interconnection interface for receiving electrical energy at the aerosol-generating device from at least one of an external charging device and a companion device configured to charge the aerosol-generating device with the electrical energy, and

processing circuitry comprising at least one processor,

wherein the processing circuitry is configured to perform steps of the method according to any of Examples 1-18.

Example 23. The aerosol-generating device according to the previous Example, comprising an aerosol-generating substrate or article, preferably wherein the aerosol-generating device is configured to generate aerosol from the aerosol-generating substrate or article.

Example 24. A companion device configured to charge an aerosol-generating device with electrical energy, comprising

an energy storage for storing electrical energy,

an electrical interconnection interface for receiving electrical energy at the companion device from at least one of an external charging device and the aerosol-generating device, and

processing circuitry comprising at least one processor,

wherein the processing circuitry is configured to perform steps of the method according to any of Examples 1-18.

Example 25. The device according to any one of previous Examples 22-24, including a fuel gauge for determining a capacity of the energy storage of the device.

Example 26. The device according to any one of previous Examples 22-25, wherein the electrical interconnection interface is one of a wireless interconnection interface or a wired connector, for example a USB connector.

Example 27. A computer program, which when executed by an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy, causes the device to perform steps of the method according to any one of Examples 1-18.

Example 28. A non-transitory computer-readable medium storing a computer program according to the previous Example.

Example 29. A computer-implemented method for managing a charging of an electronic system with electrical energy by an external charging device,

wherein the electronic system comprises a first device and a second device,

wherein each device includes an energy storage for storing electrical energy,

wherein the second device is removably electrically interconnected to the external charging device, and

wherein the first device and the second device are removably electrically interconnected to each other,

the method comprising:

determining a first maximum charging current providable by the external charging device,

determining a second maximum charging current providable from the energy storage of the second device to the energy storage of the first device,

determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents,

and, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, selecting

either a first charging path, including charging the first device from the external charging device via the second device,

or a second charging path, including charging the second device from the external charging device and then charging the first device from the second device.

Examples will now be further described with reference to the figures in which:

Figure 1 shows an exemplary aerosol-generating system and external charging devices;

Figure 2 shows a typical charging profile of an energy storage;

Figure 3 shows an electrical diagram of an aerosol-generating system;

Figure 4 shows a flowchart of the method according to the present disclosure;

Figure 5 shows a flowchart of an aspect of the method according to the present disclosure; and

Figure 6 shows a flowchart of another aspect of the method according to the present disclosure.

The figures are schematic only and not to scale.

Figure 1 shows an aerosol-generating system 1 for generating aerosol, for example for consumption or inhalation by a user in one or more usage sessions. The system 1 may comprise at least one of an aerosol-generating device 2 for generating aerosol and a companion device 3 for at least partially receiving the aerosol-generating device 2. The companion device 3 may be a charging device for charging the aerosol-generating device 2 and/or an energy storage or battery thereof.

The aerosol-generating device 2 may comprise an insertion opening 4 for at least partially inserting an aerosol-generating article 17. The aerosol-generating article 17 may comprise an aerosol-forming substrate, such as a tobacco containing substrate, and/or a cartridge comprising a liquid, for example a liquid that can be aerosolized for inhalation.

The aerosol-generating device 2 may further include processing circuitry 28 or control circuitry 28 with at least one controller 5 and one or more processors 6. For generating the aerosol during use or consumption of the aerosol-generating article 17, the aerosol-generating device 2 may comprise at least one heating element 7 or heater device for applying heat to at least a portion of the aerosol-generating article 17. Instead of the heating element 7, an ultrasonic device (not shown) may also be used to generate aerosol from the aerosol-generating article 17. The processing circuitry 28 and/or the controller 5 may be configured to control actuation, activation and/or deactivation of at least one heating element 7 or ultrasonic device.

For powering the at least one heating element 7 with electrical power, the aerosol-generating device 2 may further comprise at least one energy storage 15, for example in the form of a chargeable battery, for storing electrical energy or power. The aerosol-generating device 2 may further comprise at least one electrical interconnection interface 12 for coupling to a corresponding at least one electrical interconnection interface 13 of the companion device 3 and/or an electrical connector of an external charging device 18. The external charging device 18 may be a wired connector, for example a USB charger, which may comprise a wired interconnector 29, for example a USB plug. Alternatively, the external charging device 18 may be a wireless interconnection interface, which may comprise a wireless interconnector 30. The electrical interconnection interface 12 of the aerosol-generating device 2 and the electrical interconnection interface 13 of the companion device 3 may be configured to establish a removable electrical interconnection between each other and/or to the wired interconnector 29 or the wireless interconnector 30 of the external charging device 18. For example, when the aerosol-generating device 2 is at least partially inserted into the opening 14 of the companion device 3, the one or more electrical interconnection interfaces 12 of the aerosol-generating device 2 may be coupled with the one or more electrical interconnection interfaces 13 of the companion device 3 to charge the at least one energy storage 15 of the aerosol-generating device 2.

In the example of figure 1, the aerosol-generating device 2 may be the first device 26 according to the present disclosure and the companion device 3 may be the second device 27 according to the present disclosure. However, in different embodiments, it might also be provided that the companion device 3 is the first device and the aerosol-generating device 2 is the second device. Despite figure 1 showing an aerosol-generating system 1 comprising an aerosol-generating device 2 and a companion device 3, the aerosol-generating system 1 according to the present disclosure may also comprise two aerosol-generating devices 2 or two companion devices 3. In this case, the electrical interconnection interfaces 12 of the aerosol-generating devices 2 may be configured so that the two aerosol-generating devices 2 may be removably electrically interconnected to each other and/or to the external charging device 18. Similarly, the electrical interconnection interfaces 13 of the companion devices 3 may be configured so that the two companion devices 3 may be removably electrically interconnected to each other and/or to the external charging device 18.

