



(51) International Patent Classification:

A45D 20/10 (2006.01) A45D 20/12 (2006.01)

(21) International Application Number:

PCT/IB2023/060122

(22) International Filing Date:

09 October 2023 (09.10.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

2215208.6 14 October 2022 (14.10.2022) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,

(54) Title: HAIRCARE APPLIANCE

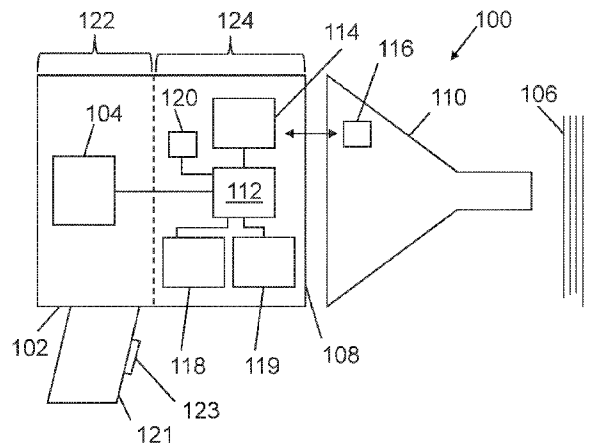


Fig. 1

(57) Abstract: The invention relates to a haircare appliance comprising an airflow generator for generating an airflow, and a sensor for detecting a usage condition of the haircare appliance. The haircare appliance further comprises a control unit configured to determine, based on an output signal from the sensor, if the usage condition satisfies a predetermined usage condition. If the control unit determines that the usage condition does not satisfy the predetermined usage condition for a predetermined period, the control unit is configured to put the airflow generator into an idle state in which a temperature and/or a flow rate of the airflow generated by the airflow generator are progressively reduced.

RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

HAIRCARE APPLIANCE

TECHNICAL FIELD

The present invention relates to a haircare appliance having an airflow generator,
5 a sensor for detecting a usage condition of the haircare appliance, and a control unit for
controlling the airflow generator.

BACKGROUND

The drying of hair has always been a significant part of one's daily or weekly
10 routine. A haircare appliance (e.g. a hair dryer) typically includes a body in which an
airflow generator is housed, the airflow generator being configured to generate an
airflow for drying and/or styling a user's hair. In most cases, the haircare appliance is
controlled manually via one or more switches on the body of the haircare appliance. The
one or more switches may be configured to enable the user to switch the airflow
15 generator on or off, as well as control parameters such as flow rate and temperature of
the airflow. In this manner, the haircare appliance can be used to provide particular hair
drying and/or styling effects.

With such a manually controlled haircare appliance, the user may tend to leave
the haircare appliance running for periods of time even when the airflow is not directed
20 towards the hair (e.g. between blow dry passes, whilst sectioning the hair, or while
applying a product to the hair). This may result in energy wastage, increased room
temperature, increased ambient noise, as well as potentially disrupt previously styled
sections of hair. A user could manually switch the haircare appliance off each time that
it is directed away from the hair, however this may present a nuisance to the user due to
25 the frequency of switching.

Issues associated with manual operation of the haircare appliance may be
alleviated by automating control of the airflow generator, which may involve use of a
sensor in the haircare appliance. For instance, some haircare appliances automatically
adjust a temperature of the airflow based on a proximity sensor that detects a proximity
30 of the user's hair to the haircare appliance.

The present invention has been devised in light of the above considerations.

SUMMARY

At its most general, the present invention provides a haircare appliance having an airflow generator where, if it is determined that the haircare appliance has not been used for a predetermined period, the airflow generator is put into an idle state in which a temperature and/or flow rate of the airflow generated by the airflow generator are progressively reduced. In other words, the temperature and/or flow rate of the airflow may be automatically reduced (e.g. gradually or incrementally) over time when the haircare appliance is not being used. In this manner, when the haircare appliance is temporarily set down by the user, the airflow generator may be put into the idle state rather than be immediately switched off. As the airflow generator is not immediately switched off in the idle state, it may be capable of responding much more quickly when the user picks the haircare appliance up again for use. For example, the airflow generator may be capable of reaching normal operating temperatures and flow rates more quickly from the idle state compared to when it is completely switched off. As a result, the user may not have to wait as long when picking up the haircare appliance in the idle state, thus leading to smoother operation of the haircare appliance and enhanced user experience.

Additionally, putting the airflow generator into the idle state in accordance with the invention may avoid keeping the airflow generator in a normal operating state during periods when it is not in active use (e.g. when it is temporarily set down by the user), thus reducing energy consumption and noise of the haircare appliance. This may also facilitate use of the haircare appliance, as the user need not switch on and off the haircare appliance each time they pick up and set down the haircare appliance. In particular, the user may occasionally set the haircare appliance onto a surface in order to free up their hands (e.g. to perform another task), which can lead to objects on the surface being blown and/or heated if the airflow generator is left in a normal operating state.

Therefore, the idle state of the invention may serve to reduce an energy consumption and noise of the haircare appliance when it is not actively being used by

the user, whilst enabling the airflow generator to reach a normal operating flow rate and temperature when the haircare appliance is picked up again for use.

According to a first aspect of the invention, there is provided a haircare appliance comprising: an airflow generator for generating an airflow; a sensor for
5 detecting a usage condition of the haircare appliance; a control unit configured to: determine, based on an output signal from the sensor, if the usage condition satisfies a predetermined usage condition; and if the control unit determines that the usage condition does not satisfy the predetermined usage condition for a predetermined period, put the airflow generator into an idle state in which a temperature and/or a flow
10 rate of the airflow generated by the airflow generator are progressively reduced.

The haircare appliance may include any suitable type of haircare appliance, such as a hair dryer, hair blower, hair curler or other.

The airflow generator may include a fan, blower or any other suitable device for generating an air flow. The airflow generator may be located in a housing of the
15 haircare appliance. The body may comprise an outlet, for discharging the airflow from the airflow generator.

The control unit may comprise any suitable computing or processing device(s) capable of performing the control steps described herein. The control unit may, for example, be implemented using a microcontroller or similar. The control unit may have
20 a processing element (e.g. a processor) and a memory coupled to the processing element, where the memory stores computer instructions that, when executed by the processor, cause the processor to perform control steps described herein.

The sensor may be communicatively coupled to the control unit (via a wired or wireless connection), i.e. so that the sensor can transmit an output signal to the control
25 unit.

The sensor is configured to detect a usage condition of the haircare appliance. The usage condition may comprise any suitable parameter or property relating to a current use or state of the haircare appliance. Various examples of a usage condition are described herein. By way of example, the usage condition may comprise one or more
30 of: a motion of the haircare appliance, an orientation of the haircare appliance, and whether the haircare appliance is held by a user or not. Herein, the sensor may also be

referred to as a first sensor, which is configured to detect a first usage condition. In particular, the sensor may be referred to as a first sensor in embodiments where the haircare appliance further comprises a second sensor, as described below.

The sensor may be a type of sensor that is specifically adapted (configured) for detecting the usage condition in question. For example, where the first usage condition comprises motion of the haircare appliance, the sensor may comprise a motion sensor. Where the usage condition is an orientation of the haircare appliance, the sensor may comprise an orientation sensor. Where the usage condition is whether the user is holding the haircare appliance or not, the sensor may comprise a sensor for detecting the user's grip on a handle of the haircare appliance.

The control unit is configured to receive the output signal from the sensor, and to determine if the usage condition satisfies the predetermined usage condition. The output signal from the sensor may be indicative (e.g. representative) of the usage condition. For instance, the output signal from the sensor may be indicative of a value (e.g. magnitude) for the first usage condition. The control unit may be configured to determine if the predetermined usage condition is satisfied by comparing the first usage condition (e.g. determined from the output signal from the sensor) to the predetermined usage condition.

The predetermined usage condition may be stored in a memory of the control unit. As an example, the predetermined usage condition may correspond to a predetermined value or range of values for the usage condition. If the usage condition determined from the output signal from the sensor matches the predetermined value or range of values, then the control unit may determine that the usage condition satisfies the predetermined usage condition.

The predetermined usage condition being satisfied may be indicative of the haircare appliance being used by the user. In contrast, the predetermined usage condition not being satisfied may indicate that the haircare appliance is not currently being used by the user, e.g. it may be set down on a surface. Thus, the predetermined usage selection may be set to correspond to typical values for the usage condition detected by the sensor when the haircare appliance is being used by the user.

The control unit is configured to put the airflow generator in an idle state if the control unit determines that the predetermined usage condition is not satisfied for a predetermined period (amount) of time. In other words, if the predetermined usage condition is not satisfied for a continuous period of time equal to or greater than the predetermined period, then the control unit puts the airflow generator in the idle state. Thus, the control unit may be configured to determine an amount of time for which the predetermined usage condition is not satisfied. For example, the control unit may comprise a timer (e.g. a microcontroller clock, or a crystal oscillator counter), and to determine, using the timer, amount of time for which the predetermined usage condition is not satisfied. For instance, the control unit may be configured to start a timer when the control unit first determines that the usage condition does not satisfy the predetermined usage condition.

The predetermined period may correspond to an amount of time, e.g. which is pre-set in a memory of the haircare appliance. The predetermined period may be set to avoid unwanted triggering of the idle mode, e.g. while the user is still using the haircare appliance. For example, the inventors have found that setting the predetermined period as 1 second or more may serve to avoid unwanted triggering of the idle mode, as such a predetermined period may increase the likelihood that the predetermined condition not being satisfied is actually a result of the user not currently using the haircare appliance. For instance, the predetermined period may be set to 1 second or more, 2 seconds or more, 3 seconds or more, 4 seconds or more, or some other suitable value.

Putting the airflow generator into an idle state comprises progressively reducing a temperature and/or a flow rate of the airflow generated by the airflow generator. In other words, the temperature and/or flow rate of the airflow may be reduced (e.g. gradually or incrementally) over time, once the predetermined usage condition is not satisfied for the predetermined period. In particular, the airflow rate and/or the temperature of the airflow may be reduced compared to a normal operating state of the airflow generator.

Thus, when the airflow generator is in a normal operating state in which it generates an airflow having a first flow rate and a first temperature, if the control unit determines that the predetermined usage condition is not satisfied for the predetermined

period, the control unit puts the airflow generator in the idle state, whereby the temperature of the airflow is reduced relative to the first temperature, and/or the flow rate is reduced relative to the first flow rate.

As an example, the progressive reduction in the idle state of the flow rate and/or temperature may comprise a gradual ramping down of the flow rate and/or temperature, e.g. from an initial value to a final value lower than the initial value. As another example, the progressive reduction in the idle state of the flow rate and/or temperature may comprise a stepped (e.g. incremental, sequential) reduction in the flow rate and/or temperature, e.g. from an initial value to a final value lower than the initial value.

In some cases, the airflow rate and the temperature of the airflow may be progressively reduced in the idle state until the airflow generator is completely switched off.

If the control unit determines that the usage condition does satisfy the predetermined usage condition, then the control unit may operate the airflow generator in a non-idle (e.g. normal) mode. Such a non-idle mode may comprise a manual control mode (e.g. based on manual user inputs) and/or an automatic control mode (e.g. where control is based on outputs from one or more sensors in the haircare appliance). In this manner, when the user is using the haircare appliance, the airflow generator may operate normally in accordance with a selected or configured operating mode.

The control unit may be configured to progressively reduce the temperature and/or flow rate of the airflow generated by the airflow generator by: putting the airflow generator in a first idle state in which the airflow has a reduced flow rate and/or temperature compared to a normal operating state of the airflow generator; and if the first usage condition is still not satisfied after a predetermined idle period, putting the airflow generator in a second idle state in which the flow rate and/or temperature of the airflow are further reduced compared to the first idle state.

