Claims

1. A method of controlling an electrical heating element, comprising:

maintaining the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element;

monitoring the duty cycle of the pulses of electrical current; and

determining if the duty cycle differs from an expected duty cycle or range of duty cycles, and if so, reducing the target temperature, or stopping the supply of current to the heating element or limiting the duty cycle of the pulses of electrical current supplied to the heating element.

2. A method according to claim 1, wherein the heating element is an electrically resistive heating element and the step of maintaining the temperature of the heating element at the target temperature comprises determining the electrical resistance of the heating element and adjusting the electrical current supplied to the heating element dependent on the determined electrical resistance.

3. A method according to any preceding claim, wherein the step of determining if the duty cycle differs from an expected duty cycle comprises periodically comparing the duty cycle with a first threshold duty cycle and using a hysteresis control loop to determine a trigger point at which to reduce the target temperature or limit the duty cycle of the pulses of electrical current.

4. A method according to any preceding claim comprising, if the duty cycle is less than a second threshold duty cycle while the temperature is above the target temperature, cutting the supply of electrical current to the heating element.

5. A method according to claim 3 or 4, comprising limiting the duty cycle of the pulses of electrical current to a maximum duty cycle limit, wherein the first or second threshold, or both the first and second threshold, is proportional to the maximum duty cycle limit.

6. A method according to claim 5, wherein a variable A, where A is equal to the maximum duty cycle divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

7. A device for controlling an electrical heating element, comprising:

a control circuit connected to the heating element, configured to maintain the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element; and

a detection circuit configured to monitor the duty cycle of the pulses of electrical current and, if the duty cycle of the pulses of electrical current differs from an expected duty cycle or range of duty cycles, to instruct the control circuit to reduce the target temperature or stop the supply of current to the heating element or limit the duty cycle or the pluses of electrical current.

8. A device according to claim 7, wherein the heating element is an electrically resistive heating element and the control circuit is configured to maintain the temperature of the heating element at the target temperature by determining the electrical resistance of the heating element and adjusting the electrical current supplied to the heating element dependent on the determined electrical resistance.

9. A device according to claim 7, or 8, wherein the detection circuit is configured to periodically compare the duty cycle with a first threshold duty cycle and comprises a hysteresis control loop configured to determine a trigger point at which to reduce the target temperature or limit the duty cycle of the pulses of electrical current.

10. A device according to any one of claims 78 to 9, wherein the detection circuit is configured such that if the duty cycle is less than a second threshold duty cycle while the temperature is at or above the target temperature, the detection circuit instructs the control circuit to cut the supply of electrical current to the heating element.

11. A device according to any one of claims 7 to 10, wherein the control circuit is configured to limit the duty cycle of the pulses of electrical current to a maximum duty cycle limit, such that a variable A, where A is equal to the maximum duty cycle divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

12. A device according to any one of claims 7 to 11, wherein the control circuit is configured to cut the supply of electrical current to the heating element if the temperature of the heating element exceeds a temperature threshold.

13. A device according to any one of claims 7 to 12, wherein the device is an aerosol generating device comprising a heating element, such as an electrically heating smoking device.

14. A device according to claim 13, wherein the aerosol generating device is configured to receive an aerosol-forming substrate, and wherein the expected duty cycle or range of duty cycles is configurable dependent on a characteristic of the aerosol-forming substrate.

15. An aerosol generating system, comprising:

an aerosol generating device comprising a heating element, and an aerosol generating article comprising an aerosol forming substrate, wherein the heater is configured to heat the aerosol forming substrate to generate an aerosol, and wherein the aerosol generating device comprises: a control circuit connected to the heating element, configured to maintain the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element;

a detection circuit configured to monitor the duty cycle of the pulses of electrical current and, if the duty cycle of the pulses of electrical current differs from an expected duty cycle or range of duty cycles, to instruct the control circuit to reduce the target temperature or stop the supply of current to the heating element or limit the duty cycle or the pulses of electrical current.

16. A system according to claim 15, wherein the aerosol generating device is configured so that the expected duty cycle or range of duty cycles is dependent on a characteristic of the aerosol-forming substrate.

17. A computer program which, when run on programmable electric circuitry for an electrically operated aerosol generating device, causes the programmable electric circuitry to perform a method according to any one of claims 1 to 6.

18. A computer readable storage medium having stored thereon a computer program according to claim 17.

19. A method of controlling an electrical heating element, comprising:

maintaining the temperature of the heating element at a target temperature during a plurality of heating phases by supplying electrical power to the heating element;

limiting the power supplied to the heating element during each heating phase to a threshold power level, such that a variable B, where B is equal to the threshold power level divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

20. A method according to claim 19, wherein the step of maintaining comprises supplying power as pulses of electrical current, and wherein the step of limiting the power supplied comprises limiting the duty cycle of the pulses of electrical current to below a threshold duty cycle, the threshold duty cycle divided by the target temperature being progressively reduced for each successive heating phase following activation of the heating element.

21. A method according to claim 19, wherein the step of limiting the power supplied comprises limiting the voltage applied to the heating element to below a threshold voltage.

22. A device for controlling an electrical heating element, comprising:

a control circuit coupled to a heating element, the control circuit configure to maintain the temperature of the heating element at a target temperature during a plurality of heating phases by supplying electrical power to the heating element, and to limit the power supplied to the heating element during each heating phase to a threshold power level, such that a variable B, where B is equal to the threshold power level divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

23. A device according to claim 22, wherein the control circuit is configured to supply power as pulses of electrical current, and to limit the power supplied to the heating element by limiting the duty cycle of the pulses of electrical current to below a threshold duty cycle, the threshold duty cycle divided by the target temperature being progressively reduced for each successive heating phase following activation of the heating element.