The aerosol-generating device 2 may further comprise a communications arrangement 9 or communication circuitry 9 with one or more communications interfaces 10 for communicatively coupling the aerosol-generating device 2 with the companion device 3 and/or a computing device like a smartphone, tablet or personal computer (not shown), for example, via an Internet connection, a wireless LAN connection, a WiFi connection, a Bluetooth connection, a mobile phone network, a mobile data connection for example but not limited to a 3G/4G/5G connection, an edge connection, an LTE connection, a BUS connection, an RFID connection, a wireless connection, a wired connection, an optical data connection such as but not limited to IrDa, a radio connection, a near field connection, and/or an IoT connection.

The aerosol-generating device 2 may further comprise a data storage 11 for storing information, program code or data. Data storage 11 may also store values of parameters, for example pertaining to different external charging devices or charging circuits, and/or one or more mathematical functions or formulas, software and computer instructions that can be executed by the controller 5 and/or processing circuitry 28. One or more sensors 16 may be arranged on, at or in the aerosol-generating device 2 and/or the companion device 3 to collect data. One or more of the sensors 16 may for example be temperature sensors, strain sensors, accelerometers or any other suitable sensors.

The aerosol-generating device 2 and/or the companion device 3 may further comprise user interface components, for example comprising an input element or input device 8, for example in the form of a pushbutton or a capacitive button. The input device 8 may be used as a power button to activate or deactivate the heating element 7 or ultrasonic device for aerosol generation thereby to activate or deactivate the aerosol-generating device 2. Upon activation of the aerosol-generating device 2, the heating element 7 may be activated and heat may be applied to at least a part of the aerosol-generating article 17, such that aerosol can be generated for consumption or inhalation by the user, for example in one or more usage sessions. The aerosol generating device 2 and/or the companion device 3 may each comprise a user interface comprising one or more output elements, such as a display and/or one or more LEDs, for outputting a signal and/or displaying information to a user, or a haptic interface for vibratory feedback.

Figure 2 shows a typical charging profile of an energy storage 15 of one of the first device 26 or the second device 27. Specifically, the abscissa or x-axis shows the time t and the ordinate or y-axis shows the value of the charging current 21 and the energy storage voltage or charging voltage 22. In the period of time t_1, the energy storage 15 may be pre-charged, meaning that the energy storage 15 is charged slowly with a comparatively low pre-charge current I_{pre}. Pre-charging may be done until the energy storage voltage or charging voltage 22 reaches a pre-charge threshold, which may, for example, be at or around 2.9 V. After this threshold is reached or exceeded at the end of the pre-charge period of time t_1, the fast-charging period of time t_2 may begin. This fast-charging period of time t_2 may contain the constant current regulation mode or phase in which the energy storage 15 may be charged with the maximum charging current I_{max}, which may be, for example, the first or the second or the third or the fourth maximum charging current. Additionally, the fast-charging period of time t_2 may contain the constant voltage regulation mode or phase in which the energy storage voltage or charging voltage 22 has reached the energy storage regulation voltage U_{reg}. The fast-charging period of time t_2 may end for example when the energy storage 15 is fully charged. The charging of the aerosol-generating system 1 according to the present disclosure may pertain to the fast-charging period of time t_2, and especially to the constant current regulation mode or phase. However, as explained above, the method may also comprise the pre-charge period of time t_1, when an energy storage voltage 22 below the pre-charge threshold is determined.

Figure 3 shows an exemplary circuit diagram of the aerosol-generating system 1. In the example shown, the first device 26 may be an aerosol-generating device 2 and the second device 27 may be a companion device 3. However, other combinations may be possible. Both the first device 26 and the second device 27 may comprise a processing circuitry 28 represented by controller 5, an energy storage 15, for example a battery or a battery pack, and a charging circuit 20. To be able to determine the capacity of the energy storage 15, for example the current or present or remaining capacity of the energy storage 15, both the first device 26 and the second device 27 may comprise a fuel gauge 19, which may, for example, be implemented as an integrated circuit electrically connected to both the controller 5, the charging circuit 20 and the energy storage 15, for example through a data bus configured as inter-integrated circuit. Specifically, fuel gauge 19 may be electrically connected to an electrical connection between the charging circuit 20 and the energy storage 15, for instance both upstream and downstream of a sampling resistor 23 arranged in the connection between the charging circuit 20 and the energy storage 15.

In the case shown in figure 3, the second device 27 may comprise an electrical interconnection interface 12, 13, which may be configured to be removably electrically interconnected to an external charging device 18 and to receive electrical energy from the external charging device 18. Also, the first device 26 and the second device 26 may be electrically interconnected by electrical interconnection interfaces 12, 13. For the second device 27, these electrical interconnection interfaces 12, 13 may be the same or different from the ones configured to be removably electrically interconnected to the external charging device 18. Specifically, the controller 5 of the first device 26 and the second device 27 may be connected through the electrical interconnection interfaces 12, 13. The controllers 5 of the devices 26, 27 may therefore transfer data between the controllers 5. Also, the energy storages 15 and the charging circuits 20 of the first device 26 and the second device 27 may be interconnected via the electrical interconnection interfaces 12, 13. For example, the charging circuit 20 of the second device 27 may be connected with a power switch 24 which may then be connected to the charging circuit 20 of the first device 26. The energy storage 15 of the second device 27 may be connected to a DC/DC boost 25, which may then also be connected to the charging circuit 20 of the first device 26 through the electrical interconnection interfaces 12, 13. However, this arrangement is purely exemplary and other arrangements may be used to implement the present disclosure.