Thus, if the predetermined usage condition is not satisfied for the predetermined period, the airflow generator may initially be put in the first idle state, and subsequently in the second idle state if the predetermined usage condition is still not satisfied after the predetermined idle state. In this manner, the flow rate and/or temperature of the airflow may be incrementally reduced based on the amount of time the haircare appliance is not

in active use (i.e. the amount of time for which the predetermined usage condition is not satisfied). For example, if the user is frequently setting down and picking up the haircare appliance, the airflow generator may only reach the first idle state when it is set down, so that the airflow generator can respond rapidly when the user picks up the haircare appliance again. On the other hand, if the haircare appliance is set down for longer periods of time, the airflow generator may reach the second idle state, thus further reducing energy consumption and noise, whilst still improving a response time of the airflow generator compared to when it is in a fully off state.

The predetermined idle period may be greater than the predetermined period. Both the predetermined idle period and the predetermined period may be measured from a time when the control unit first determines that the predetermined usage condition is not satisfied. As an example, as mentioned above, the predetermined period may be set to 1 second or more, and the predetermined idle period may be set to 5 seconds or more.

The sensor may comprise a motion sensor for detecting motion of the haircare appliance, and the control unit may be configured to determine a motion of the haircare appliance based on an output signal from the motion sensor, and to determine that the predetermined usage condition is satisfied if the motion of the haircare appliance exceeds a first motion threshold. In other words, the control unit may determine that the predetermined usage condition is not satisfied if the motion of the haircare appliance is below the first motion threshold. Thus, the motion sensor may be used to detect when the user is currently using the haircare appliance, e.g. as a user will typically move the haircare appliance around during use. On the other hand, when the haircare appliance is not in use (e.g. when it is set down on a surface), its motion may be below the first motion threshold, such that the predetermined usage condition is not satisfied and the airflow generator can be put in the idle state. Use of a motion sensor in the haircare appliance may thus enable accurate triggering of the idle state when the haircare appliance is not being used, e.g. when it has been set down by the user.

The first motion threshold may be set so that typical motions of the haircare appliance during use will exceed the first motion threshold. This may ensure reliable detection of when the user is using the haircare appliance, and avoid unwanted triggering of the idle state.

The motion sensor may comprise any sensor capable of detecting motion of the haircare appliance. For example, the motion sensor may comprise an accelerometer and/or a gyroscope. The output signal from the motion sensor may be indicative of an amount or magnitude of motion (e.g. acceleration, rotation) of the haircare appliance.

5 The first motion threshold may then correspond to a predetermined amount of motion of the haircare appliance.

The sensor may comprise a detector for detecting when a user holds the haircare appliance, and the control unit may be configured to determine that the predetermined usage condition is satisfied if the output signal from the sensor is indicative of the user
10 holding the haircare appliance. In other words, the control unit may determine that the predetermined usage condition is not satisfied if the output signal from the sensor is indicative of the user not currently holding the haircare appliance. This may enable effective detection of when the haircare appliance is not being used by the user, to enable accurate triggering of the idle state.

15 The detector may comprise any suitable detector for detecting when the user holds the haircare appliance. For example, the detector may comprise a touch sensor for detecting when the user touches the haircare appliance. Such a touch sensor may be in the form of an optical sensor which detects reflected light from the user's hand, a capacitive touch sensor, or a sensor that detects an impedance of the user's skin. As
20 another example, the detector may comprise a grip detector, for detecting when the user grips a handle of the haircare appliance. For example, the grip detector may detect a compression of a handle of the haircare appliance when the user grips the handle. The grip detector may, for example, be implemented with a transducer such as a strain gauge or a piezoresistive element. As a further example, the detector may include a switch or a
25 button which is arranged to be held down by the user when holding the haircare appliance, so that the control unit can detect when the user holds the haircare appliance.

The sensor may comprise an orientation sensor for detecting an orientation of the haircare appliance, and the control unit may be configured to determine the orientation of the haircare appliance based on an output signal from the orientation sensor, and to
30 determine that the predetermined usage condition is satisfied if the haircare appliance is oriented in a predetermined direction. In other words, the control unit may determine

that the predetermined usage condition is not satisfied if the haircare appliance is oriented in a direction different from the predetermined direction. The predetermined direction may correspond to an orientation in which the haircare appliance is typically held when in use. For example, the predetermined direction may correspond to an upright orientation of the haircare appliance (e.g. as opposed to a sideways orientation when the haircare appliance is laid down on a surface). The predetermined direction may encompass a range of orientations of the haircare appliance around the upright direction, to allow for a range of motion around the upright direction. In this manner, when the haircare appliance is not oriented in the predetermined direction, this may indicate that the user is not currently holding (or using) the haircare appliance. As a result, use of the orientation sensor may enable accurate triggering of the idle state when the haircare appliance is not being used, e.g. when it has been set down by the user.

The orientation sensor may comprise any sensor suitable of detecting an orientation of the haircare appliance. For example, the orientation sensor may comprise one or more of an accelerometer, a gyroscope, a magnetometer, and/or a tilt switch.

The haircare appliance may further comprise a second sensor for detecting a second usage condition of the haircare appliance, and the control unit may be further configured to: following a determination that the usage condition satisfies the predetermined usage condition, control the airflow generator based on an output signal from the second sensor. In this manner, automated control of the airflow generator based on the second sensor may only performed when the predetermined usage condition is satisfied (which is indicative of the haircare appliance being in use). The inventors have found that in some situations it may be undesirable for automated control of the airflow generator to be performed, as this may result in unwanted triggering of, or changes to, the airflow. For example, when the haircare appliance is not in active use, it may be undesirable to use automated control of the airflow generator, as this can in some circumstances result in unwanted triggering of the airflow generator. Thus, by first checking with the first sensor if the predetermined usage condition is met, it is possible to avoid automated control of the airflow generator in situations where this may be inconvenient or unwanted, to improve an overall user experience of the haircare appliance. In other words, this arrangement may enable the convenience of sensor-based

automated control of the airflow generator, whilst avoiding unwanted effects that can arise in situations where automated control is not desirable.

The second usage condition detected by the second sensor may be different from the first usage condition detected by the first sensor discussed above. In other words, the
5 second usage condition may relate to a different parameter or property relating to a current use or state of the haircare appliance, compared to the first usage condition. Various examples of a second usage condition are described herein. By way of example, the second usage condition may comprise one or more of: a distance to the user's hair, a property of the user's hair, a property of an environment around the haircare appliance,
10 relative movement between the haircare appliance and the user's hair, and a user command.

The second sensor may be a type of sensor that is specifically adapted (configured) for detecting the second usage condition in question. For example, where the second usage condition comprises a distance to the user's hair, the second sensor
15 may comprise a distance sensor. Where the second usage condition comprises a property of the user's hair, the second sensor may comprise an optical sensor for detecting the property of the user's hair. Examples of types of second sensor are given below.

The control unit may control the airflow generator based on the output signal from
20 the second sensor by taking the output signal from the second sensor as an input, e.g. in an algorithm for controlling the airflow generator. Control of the airflow generator based on the output signal from the second sensor may be based on one or more predetermined rules, e.g. which may be implemented in a control algorithm. The output signal from the second sensor may be indicative (e.g. representative) of the second
25 usage condition. For instance, the output signal from the second sensor may be indicative of a value for the second usage condition.

Controlling the airflow generator may comprise controlling an output of the airflow generator, i.e. controlling the airflow generated by the airflow generator. For example, controlling the airflow generator may include one or more of the following
30 steps: activating the airflow generator (i.e. so that it generates an airflow), deactivating the airflow generator (i.e. so that it stops generating the airflow), controlling a flow rate

of the airflow, controlling a temperature of the airflow. Accordingly, when the predetermined usage condition is satisfied, the output of the airflow generator may be automatically controlled, taking the output signal from the second sensor as an input.

In some embodiments, there may be multiple (e.g. two or more) first sensors, each of which is configured to detect a respective first usage condition. Each first usage condition may be associated with a respective predetermined usage condition. Then, the control unit may only be configured to control the airflow generator based on the output signal from the second sensor if each of the respective predetermined usage conditions is satisfied.

In some embodiments, there may be multiple (e.g. two or more) second sensors, each of which is configured to detect a respective second usage condition. Then, the control unit may use the output signals from each of the second sensors when controlling the airflow generator.

Where the first sensor comprises a motion sensor as described above, the control unit may be configured to control the airflow generator based on the output signal from the second sensor only when the motion of the haircare appliance is between the first motion threshold and a second motion threshold, the second motion threshold being greater than the first motion threshold. In this manner, automated control of the airflow generator based on the second sensor may only be performed when the motion of the haircare appliance is between the first motion threshold and the second motion threshold. The second motion threshold may act to deactivate the automated control in cases of rapid or erratic motion of the haircare appliance. The inventors have found that, when the haircare appliance is moved rapidly or erratically, readings from the second sensor may be inaccurate and/or the control unit may not be able to effectively control the airflow generator due to the rapidly changing reading from the second sensor. Accordingly, the second motion threshold may serve to avoid inaccurate control of the airflow generator where the haircare appliance is moved too rapidly or erratically.

The control unit may be configured to only put the airflow generator in the idle state when the motion of the haircare appliance is below the first motion threshold. Although the predetermined usage condition may not be satisfied above the second

motion threshold, it may not be appropriate to put the airflow generator in the idle state in such a situation, as the haircare appliance is likely in active use.

The second sensor may comprise a distance sensor for detecting a distance between the distance sensor and hair of a user, and wherein the controller is configured to control the airflow generator based on the output signal from the second sensor by: determining, based on the output signal from the second sensor, a distance to the user's hair; and activating the airflow generator when the distance to the user's hair is less than a threshold activation distance. In this manner, the airflow generator may be automatically activated when the distance to the user's hair is less than the threshold activation distance. This may avoid the user having to manually switch on the airflow generator, thus facilitating use of the haircare appliance. Moreover, as automatic activation of the airflow generator is performed following a determination that the predetermined usage condition is met, it is possible to avoid triggering of the airflow generator in situations where it is not wanted or needed. For example, when the haircare appliance is set down such that the predetermined usage condition is not satisfied, the airflow generator will not be triggered, even if the distance sensor detects an object within the threshold activation distance.

The distance sensor may comprise any suitable sensor for detecting a distance to the user's hair. For example, the distance sensor may comprise a time-of-flight (ToF) sensor, or any other type of proximity sensor capable of detecting a distance to the user's hair. The distance sensor is configured to provide an output signal to the control unit, which the control unit can use to determine the distance to the user's hair. The output signal may be indicative of the distance to the user's hair, so that the control unit can determine the distance from the received output signal. The threshold activation distance may be set in accordance with user preferences, so that the airflow generator is triggered at distances at which the user typically holds the haircare appliance from their hair.

The controller may be further configured to activate the airflow generator following a determination that the distance to the user's hair is less than the threshold activation distance for a predetermined activation delay. This may serve to ensure that the user has sufficient time to properly position the haircare appliance before the airflow

generator is activated. This may also avoid disrupting parts of the user's hair which have already been styled.

The controller may be further configured to, when the airflow generator is activated, and following a determination that the distance to the user's hair continuously exceeds the threshold activation distance for a predetermined deactivation delay, deactivate the airflow generator. In this manner, once the airflow generator is activated, the airflow generator may only be deactivated after the distance to the user's hair exceeds the threshold activation distance for more than the deactivation delay. This may enable quick cyclical or successive passes over the user's hair without the airflow generator being deactivated between passes over the user's hair.

The second sensor may comprise a detector for detecting a property of a user's hair. For example, the detector may detect properties of the user's hair such as a temperature a moisture content, colour, thickness or type, strand alignment, and/or shine/reflectivity of the user's hair. The control unit may then control the airflow generator in accordance with the detected property of the user's hair. For example, where the user's hair temperature exceeds a predetermined threshold, the temperature of the airflow may be reduced.

The second sensor may comprise an environmental sensor for detecting a property of an environment around the haircare appliance. For example, the environmental sensor may detect properties of the environment such as a temperature of the environment, or a humidity of the environment. The control unit may then control the airflow generator in accordance with the detected property of the environment. For example, where the temperature of the environment exceeds a predetermined threshold, the temperature of the airflow may be reduced.

The second sensor may comprise a sensor for detecting a relative movement between the haircare appliance and a user's hair. Any suitable type of sensor for detecting relative movement between the haircare appliance and the user's hair can be used. As an example, the sensor could include an optical flow sensor for detecting relative movement between the haircare appliance and the user's hair. As another example, the sensor may comprise a roller that is configured to rotate in response to friction cause by relative motion between the haircare appliance and the user's hair.

Motion of the roller may be detected in a variety of different ways, e.g. using an optical encoder (e.g. where a reflective element or pin hole is attached to the roller) or a hall effect sensor (e.g. where a magnet is positioned on the roller).

Control of the airflow generator based on the relative movement between the haircare appliance and the user's hair can include a variety of different control steps. As an example, the temperature of the airflow may be controlled based on the relative movement, e.g. to maintain a consistent hair temperature regardless of the speed of the relative movement. As another example, the temperature of the airflow may be reduced if no relative movement is detected, e.g. to prevent overheating of the user's hair.

The second sensor comprises a user command detector, for detecting a command from a user. In this manner, the airflow generator can be controlled based on a command received from the user. For example, the user command detector may comprise a microphone for detecting a voice command from the user. As another example, the user command detector may comprise a gesture detector for detecting a gesture of the user. By only controlling the airflow generator based on the user command detector when the predetermined usage condition is satisfied, it is possible to avoid unwanted triggering/control of the airflow generator in response to detected utterances from the user when the haircare appliance is not in use.

The control unit may be configured to control a temperature and/or a flow rate of the airflow generated by the airflow generator based on the output signal from the second sensor.

In a second aspect of the invention, there is provided a method of operating a haircare appliance having an airflow generator for generating an airflow, the method comprising: determining, using a control unit of the haircare appliance, if a usage condition of the haircare appliance satisfied a predetermined usage condition, based on an output signal received from a sensor in the haircare appliance; and following a determination that the usage condition does not satisfy the predetermined condition for a predetermined period, putting, by the control unit, the airflow generator into an idle state in which a temperature and/or a flow rate of the airflow generated by the airflow generator are progressively reduced.

The method of the second aspect may be used to operate the haircare appliance of the first aspect. Therefore, any features discussed above in relation to the first aspect of the invention may be shared with the second aspect of the invention. For example, any control steps performed by the control unit in the first aspect of the invention may be implemented as a method step in the second aspect of the invention.

More generally, features described above in connection with the first aspect of the invention are equally applicable to the second aspect of the invention, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a haircare appliance according to an embodiment;

Fig. 2 is a flow diagram illustrating a method according to an embodiment;

Fig. 3 is a flow diagram illustrating a method according to an embodiment;

Fig. 4 is a flow diagram illustrating a method according to an embodiment;

Fig. 5 is a schematic perspective view of a haircare appliance according to an embodiment;

Fig. 6 is a schematic cross-sectional view of part of the haircare appliance of Fig. 4; and

Fig. 7 is a flow diagram illustrating a method according to embodiment.

DETAILED DESCRIPTION

Fig. 1 is a schematic diagram of a haircare appliance 100 according to an embodiment. The haircare appliance 100 may, for example, be a hair dryer, a hair curler, or some other type of haircare appliance. The haircare appliance 100 includes a body 102 in which an airflow generator 104 is housed. The airflow generator 104 is configured to generate an airflow which is directed towards an outlet of the body 102, so that the airflow can be directed at a user's hair 106. The airflow generator 104 may include any suitable device for generating an airflow, such as a fan, turbine or blower.

The body 102 may also house a heater (not shown) for heating the airflow generated by the airflow generator 104.

The body 102 includes an attachment region 108 located on an end of the body 102, to which an accessory 110 is removably attachable. When the accessory 110 is attached to the body 102 at the attachment region 108, it is arranged to receive the airflow generated by the airflow generator 104 and discharge the airflow towards the user's hair 106. In particular, the attachment region 108 may be located so that when the accessory 110 is attached at the attachment region 108, the airflow passes from the outlet of the body 102 into the accessory 110, which then discharges the airflow towards the user's hair 106 located in front of the accessory 110. For example, the accessory 110 may include a hollow body which defines a passageway or channel for directing and/or shaping the airflow. In Fig. 1, the accessory 110 is shown spaced apart from the attachment region 108, i.e. the accessory 110 is not attached to the body 102 in Fig. 1. The attachment region 108 and the accessory 110 may include any suitable means for removably attaching the accessory at the attachment region 108. For instance, the attachment region 108 and the accessory 110 may include engageable features which are configured to releasably engage one another, to hold the accessory 110 at the attachment region 108.

The body 102 further includes a control unit 112, which may be implemented for example by a microcontroller. The control unit 112 is communicatively coupled (via a wired or wireless connection) to the airflow generator 104, so that the control unit 112 can control operation of the airflow generator 104, e.g. by transmitting control signals to the airflow generator 104. The control unit 112 is also communicatively coupled (via a wired or wireless connection) to a first sensor 118 and a second sensor 119. The first sensor 118 is configured to detect a first usage condition of the haircare appliance 100, whilst the second sensor 119 is configured to detect a second usage condition of the haircare appliance 100. The first sensor 118 is arranged to provide an output signal indicative (representative) of the first usage condition to the control unit 112, whilst the second sensor 119 is arranged to provide an output signal representative of the second usage condition to the control unit 112. Note that in some embodiments, the haircare appliance need not necessarily include the second sensor 119.

The first sensor 118 may include a variety of different types of sensor, depending of the first usage condition to be detected. For example, the first sensor 118 may be configured to detect a motion of haircare appliance 100, in which case the first sensor 118 may comprise an accelerometer and/or gyroscope. As another example, the first sensor 118 may be configured to detect when a user is holding the haircare appliance 100. In such a case, the first sensor 118 may comprise a touch detector and/or a grip detector for detecting when the user is holding a handle 121 of the haircare appliance 100. Note that in such a case the first sensor 118 may be located in the handle 121 instead of in a main part of the body 102 as shown in Fig. 1. As a further example, the first sensor 118 may comprise an orientation sensor, for detecting an orientation of the haircare appliance, e.g. for detecting when it is in an upright position. Such an orientation sensor may be implemented using one or more of an accelerometer, a gyroscope, a magnetometer, and/or a tilt switch.

Likewise, the second sensor 119 may include a variety of different sensor types, depending on the second usage condition to be detected. For example, the second sensor 119 can include a distance sensor which is configured to detect a distance between the distance sensor 119 and the user's hair 106 located in front of the haircare appliance 100. Various known types of distance sensors may be used. As an example, the distance sensor 118 may include a time of flight (ToF) sensor. Such a ToF sensor may include a light emitter (e.g. a laser or a LED) and a receiver (e.g. a photodetector). The ToF sensor may be configured to emit a light signal with the light emitter, and to detect a reflected light signal that is reflected back from the user's hair 106. The light (i.e. electromagnetic radiation) emitted by the light emitter may be visible, infrared, ultraviolet, radiofrequency, microwave, or any other suitable type of electromagnetic radiation. The distance to the user's hair 106 can then be calculated using any suitable technique. For example, the distance to the user's hair 106 can be calculate from an amount of time emission of the light signal by the emitter and detection of the reflected light signal at the receiver. As another example, the distance to the user's hair 106 can be calculated based on an intensity of the reflected light signal detected by the receiver.

As another example, the second sensor 119 may include a detector for detecting a property of the user's hair, such as temperature or moisture of the user's hair. For

instance, the second sensor 119 may comprise a temperature sensor for detecting a temperature of the user's hair. As a further example, the second sensor 119 may include an environmental sensor for detecting a property of an environment around the haircare appliance 100. For instance, the second sensor 119 may include a temperature sensor for detecting a temperature of the environment. As yet a further example, the second sensor 119 may include a relative motion sensor, for detecting relative motion between the haircare appliance and the user's hair 106.

The control unit 112 is configured to use the output from the first sensor 118 to determine if a predetermined usage condition is satisfied. For example, the haircare appliance 100 may include a memory 120 which is accessible by the control unit 112. In some cases, the memory 120 may be included as part of the control unit 112 itself. The memory 120 is configured to store data indicative of the predetermined usage condition. In this manner, the control unit 112 can compare the output signal received from the first sensor 118 to the data stored in the memory 120, to determine if the predetermined usage condition is satisfied. For instance, the predetermined usage condition may correspond to a value or range of values for the output signal from the first sensor 118. Then, if the output signal from the first sensor 118 matches the value or range of values stored in the memory 120, the control unit 112 may determine that the predetermined usage condition is met.

If the control unit 112 determines that the predetermined usage condition is not satisfied for a predetermined period, then the control unit 112 puts the airflow generator 104 into an idle state, in which a temperature and/or flow rate of the airflow generated by the airflow generator 104 are progressively reduced. Examples of putting the airflow generator 104 into an idle state are discussed in more detail below. On the other hand, if the control unit 112 determines that the predetermined usage condition is met, the control unit 112 may be configured to control the airflow generator 104, taking the output signal from the second sensor 119 as an input. In particular, the control unit 112 may control a flow rate and/or temperature of the airflow generated by the airflow generator 104, as well as activate or deactivate the airflow generator. The control unit may control the airflow generator 104 based on the output from the second sensor 119

using a predetermined set of rules, e.g. implemented in an algorithm that is carried out by the control unit 112.

The control unit 112 may also be communicatively coupled (via a wired or wireless connection) to an identifier sensor 114 located in the body 102. The identifier sensor 114 is configured to detect an identifier 116 located in the accessory 110 when the accessory 110 is attached to the body 102 at the attachment region 108. The identifier 116 is indicative of a type of the accessory 110. The identifier sensor 114 is configured to provide an output signal indicative of the detected identifier 116 to the control unit 112, so that the control unit can determine the type of the accessory 110.

For example, the memory 120 may store a database which associates each of a plurality of accessory types with a respective identifier. Then, the control unit 112 can look up the accessory type associated with the identifier detected by the identifier sensor 114, to determine the type of the accessory. Various types of identifiers can be used, and the identifier sensor 114 is specifically adapted to the type of identifier 116 used, so that the identifier sensor 114 can effectively detect the identifier 116 and generate a corresponding output signal. By way of example, the identifier 116 may include a distinguishing mark on the accessory 110, in which case the identifier sensor 114 may include an optical detector for detecting the distinguishing mark. As another example, the identifier 116 may include one or more magnets in the accessory 110, in which case the identifier sensor 114 may include a magnetometer for detecting the one or more magnets. As a further example, the identifier 116 may include an electrical component (e.g. resistor, capacitor and/or inductor) in the accessory 110, in which case the identifier sensor 114 may be configured to measure a property of the electrical component (e.g. resistance, capacitance and/or inductance). In some case the identifier 116 may be in the form of a radio-frequency identification (RFID) tag in the accessory 110. The RFID tag may be passive or active. The identifier sensor 114 may then comprise an antenna which is configured to read the RFID tag wirelessly, in order to obtain identification information from the RFID tag.

The haircare appliance 100 may further comprise a user input 123 in the form of a switch, button, or other suitable user interface. The user input 123 is communicatively coupled to the control unit 112 (via a wired or wireless connection), so that the control

unit 112 can receive a signal from the user input 123. The user input 123 may, for example, be used to select an operating mode of the haircare appliance, as discussed below.