Figure 4 shows a flowchart of a method 50 according to some aspects of the present disclosure. In steps 31 and 32, removable electrical interconnections between the external charging device 18 and the aerosol-generating system 1 as well as between the first device 26 and the second device 27 may be established. These steps 31, 32 may comprise at least partially inserting the aerosol-generating device 2 into the companion device 3 in case these devices are comprised by the aerosol-generating system 1. Additionally, these steps 31, 32 may comprise connecting the aerosol-generating system 1 to the external charging device 18, for example by plugging a wired interconnector 29 of the external charging device 18 into one of the first device 26 or the second device 27 or by placing the first device 26 and/or the second device 27 in the vicinity of a wireless interconnector 30 of the external charging device 18. As can be seen, steps 31 and 32 may thus require manual intervention by a user. Therefore, steps 31 and 32 may not be part of the method 50 itself, as indicated by the broken line in figure 4, but may constitute preliminary or preparatory steps that are performed before the method 50 itself is performed. The method 50 may be performed on an aerosol-generating system 1 that has been prearranged according to the steps 31 and 32. In other words, method 50 may be performed on an aerosol-generating system 1 in which a removable electrical interconnection between the first device 26 and the second device 27 as well as between at least one of the first device 26 and the second device 27 and the external charging device 18 has already been established.

In step 33, the first maximum charging current providable by the external charging device 18 may be determined. The maximum charging current providable by the external charging device 18 to the energy storage 15 of the first device 26 may be different to the maximum charging current providable to the energy storage 15 of the second device 27. For example, different loads may be draining the energy storages 15 of the first device 26 and the second device 27, for example because one or more auxiliary functions of the devices 26, 27 may be activated. Thus, determining the first maximum charging current providable by the external charging device 18 , or a value that is representative of the first maximum charging current, may optionally comprise determining a third maximum charging current providable by the external charging device 18 to the energy storage 15 of the first device 26 in step 34 and/or determining a fourth maximum charging current providable by the external charging device 18 to the energy storage 15 of the second device 27 in step 35. To determine the respective maximum charging currents providable by the external charging device 18, the method 50 may, for example, comprise exclusively charging the energy storage 15 of the first device 26 or the second device 27 by the external charging device 18 and reading the charging current from the charging circuit 20 of the respective device 26, 27. In this way, loads applied to the respective energy storage 15 may be automatically accounted for in the reading.

In step 36, the second maximum charging current providable from the energy storage 15 of the second device 27 to the energy storage 15 of the first device 26 may be determined. This value may, for example, also be read from the charging circuit 20 of the energy storage 15 of the first device 26, particularly when the first device 26 is exclusively charged by the second device 27. Also, this value may be known beforehand from the known configuration of the first device 26 and/or the second device 27.

In step 37, the order of charging the first device 26 and the second device 27 may be determined. In other words, the charging path may be determined. This determination comprises determining which one of the first device 26 and the second device 27 is to be charged by the external charging device 18 from the first and/or the third or fourth maximum charging current and the second maximum charging current as determined in steps 33, and optionally 34 and/or 35, and 36. Determining the charging path may comprise a comparison between the first maximum charging current and the second maximum charging current. Determining the charging path may alternatively comprise a comparison between the third maximum charging current or the fourth maximum charging current and the second maximum charging current. For example, it may be determined which of these currents is greater or the greatest. However, as explained herein, other parameters may also be taken into account.

The method 50 may differentiate between two distinct charging paths, namely a first charging path 44 and a second charging path 45. The first charging path 44 may comprise a step 38 in which the first device 26 may be directly charged by the external charging device 18. In other words, the energy storage 15 of the first device 26 may be charged with electrical energy by the external charging device 18 without the second device 27 being charged by the external charging device 18 beforehand. The second device 27 may act as an intermediary between the external charging device 18 and the first device 26 in the sense that the second device 27 may be used to establish the electrical interconnection between the external charging device 18 and the first device 26. However, when the first device 26 is directly charged by the external charging device 18 in the first charging path 44, the energy storage 15 of the second device 27 may be explicitly not charged with electrical energy by the external charging device 18. The first charging path 44 may therefore include exclusively charging the first device 26 from the external charging device 18. Therefore, the first charging path 44 may always be chosen when the first device 26 may be brought into a condition in which at least one usage session or more usage sessions may be provided to a user more quickly by directly charging the first device 26 from the external charging device 18 than by first charging the second device 27 and then charging the first device 26 from the second device 27.

The second charging path 45 may comprise a step 39 in which the second device 27 may be directly charged by the external charging device 18. The energy storage 15 of the second device 27 may be charged with electrical energy by the external charging device 18 without the first device 26 being charged by the external charging device 18. However, the first device 26 may act as an intermediary between the external charging device 18 and the second device 27 in the sense that the first device 26 may be used to establish the electrical interconnection between the external charging device 18 and the second device 27. Then, after the second device 27 has been charged by the external charging device 18, the method 50 may comprise a step 40 in which the first device 26 may be charged from the second device 27. In other words, in step 40, the energy storage 15 of the first device 26 may be charged with electrical energy from the energy storage 15 of the second device 27. The charging of the first device 26 in the second charging path 45 therefore may only be performed after the charging of the second device 27. Therefore, the second charging path 45 may always be chosen when the first device 26 may be brought into a condition in which at least one usage session or more usage sessions may be provided to a user more quickly by indirectly charging the first device 26 from the external charging device 18 by first charging the second device 27 and then charging the first device 26 from the second device 27 than by directly charging the first device 26 from the external charging device 18.

Further aspects of the method 50 according to the present disclosure may be shown in figure 5. For example, method 50 may take into account the remaining capacities of the energy storages 15 of the first and second devices 26, 27 before the charging. For this, in step 46, the method 50 may comprise determining the capacity of the first device 26. In step 47, the method 50 may comprise determining the capacity of the second device 27. The capacities of the first and second devices 26, 27 may pertain to the current or present or remaining capacities, especially the capacities in the energy storages 15 of the first and second devices 26, 27 before any charging occurs. In step 48, a target capacity, for example a target energy storage capacity, may be determined. The target energy storage capacity may pertain to the first device 26 or the second device 27. For instance, the target energy storage capacity may describe a minimum capacity that is necessary to provide the user of the first device 26, for example the aerosol-generating device 2, with at least one or at least two or at least three or more consecutive usage sessions without having to recharge the device in between. Alternatively, the target energy storage capacity may describe a minimum capacity that is necessary in the second device 27 to recharge the first device 26 up to the target energy storage capacity of the first device 26.