In some embodiments, the body 102 may be formed of a main body portion 122 in which the airflow generator 104 is located, and an intermediate body portion 124 in which the control unit 112, identifier sensor 114, first sensor 118, second sensor 119 and memory 120 are located. The intermediate body portion 124 may be removably attachable to the main body portion 122, e.g. the intermediate body portion 124 may be engageable with the main body portion 122 to attach the intermediate body portion 124 to the main body portion 122. The main body portion 122 and the intermediate body portion 124 may have connectors (e.g. pogo pins or similar) which are configured to engage with one another when the intermediate body portion 124 is attached to the main body portion 122, in order to connect the control unit 112 to the airflow generator 104. Alternatively, the control unit 112 may be configured to communicate wirelessly with the airflow generator 104. The attachment region 108 may be located on an end of the intermediate body portion 124, such that in use the intermediate body portion 124 may be connected between the main body portion 122 and the accessory 110. The intermediate portion 124 may be configured to convey the airflow from the airflow generator 104 to the accessory 110, which then discharges (i.e. expels) the airflow towards the user's hair 106. Housing electronics such as the control unit 112, identifier sensor 114, first sensor 118, second sensor 119 and memory 120 in the intermediate body portion 124 may enable a haircare appliance having the main body portion 122 to be retro-fitted with the intermediate body portion 124, in order to enable control of the airflow generator 104 by the control unit 112.

An example of putting the haircare appliance 100 into an idle state will now be discussed, with reference to Fig. 2. Fig. 2 shows a flow diagram illustrating a method 200 according to an embodiment. The method 200 may be initiated at step 202, e.g. by turning on the haircare appliance 100 or otherwise starting a use session of the haircare appliance 100. At step 204, the control unit 112 determines if the predetermined usage condition is satisfied. To do this, the control unit 112 receives the output signal from the first sensor 118, and compares the output signal to the predetermined usage condition

stored in the memory 120. If the output signal matches the predetermined usage condition (e.g. if a value detected by the first sensor 118 matches a value or range of values corresponding to the predetermined usage condition), then the control unit 112 determines that the predetermined usage condition is satisfied, and the method proceeds to step 210. Otherwise, if the predetermined usage condition is not satisfied, the method proceeds to step 206.

At step 206, the control unit 112 determines if an idle timing condition is satisfied. In particular, the control unit 112 determines an amount of time for which the predetermined usage condition has not been satisfied. If the amount of time for which the predetermined usage condition has not been satisfied exceeds a predetermined period, then the control unit 112 determines that the idle timing condition is satisfied. To determine the amount of time for which the predetermined usage condition has not been satisfied, the control unit 112 may employ a timer or clock (e.g. a microcontroller clock or a crystal oscillator counter). For example, the control unit 112 may start a timer the first time that the predetermined usage condition is determined not to be satisfied at step 204, so that the control unit 112 can determine the amount of time that has elapsed since the initial determination of the predetermined usage condition not being satisfied. The predetermined period may correspond to a parameter that is stored in the memory 120. The predetermined period may be set so as to avoid unwanted triggering of the idle state whilst the haircare appliance 100 is still in use. By way of example, the predetermined period may be set to 1 second or more (e.g. 1, 2, or 3 seconds).

If the idle timing condition is determined to be satisfied, the method 200 proceeds to step 208. Otherwise, if the idle timing condition is not yet satisfied, the method 200 returns to step 204 to determine again if the predetermined usage condition is satisfied. At step 208, the control unit 112 puts the airflow generator 104 into an idle state. In the idle state, the temperature and/or the flow rate of the airflow generated by the airflow generator 104 are progressively reduced, e.g. they may be gradually or incrementally reduced over time. The temperature and/or flow rate of the airflow may be gradually decreased relative to a normal operating state of the haircare appliance 100. For example, if at the start 202 the airflow generator 104 is in a normal operating state with a first airflow rate and a first temperature, when the airflow generator 104 is put into the

idle state at step 208, the airflow rate may be progressively reduced relative to the first airflow rate, and/or the temperature of the airflow may be progressively reduced relative to the first temperature. Following the putting of the airflow generator 104 into the idle state, the method 200 returns to the step 204 to check if the predetermined usage condition is still not satisfied, and thus if the airflow generator should be kept in the idle state or not. When the airflow generator 104 is in the idle state, automated control of the airflow generator 104 based on the second sensor 119 may be deactivated.

If at step 204 the control unit 112 determines that the predetermined usage condition is satisfied, then the method 200 proceeds to step 210 and the airflow generator 104 is not put into the idle state. Step 210 may involve various different operations of the control unit 112, depending on a current operation of the haircare appliance 100. For example, where the airflow generator 104 is in a normal operating state, the control unit 112 may keep the airflow generator 104 in the normal operating state, e.g. so that the output of the airflow generator 104 remains unchanged. In some cases, step 210 may involve performing automated control of the airflow generator 104 based on the output signal from the second sensor 119. An example of this is described below with reference to Fig. 4, which illustrates a sequence of control steps that may be performed following a determination that the predetermined usage condition is satisfied.

The control unit 112 may repeat the loop of method 200 at regular intervals, in order to repeatedly determine if the airflow generator 104 should be put into the idle state. In this manner, the idle state may be accurately triggered based on a current usage condition of the haircare appliance 100.

Fig. 3 shows a flow diagram illustrating a method 300 according to an embodiment. The method 300 may be used with the haircare appliance 100, and implemented by the control unit 112 discussed above. The method 300 represents a particular implementation of the method 200 described above, and any features discussed in relation to the method 200 may be shared with the method 300 (and vice versa).

The method 300 serves to progressively reduce a power consumption of the haircare appliance when it is not in active use, e.g. when it has been set down by the user. At step 302, the control unit 112 determines if the predetermined usage condition

is satisfied, using the output signal from the first sensor 118. Step 302 is equivalent to the step 204 of the method 200 discussed above, and may be implemented as discussed above. If the predetermined usage condition is satisfied, the method proceeds to step 304 and does not put the airflow generator 104 into an idle state. Step 304 is equivalent to the step 210 discussed above, and may be implemented as discussed above. In particular, the step 304 may involve a variety of different control steps, e.g. as discussed with reference to Fig. 4 below. Otherwise, if at step 302 the predetermined usage condition is not satisfied, the method 300 proceeds to step 306.

At step 306, the control unit 112 determines if a first idle timing condition is satisfied. In more detail, the control unit 112 determines the amount of time for which the predetermined usage condition has continuously not been satisfied. For example, the control unit 112 may start a timer when it initially determines that the predetermined usage condition is not satisfied, so that it can determine the amount of time since the initial determination. The control unit 112 then determines if the first idle timing condition is satisfied if the predetermined usage condition has not been satisfied for a predetermined first idle period. For example, the predetermined first idle period may be a period of at least 1 second, such as 1 second or 2 seconds. Thus, if the amount of time for which the predetermined usage condition is not satisfied exceeds the predetermined first idle period, then the control unit 112 determines that the first idle timing condition is satisfied. The first idle timing condition being satisfied may indicate that the haircare appliance 100 has not been in active use for at least the predetermined first idle period (e.g. for 1 or 2 seconds).

If the first idle timing condition is not yet satisfied, then the method 300 returns to the step 302. If the first idle timing condition is satisfied, then the method 300 proceeds to step 308 and puts the airflow generator 104 into a first idle state. In the first idle state, the airflow generated by the airflow generator 104 has a reduced flow rate and/or temperature compared to a normal (i.e. non-idle) operating state of the airflow generator 104. In other words, at step 308, the flow rate and/or the temperature of the airflow are reduced, without completely switching off the airflow generator 104. For example, if at the start of the method 300 the airflow generator 104 is in a normal operating state with a first airflow rate and a first temperature, when the airflow generator 104 is put into the

first idle state at step 308, the airflow rate may be reduced relative to the first airflow rate, and/or the temperature of the airflow may be reduced relative to the first temperature. When the airflow generator 104 is in the first idle state 308, automated control of the airflow generator 104 based on the second sensor 119 may be deactivated,
5 as in step 214 described above. This may avoid unwanted control of the airflow generator 104 when it is in the first idle state.

Following a determination that the first idle timing condition is satisfied, the method 300 also proceeds to step 310, where the control unit 112 determines if a second idle timing condition is satisfied. In particular, the control unit 112 determines (e.g.
10 using the timer mentioned above), if the amount of time for which the predetermined usage condition has not been satisfied exceeds a predetermined second idle period, the predetermined second idle period being greater than the first predetermined idle period. For example, the second predetermined idle period may be 5 seconds or greater. Thus, the second idle timing condition being satisfied may indicate that the haircare appliance
15 100 has not been in active use for a longer period of time, i.e. for at least the predetermined second idle period (e.g. for at least 5 seconds).

If the second idle timing condition is not yet satisfied, then the method 300 returns to the step 302, to check again if the predetermined usage condition is satisfied and determine if the airflow generator 104 should be kept in the first idle state. If the second
20 idle timing condition is satisfied, then the method 300 proceeds to step 312 and puts the airflow generator 104 in a second idle state. In other words, the airflow generator 104 is transitioned from the first idle state into the second idle state. In the second idle state, the flow rate and/or temperature of the airflow generated by the airflow generator 104 are further reduced compared to the first idle state. In this manner, where the haircare
25 appliance 100 has not been used for a longer period of time, energy consumption and noise of the haircare appliance 100 may be reduced automatically. In some cases, the airflow generator 104 may be switched off when in the second idle state. Following step 312, the method 300 returns to step 302, to check again if the predetermined usage condition is satisfied, to determine if the airflow generator 104 should be kept in the
30 second idle state. When the airflow generator 104 is in the second idle state, automated control of the airflow generator 104 based on the second sensor 119 may be deactivated.

This may avoid unwanted control of the airflow generator 104 when it is in the second idle state.

In the example of Fig. 3, there are two idle states, corresponding to an incremental (stepped) reduction in the temperature and/or flow rate of the airflow between the first idle state and the second idle state. In other examples, there may be more than two idle states (e.g. three, four or more idle states), with each subsequent idle state being associated with a respective timing condition, and involving a further reduction in temperature and/or flow rate of the airflow compared to the previous idle state. In this manner, the temperature and/or flow rate of the airflow may be gradually stepped down over time, the longer that the haircare appliance 100 is not used by the user.

An example of control of the airflow generator 104 by the control unit 112 using the second sensor 119 will now be described with reference to Fig. 4. Fig. 4 shows a flow diagram illustrating a method 400 according to an embodiment.

The method 400 may be initiated at step 402, e.g. by turning on the haircare appliance 100 or otherwise starting a use session of the haircare appliance 100. At step 404, the control unit 112 checks if a predetermined user input condition is satisfied. To do this, the control unit 112 may receive an output signal from the user input 123. For example, the user input 123 may be a switch or a toggle which enables the user to select a manual control mode or an automatic control mode. If the user input 123 is set to the automatic control mode, then the control unit 112 may determine that the predetermined user input condition is satisfied, in which case the method proceeds to step 406. Otherwise, if the predetermined user input condition is not satisfied (e.g. if the user input 123 is set to the manual control mode), then the method proceeds to step 414.

At step 406, the control unit 112 determines if the predetermined usage condition is satisfied. This is equivalent to the step 204 described above, and may be performed as described above. If the output signal from the first sensor 118 matches the predetermined usage condition (e.g. if a value detected by the first sensor 118 matches a value or range of values corresponding to the predetermined usage condition), then the control unit 112 determines that the predetermined usage condition is satisfied, and the method proceeds to step 408. Otherwise, if the predetermined usage condition is not satisfied, the method proceeds to step 414.

Additionally, if at step 406 it is found that the predetermined usage condition is not satisfied, step 416 is also performed. At step 416, the control unit 116 determines if an idle timing condition is satisfied. This is equivalent to step 206 described above, and is performed in the same manner. If the idle timing condition is determined to be satisfied, the method 400 proceeds to step 418. Otherwise, if the idle timing condition is not yet satisfied, the method 400 returns to step 404. At step 418, the control unit 112 puts the airflow generator 104 into an idle state. This is equivalent to the step 208 described above, and is performed in the same manner. In some cases, instead of steps 416 and 418, steps equivalent to steps 306, 308, 310 and 312 described above may be implemented, e.g. to implement a first and second idle state as described above.

As noted above, if at step 406 the predetermined usage condition is determined to be satisfied, the method 400 proceeds to step 408. At step 408, the control unit 112 determines if a predetermined accessory condition is satisfied. To do this, the control unit 112 receives the output signal from the identifier sensor 114 and determines the type of the accessory 110 attached at the attachment region 108. For example, the control unit 112 may look up in the memory 120 the accessory type corresponding to the identifier detected by the identifier sensor 114. If the determined accessory type corresponds to any of one or more predetermined accessory types (e.g. stored in the memory 120), then the control unit 112 determines that the predetermined accessory condition is satisfied, and the method proceeds to step 410. Otherwise, if the determined accessory type does not correspond to a predetermined accessory type, then the method proceeds to step 414.

At step 410, the control unit 112 determines if any timing conditions associated with any of steps 404-408 are satisfied. For example, a timing condition may be associated with step 406, whereby the timing condition for step 206 is only satisfied if an amount of time in which the predetermined usage condition is satisfied exceeds a predetermined threshold. In other words, the predetermined usage condition must be continuously satisfied for an amount of time exceeding the predetermined threshold (which may be stored in the memory 120), in order for the timing condition at step 410 to be satisfied. Using such a timing condition may serve to ensure that the predetermined usage condition being satisfied is as a result of the user intending to use

the haircare appliance 100, rather than as a result of a spike in the output signal from the first sensor 118. The control unit 112 may use an internal clock in order to count the amount of time for which the predetermined usage condition is satisfied.

At step 412, the control unit uses the output signal from the second sensor 119 as an input for controlling the airflow generator 104. In particular, the control unit 112 may control a temperature and/or flow rate, as well as activate or deactivate the airflow generator 104, using the output signal from the second sensor 119 as an input (e.g. in a control algorithm). More specific examples of the types of control that may be performed using the output signal from the second sensor 119 are discussed below, in relation to Figs. 5-6. Following the control of the airflow generator 104 at step 412, the method 400 returns to step 404, such that the checks of steps 404-410 are performed again to determine if automated control of the airflow generator 104 using the second sensor 119 should continue.

Where any of the conditions checked in steps 404-410 are not satisfied, the method proceeds to step 414. At step 414, the control unit 112 does not control the airflow generator 104 based on the output signal from the second sensor 119. In other words, automated control of the airflow generator 104 using the second sensor 119 is disabled if any of the conditions checked in steps 404-410 is not satisfied. For example, if the predetermined user input condition is not satisfied (step 404), this may mean that the user input 123 is set to the manual control mode, such that automated control of the airflow generator 104 is not needed. If the predetermined usage condition is not satisfied (step 406), this may mean that the haircare appliance 100 is not in active use by the user, such that it may not be desirable to perform automated control of the airflow generator 104. If the accessory condition is not satisfied (step 408), this may mean that manual control of the airflow generator is preferred for the type of accessory attached at the attachment region. If the timing condition is not satisfied (step 410), this may mean, for example, that the predetermined usage condition has not been satisfied for long enough to confirm that the haircare appliance is actually in active use by the user.

In some implementations, at step 414, the airflow generator 104 may remain in its current state. For example, where the airflow generator 104 is in an off (or on) state, it may remain in the off (or on) state. Where the airflow generator 104 is in an on state,

the flow rate and temperature of the airflow may remain unchanged, or it may be controlled manually (e.g. where the user input 123 is set to manual control mode), at step 414. In some cases, at step 414 the airflow generator may be controlled using the output signal from the first sensor 118 as an input, e.g. as discussed above in relation to Figs. 2-3. In particular, the airflow generator 104 may be put into the idle state based on the output signal from the first sensor 118, in accordance with steps 416 and 418. Following step 414, the method 400 returns to step 404, such that the checks of steps 404-410 are performed again to determine if automated control of the airflow generator 104 using the second sensor 119 should be performed. The control unit 112 may repeat the loop of method 400 at regular intervals, in order to repeatedly determine if the second sensor 119 should be used to control the airflow generator 104. In this manner, control of the airflow generator 104 may be dynamically adapted to the current usage conditions of the haircare appliance 100.

Turning to Figs. 5 and 6, a haircare appliance 500 according to an embodiment will now be described. The haircare appliance 500 operates in a similar way to the haircare appliance 100 described above, and any features discussed in relation to the haircare appliance 100 may be shared with the haircare appliance 500 (and vice versa). Fig. 5 shows a schematic perspective view of the haircare appliance 500, whilst Fig. 6 shows a schematic cross-sectional view of part of the haircare appliance 500.

The haircare appliance 500 includes a body 502 in which an airflow generator (not shown) is located. In this example, the airflow generator may be located in a handle 503 of the body 502. The body 502 includes an attachment region located on an end of the body 502, to which an accessory 510 is removably attachable (in a manner analogous to the accessory 110 being removably attachable to the attachment region 108). In Figs. 5 and 6, the accessory 510 is shown as being attached at the attachment region.

As shown in Fig. 6, a control unit 512 is mounted within the body 502. The control unit 512 is split between two locations in the haircare appliance 500. Specifically, the control unit 512 includes a first microcontroller which is located in a central portion of the body which is located at a central axis of the body 502, and a second microcontroller located in a main part of the body 502. A first sensor in the form of a motion sensor 517 is located in the body 502, and communicatively coupled to the

control unit 512. For example, the motion sensor 517 may be implemented with an accelerometer. A second sensor in the form of a single pixel ToF sensor 518, and an identifier sensor in the form of a magnetometer 514 are also mounted within the body 502. As can be seen, the magnetometer 514 and the ToF sensor 518 are located in the central portion of the body at the central axis of the body 502, such that the magnetometer 514 and the ToF sensor 518 are centred within an airflow channel 509 within the body 502. In this manner, the magnetometer 514 and the ToF sensor 518 are centred relative to the attachment region and thus relative to the accessory 510 when the accessory 510 is attached at the attachment region. In other words, the magnetometer 514 and the ToF sensor 518 are arranged so that they are aligned with a central axis of the accessory 510 when the accessory 510 is attached at the attachment region. The body 502 may further include a memory which is accessible by the control unit 512, and which performs a function analogous to the memory 120 discussed above. The haircare appliance 500 may also include a user interface (e.g. similar to the user input 123), to enable selection between operating modes such as a manual control mode and an automatic control mode.

As noted above, in the present embodiment, the control unit 412 is split between two locations in the haircare appliance 400, which enables various functions of the control unit 412 to be split across the two locations. This may allow for more processing capacity as well as enable parallel processing across the two locations. In one example, the first microcontroller located in the central portion of the body 402 may implement sensor reading functions (e.g. for the ToF sensor 418 and the magnetometer 414), as well as other functions such as LED control. The first microcontroller may also detect a state of a mode selection button on the haircare appliance 400 (e.g. selection between automatic control and manual control modes). The second microcontroller located in the main part of the body 402 may act as the main controller, and may thus implement functions for controlling the airflow generator (including heater control) discussed herein. The first microcontroller may be connected to the second microcontroller, to provide sensor readings to the second microcontroller to enable control of the airflow generator. The second microcontroller may also read states of various buttons (such as a button for selecting heat level and/or a button for selecting flow level), as well as

implement fault detection processes. Using the first microcontroller to obtain sensor readings may facilitate providing sensor readings to the second microcontroller, as only a single communication channel between the first and second microcontrollers may be required (e.g. as opposed to individually connecting each sensor to the second
5 microcontroller), which may facilitate integration of multiple sensors into the haircare appliance 400. Of course, in other embodiments the control unit 412 may be implemented at a single location in the haircare appliance 400, e.g. using a single microcontroller.

The motion sensor 517 is configured to detect a motion of the haircare appliance
10 500, and to generate an output signal which is indicative (representative) of the motion. For example, the motion sensor 517 may detect an acceleration and/or an angular velocity of the haircare appliance 500, and output a signal which indicates a magnitude of the acceleration and/or the angular velocity. The ToF sensor 518 is configured to detect a distance to the user's hair, in a manner similar to the distance sensor 118
15 discussed above. In particular, the ToF sensor 518 may include an emitter configured to emit a light signal towards the user's hair, and a receiver configured to detect a reflected light signal from the user's hair. The ToF sensor may then provide an output signal to the control unit 512 which is indicative of an amount of time taken for the reflected light signal to reach the receiver. As the ToF sensor 518 is located centrally within the body
20 502, the light signals may pass through an opening in the accessory 410 when the accessory 510 is attached at the attachment region, in order to reach the user's hair. Alternatively, windows may be formed in the accessory 510 for transmitting the light signals between the ToF sensor 518 and the user's hair.

The accessory 510 includes a plurality of magnets, which may serve to secure the
25 accessory 510 to the attachment region on the body 502. For example, the body 502 may include a set of magnets which is arranged to attract the magnets in the accessory 510 in order to retain the accessory 510 at the attachment region. The magnets in the accessory 510 further act as an identifier for the accessory (e.g. like the identifier 116 discussed above). In particular, when the accessory 510 is attached at the attachment
30 region, the magnetometer 514 can detect a magnetic field caused by the magnets in the accessory 510 and generate an output signal which is indicative of the magnetic field

experienced by the magnetometer 514. For example, the magnetometer 514 may be a 3-axis magnetometer, such that the magnetometer 514 can determine a strength and/or orientation of the magnetic field. The control unit 512 can then determine a type of the accessory based on the output signal received from the magnetometer 514. Different accessories may include different arrangements of magnets, which may result in different field strengths and/or orientations detected by the magnetometer 514. For example, different numbers of magnets can be used, different arrangements of magnet polarisation can be used, and/or different sizes and strengths of magnets can be used. In this manner, each accessory type may have a particular arrangement of magnets, resulting in a recognisable magnetic signature for that accessory type. The control unit 512 can then determine the accessory type using a database (e.g. stored in a memory located in the body 502) which associates each of a plurality of accessory types with respective magnetic signature (e.g. magnetic field strength and/or orientation detected by the magnetometer 514).

In order to control the airflow generator in the haircare appliance 500, the control unit 512 implements a method similar to the method 400 described above. In more detail, the control unit 512 uses the output signal from the motion sensor 417 to determine if the predetermined usage condition is satisfied at step 506. Specifically, the control unit 512 determines a magnitude of the motion (e.g. acceleration and/or angular velocity) of the haircare appliance 500 from the output signal received from the motion sensor 517, and compares the magnitude of the motion to a first motion threshold. If the magnitude of the motion is greater than the first motion threshold, then the control unit 512 determines that the predetermined usage condition is satisfied, and proceeds to step 408 of the method 400. The first motion threshold may correspond to a predetermined magnitude of motion which is indicative of the haircare appliance 500 being held for use by the user. In this manner, if the magnitude of motion of the haircare appliance 500 exceeds the first motion threshold, this may be indicative of the user using the haircare appliance 500, such that automated control of the airflow generator can be performed.

In some cases, at step 406 of the method 400, the control unit 512 may further be configured to compare the magnitude of motion of the haircare appliance 500 to a second motion threshold, which is greater than the first motion threshold. If the

magnitude of motion of the haircare appliance 500 is greater than the second motion threshold, then the control unit 512 determines that the predetermined usage condition is not satisfied. In other words, the control unit 512 may only determine that the predetermined usage condition is satisfied if the magnitude of motion of the haircare appliance 500 is between the first motion threshold and the second motion threshold. Using the higher second motion threshold may serve to cut off automated control of the haircare appliance 500 in situations where the haircare appliance 500 is moved rapidly or erratically, as automated control of the haircare appliance 500 may not be suitable in such a situation.

If the control unit 512 determines that the conditions of steps 404-410 are satisfied, then the control unit 512 controls the airflow generator using the output signal from the ToF sensor 518 as an input. The control unit 512 implements a control algorithm which takes the distance to the user's hair (as determined from the ToF sensor 518), together with any other suitable sensor readings, as inputs. Controlling the airflow generator can include activating the airflow generator, deactivating the airflow generator, controlling a flow rate of the airflow (e.g. by controlling a speed of the airflow generator), and/or controlling a temperature of the airflow (e.g. by controlling a heater in the body 502).