The capacities determined in steps 46, 47 and 48 may be taken into account in determining the order of charging or the charging path in step 37. For this, it may be provided that the method comprises determining the time necessary or at least an estimation of the time necessary to reach the target energy storage capacity in the first device 26 by either selecting and implementing the first charging path 44 or the second charging path 45. This may be performed in step 49 of the method 50. Actual determination of the mentioned time may, for example, be achieved by one of the formulas according to the present disclosure. The first charging path 44 may be chosen when it is determined that the time necessary to recharge the first device 26 up to the target energy storage capacity by the first charging path 44 is shorter than the time necessary to recharge the first device 26 up to the target energy storage capacity by the second charging path 45. Conversely, the second charging path 45 may be chosen when it is determined that the time necessary to recharge the first device 26 up to the target energy storage capacity by the second charging path 45 is shorter than the time necessary to recharge the first device 26 up to the target energy storage capacity by the first charging path 44.

Another aspect of the method 50 according to the present disclosure is shown in figure 6. Specifically, method 50 may comprise a step 41 of determining whether an auxiliary function of one of the first device 26 or the second device 27 has been turned on or off. For this, it may be provided that the usage status, i.e. whether these are turned on or off, of the auxiliary functions of the first device 26 and the second device 27 are repeatedly or continuously monitored. Auxiliary functions of the devices 26, 27 may be electrically powered so that an auxiliary function that is turned on may represent a load or drain on the energy storage 15 of the respective device 26, 27. This may directly alter the values of the first, second, third and fourth maximum charging currents. Therefore, step 41 or a continuous monitoring according to step 41 may be particularly helpful when implemented after determining any or all of the mentioned currents.

The determination according to step 41 may give the result that no auxiliary function of the respective device 26, 27 has been turned on or off since the last check and/or since the mentioned currents have been determined. In this case, the load on the respective energy storage 15 may not have changed and neither have the currents. Therefore, the method 50 may continue in step 43, which merely lets the method 50 continue without any adjustments.

The determination according to step 41 may alternatively give the result that at least one or more auxiliary functions of the respective device 26, 27 has been turned on or off since the last check and/or since the mentioned currents have been determined. In this case, the load on the respective energy storage 15 may have changed, which may directly alter the mentioned currents. Therefore, the method 50 may comprise step 42, in which at least one of the first maximum charging current, the second maximum charging current, the third maximum charging current, and the fourth maximum charging current are determined again. In other words, the determining of the mentioned currents may be repeated so as to determine updated values for these currents. Method 50 may then continue using the redetermined currents.

In summary, the present disclosure may provide improved management of the charging of the energy storage 15 of at least one of the devices 26, 27 of an aerosol-generating system 1. The method 50 according to the present disclosure may especially cover cases in which the first maximum charging current is smaller than the second maximum charging current. Especially in these cases, conventional systems may not differentiate enough subcases to provide the user an opportunity for the next usage session in the shortest time possible. The method 50 as described herein may therefore improve user experience.

For the purpose of the present description and of the appended claims, except where otherwise indicated, all numbers expressing amounts, quantities, percentages, and so forth, are to be understood as being modified in all instances by the term "about". Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein. In this context, therefore, a number A is understood as A ± 10% of A. Within this context, a number A may be considered to include numerical values that are within general standard error for the measurement of the property that the number A modifies. The number A, in some instances as used in the appended claims, may deviate by the percentages enumerated above provided that the amount by which A deviates does not materially affect the basic and novel characteristic(s) of the claimed invention. Also, all ranges include the maximum and minimum points disclosed and include any intermediate ranges therein, which may or may not be specifically enumerated herein.

CLAIMS

1. A computer-implemented method for managing a charging of an aerosol-generating system with electrical energy by an external charging device,

wherein the aerosol-generating system comprises a first device and a second device,

wherein each device includes an energy storage for storing electrical energy,

wherein the second device is removably electrically interconnected to the external charging device, and

wherein the first device and the second device are removably electrically interconnected to each other,

the method comprising:

determining a first maximum charging current providable by the external charging device,

determining a second maximum charging current providable from the energy storage of the second device to the energy storage of the first device,

determining which one of the first device and the second device is to be charged by the external charging device from the first and second maximum charging currents,

and, depending on a result of the step of determining which one of the first device and the second device is to be charged by the external charging device, selecting

either a first charging path, including charging the first device from the external charging device via the second device,

or a second charging path, including charging the second device from the external charging device and then charging the first device from the second device.

2. The method according to claim 1,

wherein the first charging path is chosen in case the first maximum charging current is greater than or equal to the second maximum charging current.

3. The method according to any one of the previous claims, comprising:

determining a capacity of the energy storage of the first device,

determining a capacity of the energy storage of the second device,

determining a target energy storage capacity of the first device,

wherein determining which one of the first charging path and the second charging path is chosen includes determining a time necessary to reach the target energy storage capacity in the first device by the first charging path and by the second charging path, and

wherein the first charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the first charging path is shorter than the time necessary to reach the target energy storage capacity in the first device by the second charging path, and wherein the second charging path is chosen when the time necessary to reach the target energy storage capacity in the first device by the second charging path is shorter than the time necessary to reach the target energy storage capacity in the first device by the first charging path.

4. The method according to the previous claim, wherein the target energy storage capacity is an energy storage capacity necessary to provide a user with at least one usage session or at least two usage sessions or at least three usage sessions.

5. The method according to any one of the previous claims, wherein the first device is at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy, preferably wherein the second device is at least one of an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy.

6. The method according to any one of the previous claims, wherein determining the first maximum charging current providable by the external charging device includes at least one of:

determining a third maximum charging current providable by the external charging device to the energy storage of the first device, and

determining a fourth maximum charging current providable by the external charging device to the energy storage of the second device.