An example of control of the airflow generator performed by the control unit 512 will now be described. The control unit 512 may be configured to only activate the airflow generator when the distance to the user's hair is less than a threshold activation distance. In this manner, the airflow generator may be activated when it is brought within the threshold activation distance from the user's hair, and deactivated when it is moved further away than the threshold activation distance from the user's hair. This may avoid having to manually switch the haircare appliance 500 on an off, which may reduce an energy wastage and facilitate use of the haircare appliance 500. The threshold activation distance may be a preset parameter which is stored in a memory of the haircare appliance 500.

In addition to using a threshold activation distance, the control unit 512 can also use an activation delay. In particular, the control unit 512 may be configured to only activate the airflow generator after the control unit 512 determines that the distance to

the user's hair has been less than the threshold activation distance for an amount of time corresponding to the activation delay. In other words, the user must hold the haircare appliance 500 within the threshold activation distance for at least the activation delay, in order for the airflow generator to be activated (i.e. switched on). This may avoid
5 spurious or unintended activation of the airflow generator, and may serve to ensure that the haircare appliance 500 is properly aligned with the user's head prior to activating the airflow generator. Similarly, the control unit 512 may also use a deactivation delay. In particular, the control unit 512 may be configured to, following activation of the airflow generator, only deactivate the airflow generator after the control unit 512 determines
10 that the distance to the user's hair has continuously exceeded the threshold activation distance for an amount of time corresponding to the deactivation delay. In other words, the control unit 512 only deactivates (i.e. switches off) the airflow generator after the user continuously holds the haircare appliance 500 at a distance greater than the threshold activation distance for more than the deactivation delay. This may avoid
15 intermittent switching off of the airflow generator, e.g. when making quick passes with the haircare appliance 500 over the user's head.

The control unit 512 may perform other types of control in addition to or instead of the examples given above. For example, the control unit 512 may adjust a temperature and/or a flow rate of the airflow generated by the airflow generator based
20 on the distance to the user's hair. For instance, in some cases, instead of switching off the airflow generator when the distance to the user's hair exceeds the threshold activation distance, the control unit 512 may reduce the temperature and/or flow rate of the airflow. The examples of control given for the control unit 512 are equally applicable to the control unit 112 discussed above, and may be adapted for use with
25 different types of sensors (e.g. in addition to, or instead of the ToF sensor 518).

Fig. 7 shows a flow diagram illustrating a method 700 according to an embodiment. The method 700 represents an adaptation of the method 300 for use with a haircare appliance of the invention that uses a motion sensor as its first sensor. For example, the method 700 may be used with the haircare appliance 500 described above.
30 For the purposes of illustration, the method 700 will be described in the context of the

haircare appliance 500, however the method 700 is not limited to use with the haircare appliance 500.

Similarly to the method 300, the method 700 serves to progressively reduce a power consumption of the haircare appliance when it is not in active use, e.g. when it has been set down by the user. At step 702, the control unit 512 determines if the motion of the haircare appliance 500 is below the first motion threshold. In particular, as discussed above, the control unit 512 uses the output signal from the motion sensor 517, to determine if the motion of the haircare appliance 500 is below the first motion threshold. If the motion of the haircare appliance 500 is determined to not be below the first motion threshold (e.g. it is above the first motion threshold), then the method 700 moves on to step 704. At step 704, the control unit 512 again uses the output signal from the motion sensor 517, this time to determine if the motion of the haircare appliance 500 is below the second motion threshold. If the motion of the haircare appliance 500 is determined to be below the second motion threshold, then the predetermined usage condition may be determined to be satisfied. In other words, the combination of steps 702 and 704 may correspond to the determining if the predetermined usage condition is satisfied in step 302 of method 200 or in step 406 of method 400. If the predetermined usage condition is determined to be satisfied (i.e. if the motion of the haircare appliance is between the first and second motion thresholds), then at step 706 the method does not put the airflow generator into an idle state. For example, at step 706 the method 700 may return to the method 400 and perform the steps of method 400 following a determination that the predetermined usage condition is satisfied (i.e. steps 408-414).

Otherwise, if at step 704 it is determined that the motion of the haircare appliance 500 is not below the second motion threshold (e.g. it is above the second motion threshold), then the predetermined usage condition is not satisfied and the method moves on to step 708. At 708, the control unit 512 determines to not use the second sensor (e.g. the ToF sensor 518) for controlling the airflow generator. In other words, step 508 corresponds to the step 414 of method 400 described above.

If at step 702 it is determined that the motion of the haircare appliance 500 is below the first motion threshold, then the control unit moves on to step 710 to check if a

first idle timing condition is satisfied. Step 710 is equivalent to the step 306 described above, and performed in an analogous manner. In particular, the control unit 512 determines an amount of time for which the motion of the haircare appliance 500 has been continuously below the first motion threshold, e.g. using a timer. If the amount of time for which the motion of the haircare appliance 500 has been continuously below the first motion threshold exceeds a first idle period, then the control unit 512 determines that the first idle timing condition is satisfied. If the control unit 512 determines that the first idle timing condition not yet satisfied, then the method 700 returns to step 702.

If at step 710 the first idle timing condition is satisfied, then the method 700 proceeds to step 712 and puts the airflow generator into a first idle state. This is equivalent to the step 308 described above, and may involve the same operations as described in relation to step 308. Following a determination that the first idle timing condition is satisfied, the method 700 also proceeds to step 714, where the control unit 512 determines if a second idle timing condition is satisfied. Step 714 is equivalent to the step 310 described above, and performed in an analogous manner. In particular, the control unit 512 determines an amount of time for which the motion of the haircare appliance 500 has been continuously below the second motion threshold, e.g. using the timer. If the amount of time for which the motion of the haircare appliance 500 has been continuously below the second motion threshold exceeds a second idle period (greater than the first idle period), then the control unit 512 determines that the second idle timing condition is satisfied. If the second idle timing condition is not yet satisfied, then the method 700 returns to the step 702, to check again if the motion of the haircare appliance 500 is below the first motion threshold to determine if the airflow generator should be kept in the first idle state. If the second idle timing condition is satisfied, then the method 700 proceeds to step 716 and puts the airflow generator in a second idle state. Step 716 is equivalent to the step 312 described above, and may involve the same operations as described in relation to step 312.

The method 700 is implemented as a loop, which the control unit 512 may repeat at regular intervals, in order to repeatedly determine if the airflow generator should be put into either of the idle states, and/or if automated control based on the second sensor

should be performed. In this manner, control of the airflow generator may be dynamically adapted to current usage conditions of the haircare appliance 500.

The features disclosed in the foregoing description, or in the following claims, or in the accompanying drawings, expressed in their specific forms or in terms of a means
5 for performing the disclosed function, or a method or process for obtaining the disclosed results, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

While the invention has been described in conjunction with the exemplary
embodiments described above, many equivalent modifications and variations will be
10 apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

For the avoidance of any doubt, any theoretical explanations provided herein are
15 provided for the purposes of improving the understanding of a reader. The inventors do not wish to be bound by any of these theoretical explanations.

Any section headings used herein are for organizational purposes only and are not to be construed as limiting the subject matter described.

Throughout this specification, including the claims which follow, unless the
20 context requires otherwise, the word “comprise” and “include”, and variations such as “comprises”, “comprising”, and “including” will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

It must be noted that, as used in the specification and the appended claims, the
25 singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from “about” one particular value, and/or to “about” another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by the use of the
30 antecedent “about,” it will be understood that the particular value forms another

embodiment. The term “about” in relation to a numerical value is optional and means for example $\pm 10\%$.

CLAIMS

1. A haircare appliance comprising:

an airflow generator for generating an airflow;

a sensor for detecting a usage condition of the haircare appliance;

5 a control unit configured to:

determine, based on an output signal from the sensor, if the usage condition satisfies a predetermined usage condition; and

10 if the control unit determines that the usage condition does not satisfy the predetermined usage condition for a predetermined period, put the airflow generator into an idle state in which a temperature and/or a flow rate of the airflow generated by the airflow generator are progressively reduced.

2. A haircare appliance according to claim 1, wherein the control unit is configured
15 to progressively reduce the temperature and/or flow rate of the airflow generated by the airflow generator by:

putting the airflow generator in a first idle state in which the airflow has a reduced flow rate and/or temperature compared to a normal operating state of the airflow generator; and

20 if the first usage condition is still not satisfied after a predetermined idle period, putting the airflow generator in a second idle state in which the flow rate and/or temperature of the airflow are further reduced compared to the first idle state.

3. A haircare appliance according to claim 2, wherein the predetermined idle
25 period is greater than the predetermined period.

4. A haircare appliance according to any preceding claim, wherein the sensor comprises a motion sensor for detecting motion of the haircare appliance, and wherein the control unit is configured to determine a motion of the haircare appliance based on
30 an output signal from the motion sensor, and to determine that the predetermined usage

condition is satisfied if the motion of the haircare appliance exceeds a first motion threshold.

5. A haircare appliance according to any preceding claim, wherein the sensor comprises a detector for detecting when a user holds the haircare appliance, and wherein the control unit is configured to determine that the predetermined usage condition is satisfied if the output signal from the sensor is indicative of the user holding the haircare appliance.

6. A haircare appliance according to any preceding claim, wherein the sensor comprises an orientation sensor for detecting an orientation of the haircare appliance, and wherein the control unit is configured to determine the orientation of the haircare appliance based on an output signal from the orientation sensor, and to determine that the predetermined usage condition is satisfied if the haircare appliance is oriented in a predetermined direction.

7. A haircare appliance according to any preceding claim, further comprising a second sensor for detecting a second usage condition of the haircare appliance, wherein the control unit is further configured to: following a determination that the usage condition satisfies the predetermined usage condition, control the airflow generator based on an output signal from the second sensor.

8. A haircare appliance according to claims 4 and 7, wherein the control unit is configured to control the airflow generator based on the output signal from the second sensor only when the motion of the haircare appliance is between the first motion threshold and a second motion threshold, the second motion threshold being greater than the first motion threshold.

9. A haircare appliance according to claim 7 or 8, wherein the second sensor comprises a distance sensor for detecting a distance between the distance sensor and

hair of a user, and wherein the controller is configured to control the airflow generator based on the output signal from the second sensor by:

determining, based on the output signal from the second sensor, a distance to the user's hair; and

5 activating the airflow generator when the distance to the user's hair is less than a threshold activation distance.

10. A haircare appliance according to claim 9, wherein the controller is further configured to:

10 activate the airflow generator following a determination that the distance to the user's hair is less than the threshold activation distance for a predetermined activation delay; and/or

when the airflow generator is activated, and following a determination that the distance to the user's hair continuously exceeds the threshold activation distance for a
15 predetermined deactivation delay, deactivate the airflow generator.

11. A haircare appliance according to one of claims 7 to 10, wherein the second sensor comprises a detector for detecting a property of a user's hair.

20 12. A haircare appliance according to one of claims 7 to 11, wherein the second sensor comprises an environmental sensor for detecting a property of an environment around the haircare appliance.

13. A haircare appliance according to one of claims 7 to 12, wherein the second
25 sensor comprises a sensor for detecting a relative movement between the haircare appliance and a user's hair.

14. A haircare appliance according to one of claims 7 to 13, wherein the second sensor comprises a user command detector, for detecting a command from a user.

30

15. A haircare appliance according to one of claims 7 to 14, wherein the control unit is configured to control a temperature and/or a flow rate of the airflow generated by the airflow generator based on the output signal from the second sensor.

5 16. A method of operating a haircare appliance having an airflow generator for generating an airflow, the method comprising:

determining, using a control unit of the haircare appliance, if a usage condition of the haircare appliance satisfied a predetermined usage condition, based on an output signal received from a sensor in the haircare appliance; and

10 following a determination that the usage condition does not satisfy the predetermined condition for a predetermined period, putting, by the control unit, the airflow generator into an idle state in which a temperature and/or a flow rate of the airflow generated by the airflow generator are progressively reduced.