7. The method according to the previous claim, wherein determining at least one of the third and fourth maximum charging currents includes reducing the maximum charging current providable by the external charging device by a portion used to power at least one auxiliary function of at least one of the first device and the second device, preferably wherein the at least one auxiliary function comprises a wireless communications arrangement, for example at least one of Wi-Fi, WLAN, and Bluetooth, a positioning system, for example GPS, a display device, a loudspeaker or a heating element.

8. The method according to any one of the previous claims, comprising determining a temperature of at least one of the first device and the second device, wherein at least one of determining the first maximum charging current and determining the second maximum charging current includes adjusting the current for the determined temperature.

9. The method according to any one of the previous claims, wherein determining the first maximum charging current providable by the external charging device includes determining the first maximum charging current from a charging circuit of at least one of the first device and the second device.

10. An aerosol-generating system, comprising a first device and a second device,

wherein the first device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy, and

wherein the second device is one of an aerosol-generating device and a companion device configured to charge an aerosol-generating device with electrical energy,

wherein each device includes an energy storage for storing electrical energy,

wherein at least one of the devices includes an electrical interconnection interface for receiving electrical energy from an external charging device,

wherein at least one of the devices includes processing circuitry comprising at least one processor, and

wherein the processing circuitry is configured to perform steps of the method according to any of the previous claims.

11. An aerosol-generating device, comprising

an energy storage for storing electrical energy,

an electrical interconnection interface for receiving electrical energy at the aerosol-generating device from at least one of an external charging device and a companion device configured to charge the aerosol-generating device with the electrical energy, and

processing circuitry comprising at least one processor,

wherein the processing circuitry is configured to perform steps of the method according to any of claims 1-9.

12. The aerosol-generating device according to the previous claim, comprising an aerosol-generating substrate or article, preferably wherein the aerosol-generating device is configured to generate aerosol from the aerosol-generating substrate or article.

13. A companion device configured to charge an aerosol-generating device with electrical energy, comprising

an energy storage for storing electrical energy,

an electrical interconnection interface for receiving electrical energy at the companion device from at least one of an external charging device and the aerosol-generating device, and

processing circuitry comprising at least one processor,

wherein the processing circuitry is configured to perform steps of the method according to any of claims 1-9.

14. A computer program, which when executed by an aerosol-generating device or a companion device configured to charge an aerosol-generating device with electrical energy, causes the device to perform steps of the method according to any one of claims 1-9.