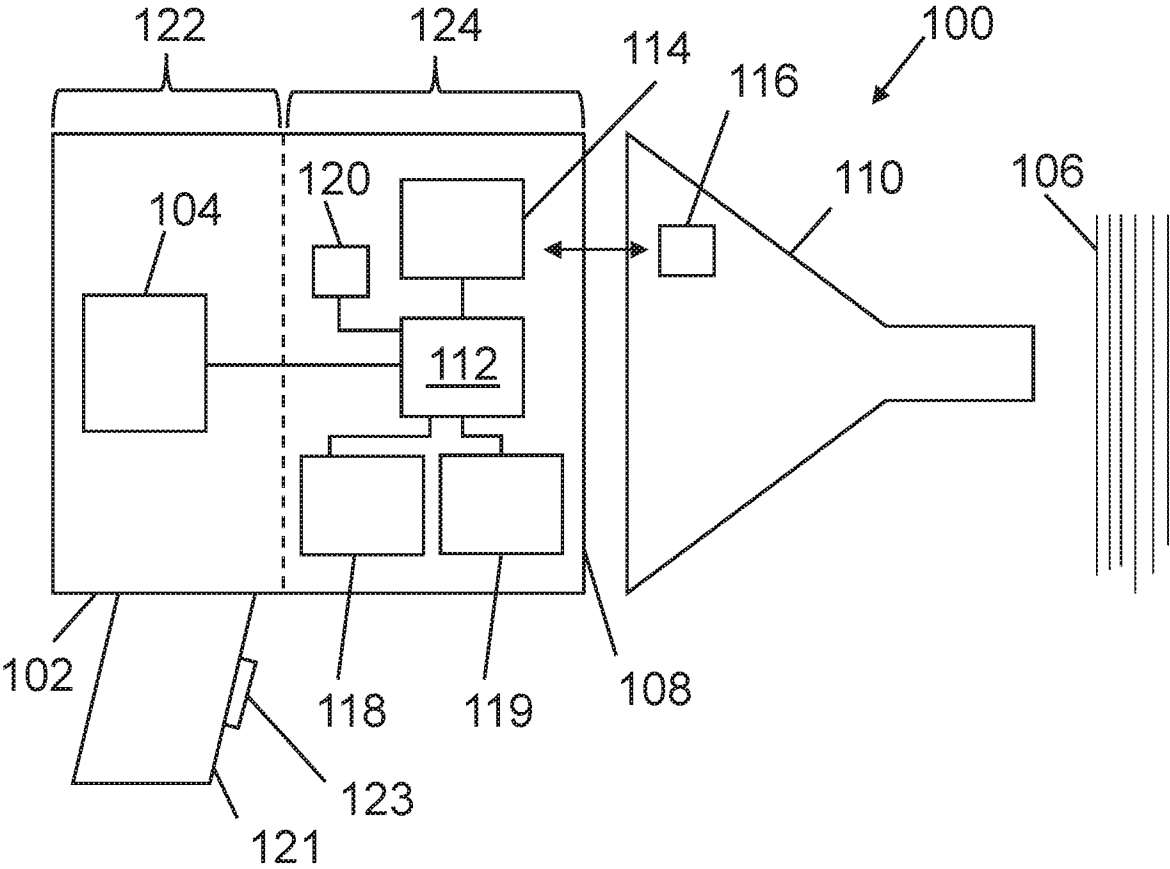


Fig. 1

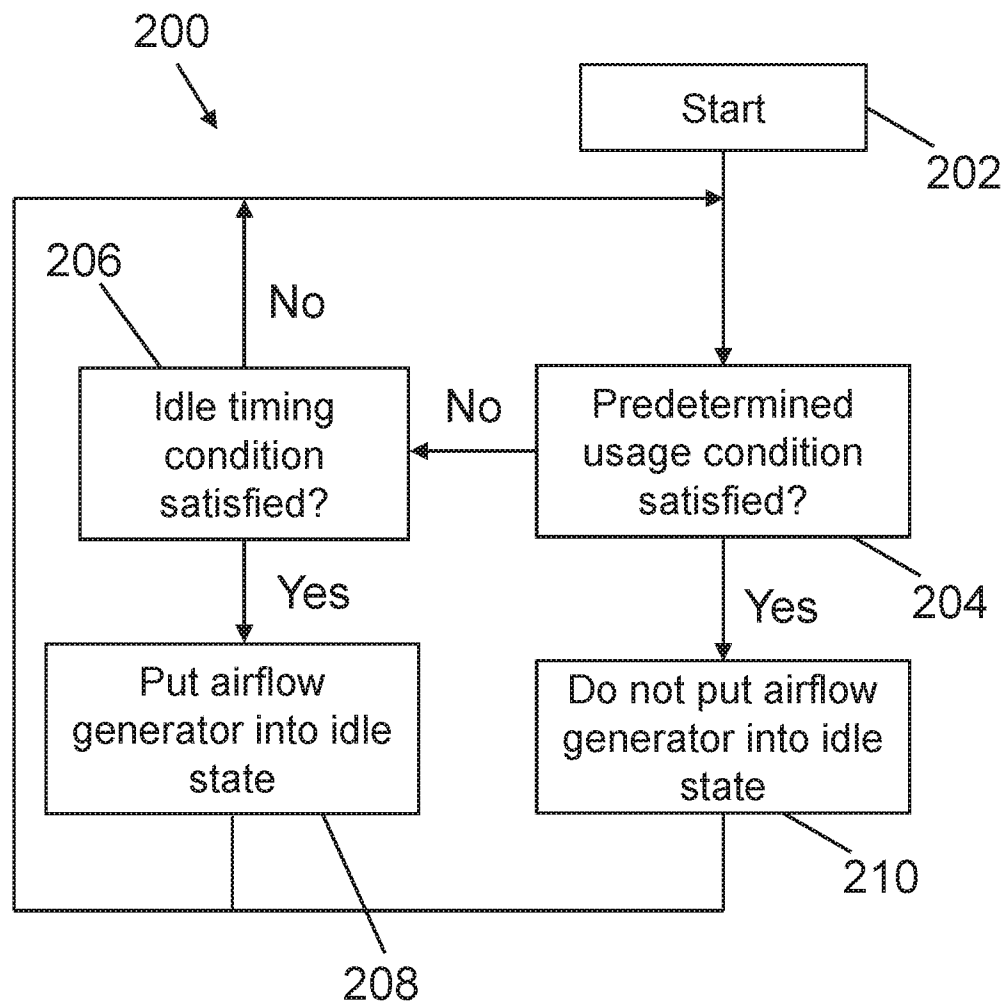


Fig. 2

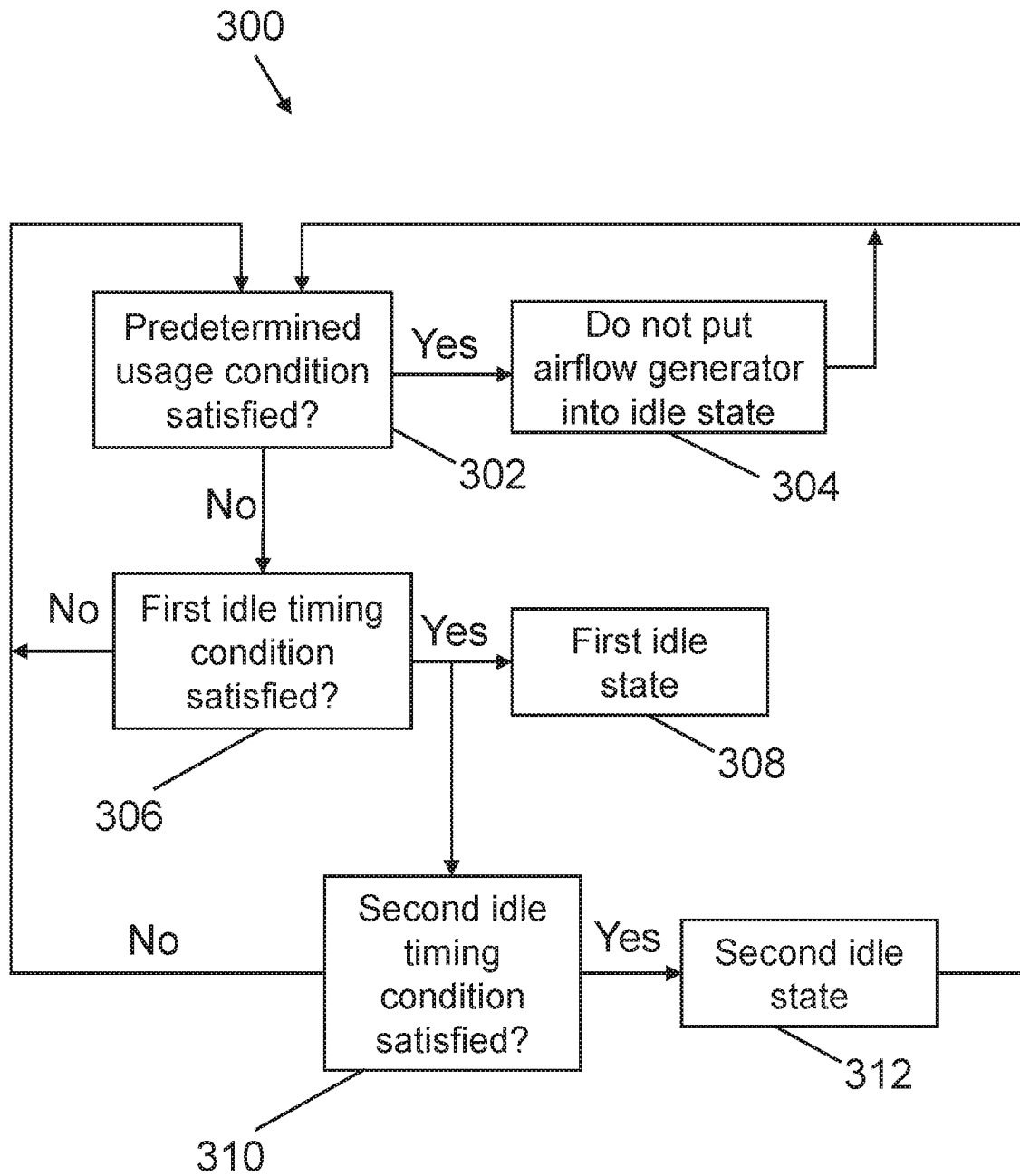


Fig. 3

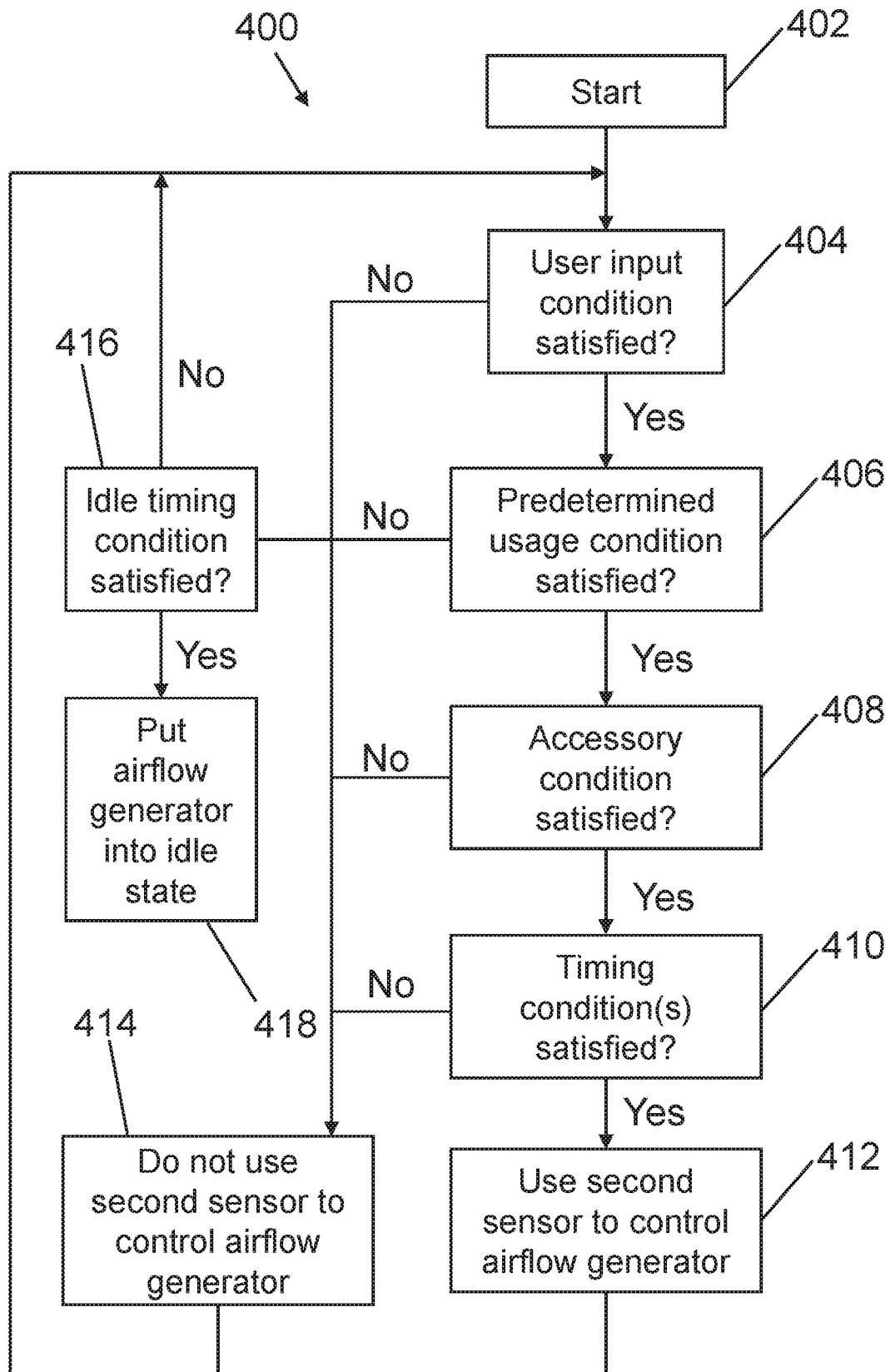


Fig. 4

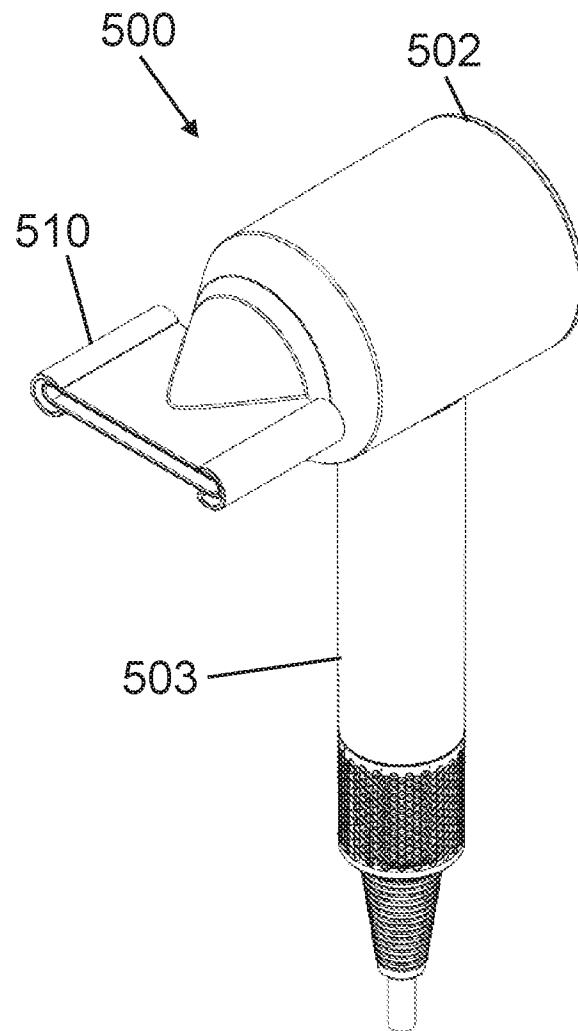


Fig. 5

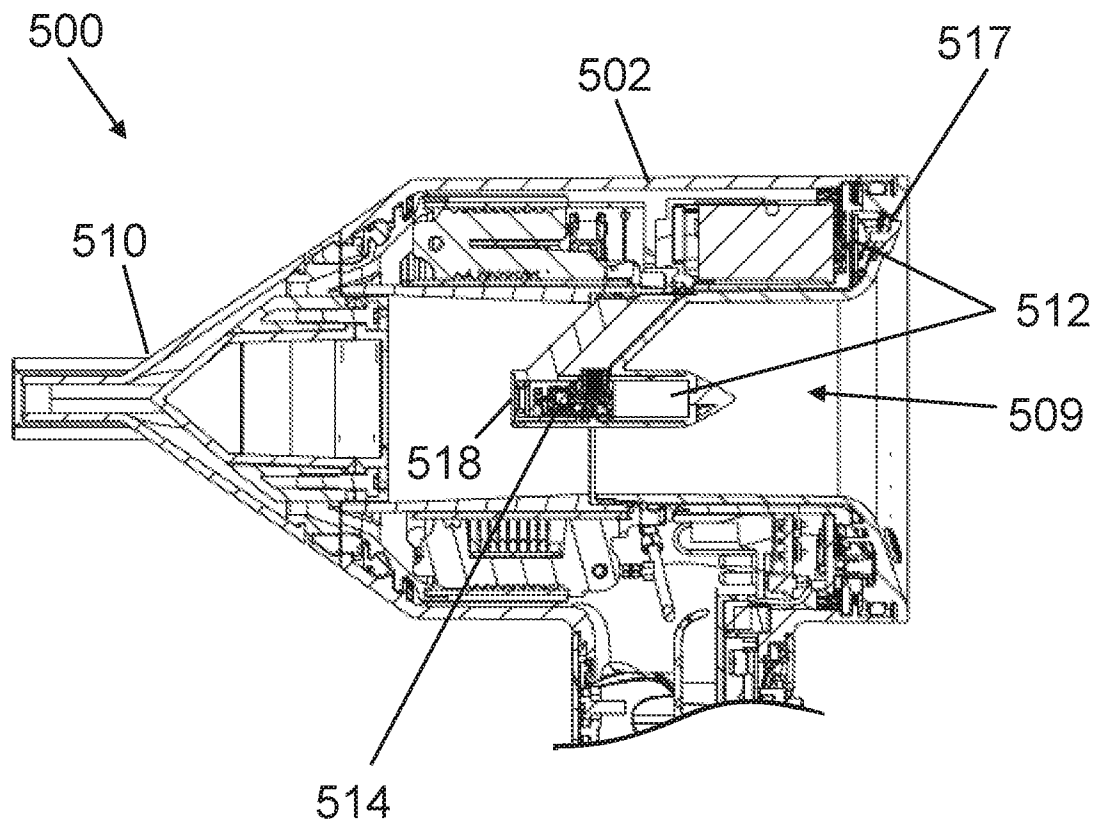


Fig. 6

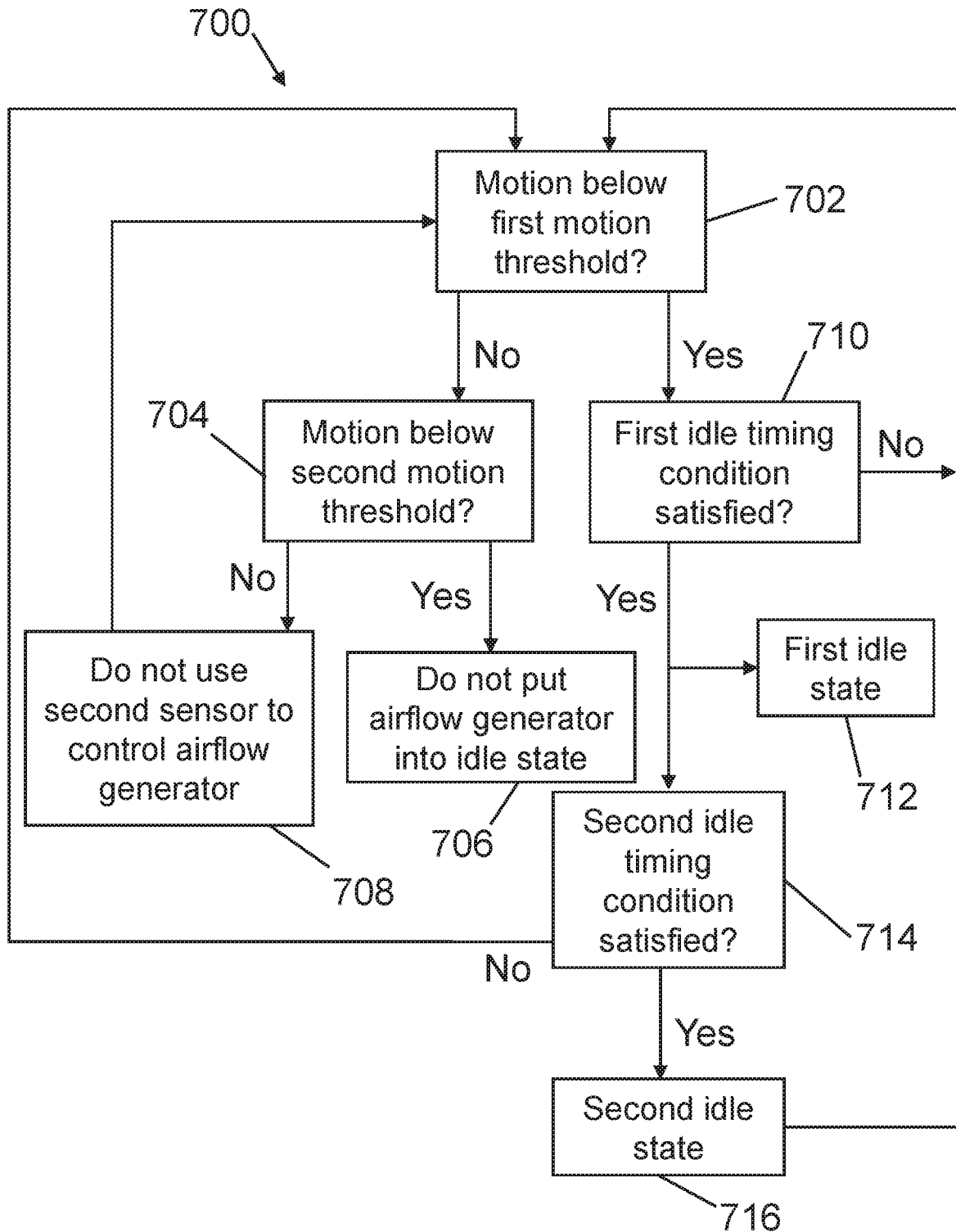


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2023/060122

A. CLASSIFICATION OF SUBJECT MATTER

INV. A45D20/10 A45D20/12

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)

A45D

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	WO 2022/061175 A1 (OREAL [FR]; KOSECOFF DAVID [US]) 24 March 2022 (2022-03-24)	1, 4-7, 9-16
A	page 13, line 28 - page 18, line 31 -----	2, 3, 8
X	CN 113 633 085 A (SUZHOU JUJUBE NETWORK TECH CO LTD) 12 November 2021 (2021-11-12)	1, 4-7, 9-16
A	paragraph [0004] - paragraph [0103]; figures 1-5 -----	2, 3, 8
X	JP 2019 072373 A (MAXELL HOLDINGS LTD) 16 May 2019 (2019-05-16)	1, 5-7, 9-16
A	paragraph [0016] paragraph [0051] - paragraph [0089]; figures 1-19 ----- -/--	2, 3, 8



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search

21 November 2023

Date of mailing of the international search report

05/12/2023

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2023/060122

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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