15. A non-transitory computer-readable medium storing a computer program according to the previous claim.

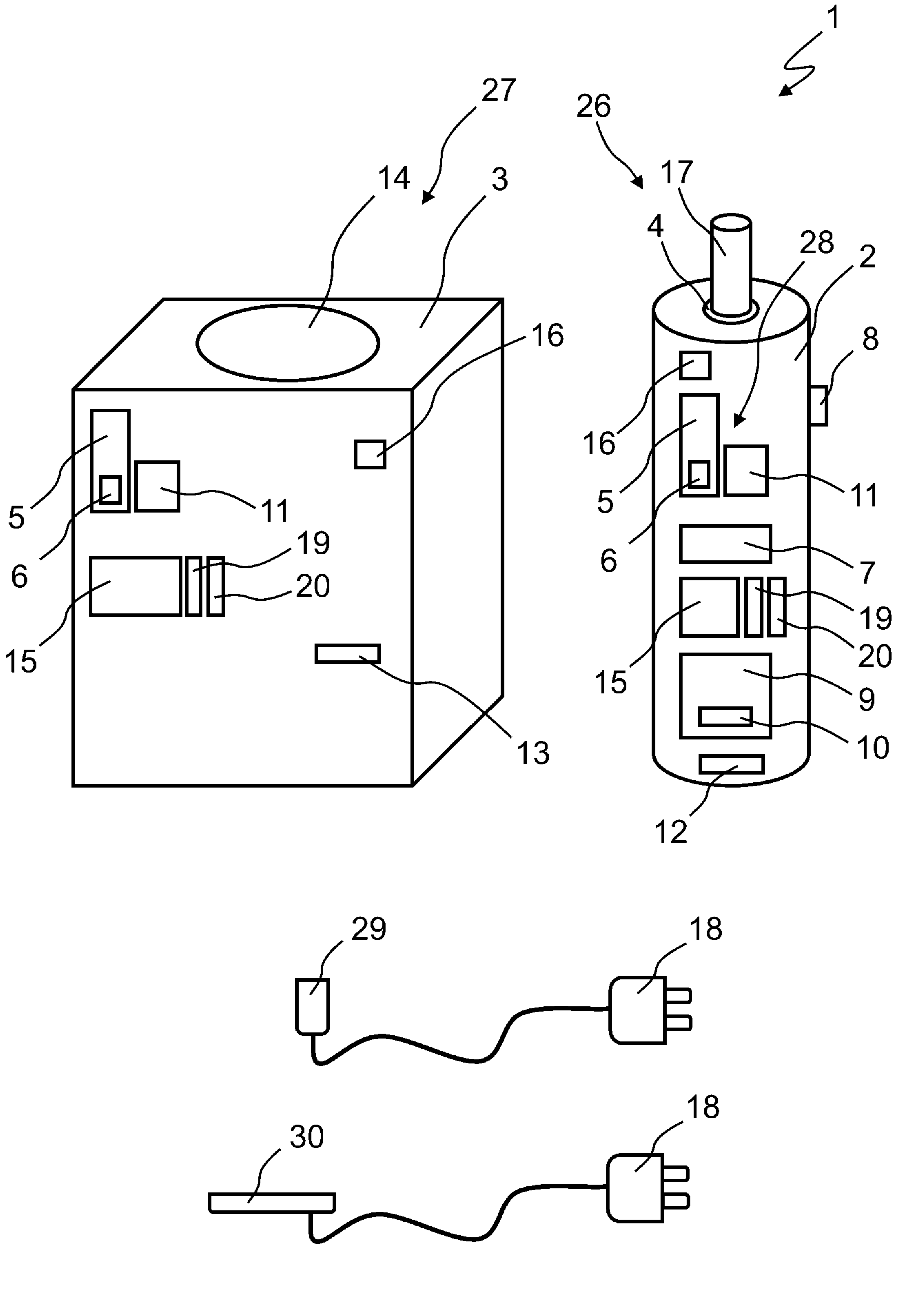

Fig. 1

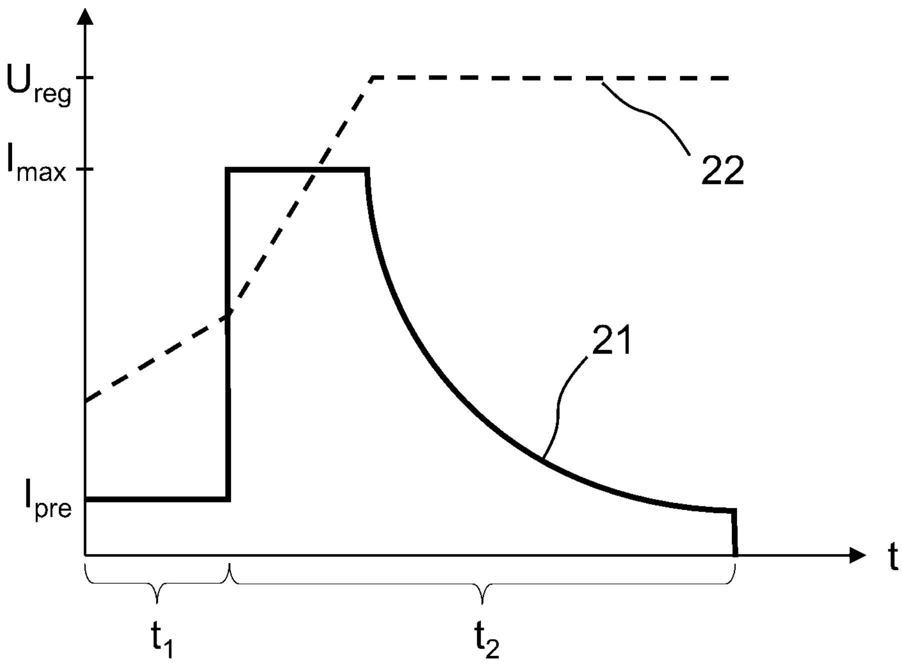

Fig. 2

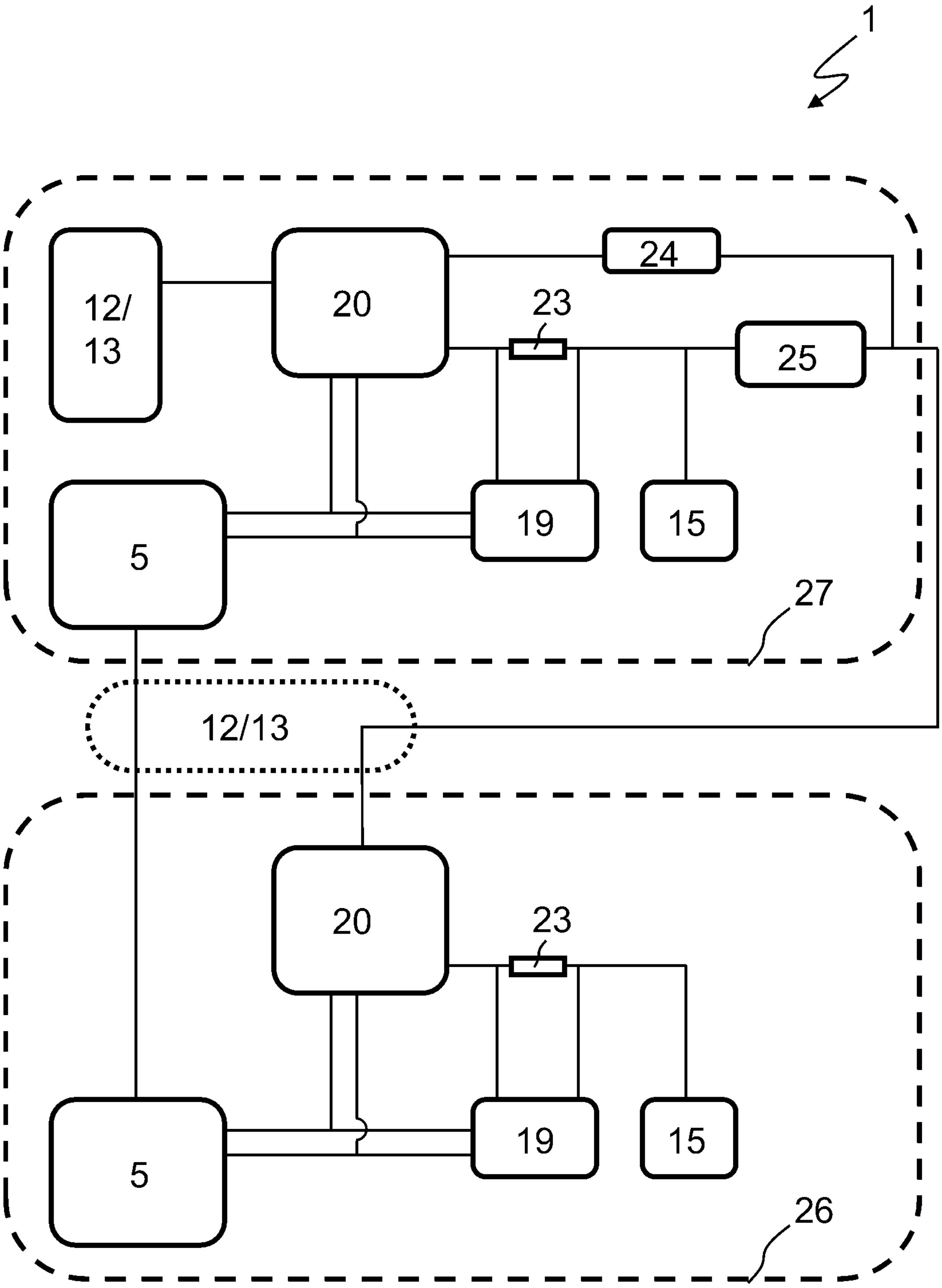

Fig. 3

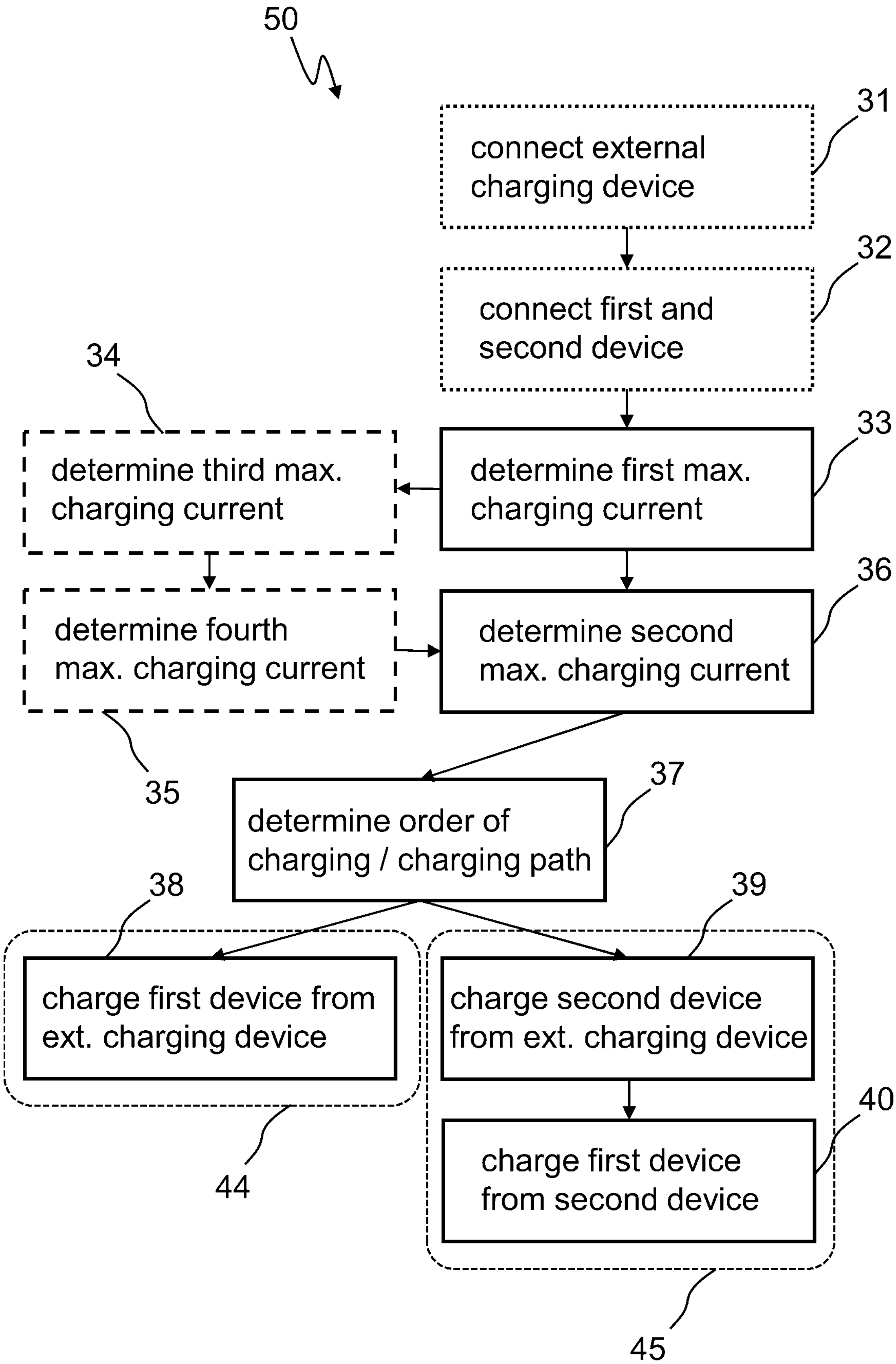
50
connect external charging device
31
connect first and second device
32
determine third max. charging current
34
determine first max. charging current
33
determine fourth max. charging current
35
determine second max. charging current
36
determine order of charging / charging path
37
charge first device from ext. charging device
38
charge second device from ext. charging device
39
charge first device from second device
40
44
45

Fig. 4

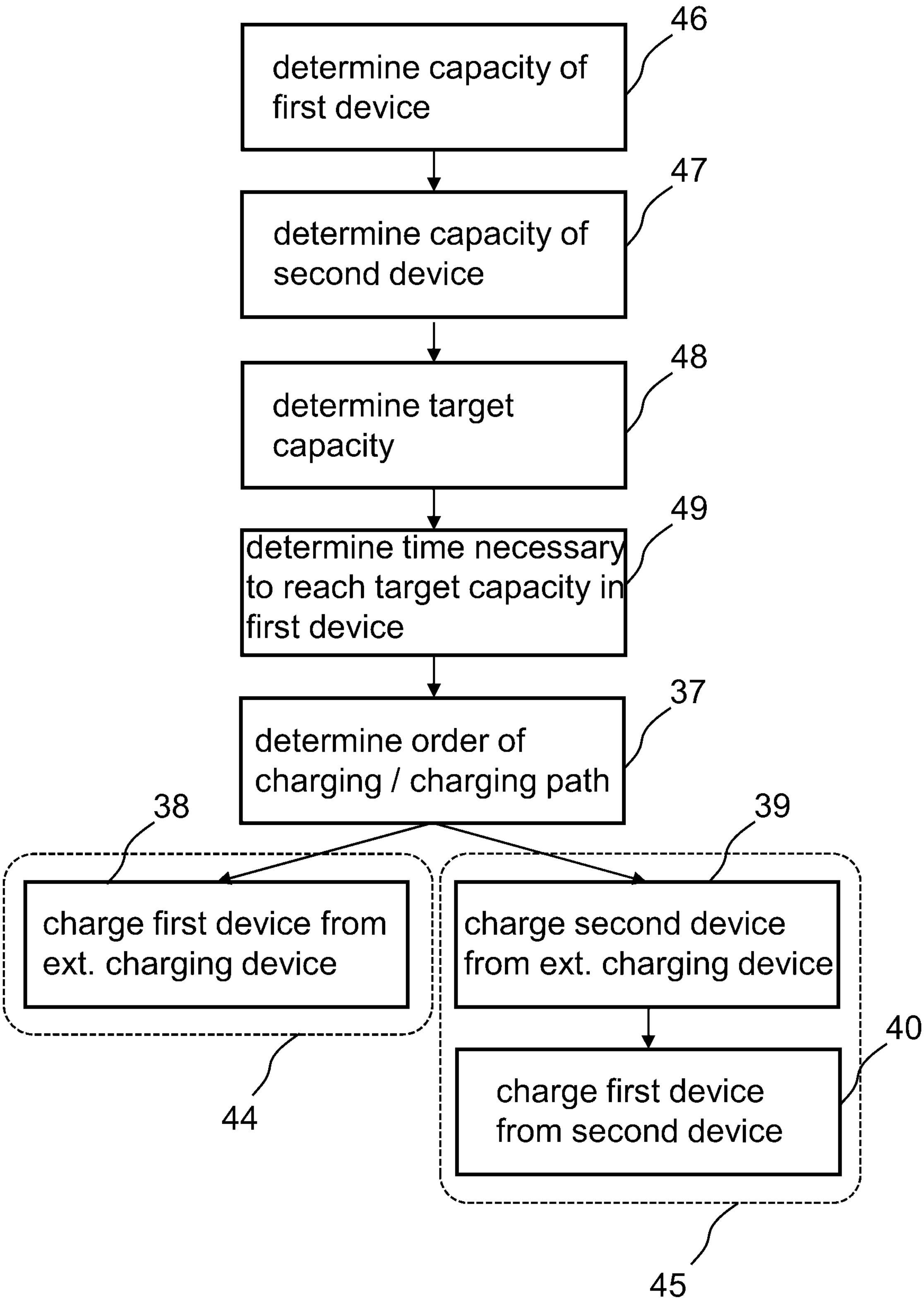
determine capacity of first device
46
determine capacity of second device
47
determine target capacity
48
determine time necessary to reach target capacity in first device
49
determine order of charging / charging path
37
charge first device from ext. charging device
38
44
charge second device from ext. charging device
39
charge first device from second device
40
45

Fig. 5

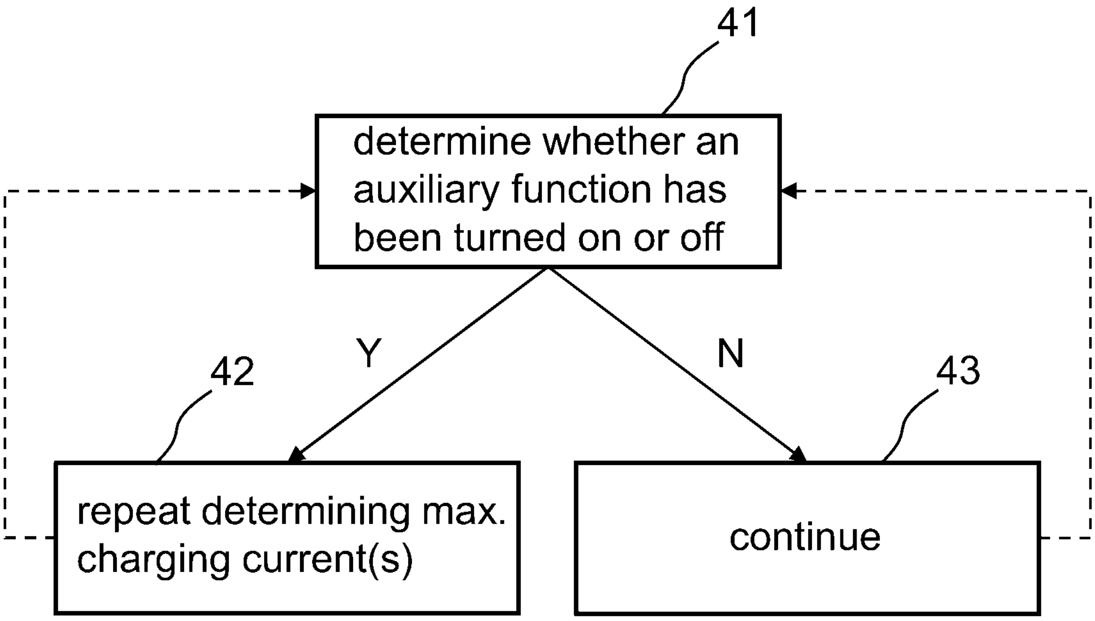
41
determine whether an auxiliary function has been turned on or off
Y
N
42
43
repeat determining max. charging current(s)
continue

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/CN2023/098038

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J7/00 A24F40/90 H02J7/34
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 A24F

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	US 2020/127478 A1 (GRATTON COLIN [GB]) 23 April 2020 (2020-04-23) figures 1,2,7,8 paragraph [0072] - paragraph [0079] paragraph [0088] - paragraph [0095] paragraph [0100] paragraph [0117] -----	1-15
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A	WO 2020/132127 A1 (JUUL LABS INC [US]) 25 June 2020 (2020-06-25) figure 7A paragraph [0107] - paragraph [0109] paragraph [0122] -----	1,10,11, 13-15
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 November 2023	29/11/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Despis, Enguerran

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INTERNATIONAL SEARCH REPORT

International application No
PCT/CN2023/098038

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023/043830 A1 (VALENTINE VAL [US]) 9 February 2023 (2023-02-09) figures 4,7 -----	1,10,11, 13-15

1

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