24. A device according to claim 22 or 23, wherein the device is an aerosol generating device comprising a heating element, such as an electrically heating smoking device.

25. A device according to claim 24, wherein the aerosol generating device is configured to receive an aerosol-forming substrate, and wherein the duration of the heating phases

and the threshold duty cycle for each heating phase is configurable dependent on a user input to the control circuit or dependent on a sensed characteristic of the aerosol-forming substrate or dependent on a sensed environmental parameter.

26. An aerosol generating system, comprising:

an aerosol generating device comprising a heating element, and an aerosol generating article comprising an aerosol forming substrate, wherein the heater is configured to heat the aerosol forming substrate to generate an aerosol, and wherein the aerosol generating device comprises: a control circuit coupled to the heating element, the control circuit configure to maintain the temperature of the heating element at a target temperature during a plurality of heating phases by supplying electrical power to the heating element, and to limit the power supplied to the heating element during each heating phase to a threshold power level, such that a variable B, where B is equal to the threshold power level divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

27. A system according to claim 26, wherein the aerosol generating device is configured so that the threshold power level is dependent on a characteristic of the aerosol-forming substrate.

28. A computer program which, when run on programmable electric circuitry for an electrically operated aerosol generating device, causes the programmable electric circuitry to perform the method of any one of claims 19 to 21.

29. A computer readable storage medium having stored thereon a computer program according to claim 28.

30. An aerosol generating device comprising:

an electrical heating element;

a detection circuit configured to detect a temperature of the heating element; and

a control circuit coupled to the heating element and the detection circuit, wherein the control circuit is configured to control the supply of power to the heating element from a power source, and wherein the control circuit is configured to prevent the supply of power to the heating element from the power source if the detection circuit detects that the temperature of the heating element is above a threshold temperature.

31. An aerosol generating device according to claim 30, wherein the threshold temperature is varied with time following activation of the heating element.

32. An aerosol generating device according to claim 30 or 31, wherein the aerosol generating device is an electrically heated smoking device.

33. An aerosol generating system, comprising:

an aerosol generating device comprising a heating element, and an aerosol generating article comprising an aerosol forming substrate, wherein the heater is configured to heat the aerosol forming substrate to generate an aerosol, and wherein the aerosol generating device comprises: a detection circuit configured to detect a temperature of the heating element; and a control circuit coupled to the heating element and the detection circuit, wherein the control circuit is configured to control the supply of power to the heating element from a power source, and wherein the control circuit is configured to prevent the supply of power to the heating element from the power source if the detection circuit detects that the temperature of the heating element is above a threshold temperature.

Claims

1. A method of controlling an electrical heating element, comprising:

maintaining the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element;

monitoring the duty cycle of the pulses of electrical current; and

determining if the duty cycle differs from an expected duty cycle or range of duty cycles, and if so, reducing the target temperature, or stopping the supply of current to the heating element or limiting the duty cycle of the pulses of electrical current supplied to the heating element.

2. A method according to claim 1, wherein the heating element is an electrically resistive heating element and the step of maintaining the temperature of the heating element at the target temperature comprises determining the electrical resistance of the heating element and adjusting the electrical current supplied to the heating element dependent on the determined electrical resistance.

3. A method according to any preceding claim, wherein the step of determining if the duty cycle differs from an expected duty cycle comprises periodically comparing the duty cycle with a first threshold duty cycle and using a hysteresis control loop to determine a trigger point at which to reduce the target temperature or limit the duty cycle of the pulses of electrical current.

4. A method according to any preceding claim comprising, if the duty cycle is less than a second threshold duty cycle while the temperature is above the target temperature, cutting the supply of electrical current to the heating element.

5. A method according to claim 3 or 4, comprising limiting the duty cycle of the pulses of electrical current to a maximum duty cycle limit, wherein the first or second threshold, or both the first and second threshold, is proportional to the maximum duty cycle limit.

6. A method according to claim 5, wherein a variable A, where A is equal to the maximum duty cycle divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

7. A device for controlling an electrical heating element, comprising:

a control circuit connected to the heating element, configured to maintain the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element; and

a detection circuit configured to monitor the duty cycle of the pulses of electrical current and, if the duty cycle of the pulses of electrical current differs from an expected duty cycle or range of duty cycles, to instruct the control circuit to reduce the target temperature or stop the supply of current to the heating element or limit the duty cycle or the pluses of electrical current.

8. A device according to claim 7, wherein the heating element is an electrically resistive heating element and the control circuit is configured to maintain the temperature of the heating element at the target temperature by determining the electrical resistance of the heating element and adjusting the electrical current supplied to the heating element dependent on the determined electrical resistance.

9. A device according to claim 7, or 8, wherein the detection circuit is configured to periodically compare the duty cycle with a first threshold duty cycle and comprises a hysteresis control loop configured to determine a trigger point at which to reduce the target temperature or limit the duty cycle of the pulses of electrical current.

10. A device according to any one of claims 7 to 9, wherein the detection circuit is configured such that if the duty cycle is less than a second threshold duty cycle while the temperature is at or above the target temperature, the detection circuit instructs the control circuit to cut the supply of electrical current to the heating element.

11. A device according to any one of claims 7 to 10, wherein the control circuit is configured to limit the duty cycle of the pulses of electrical current to a maximum duty cycle limit, such that a variable A, where A is equal to the maximum duty cycle divided by the target temperature, is progressively reduced with increasing time following activation of the heating element.

12. A device according to any one of claims 7 to 11, wherein the control circuit is configured to cut the supply of electrical current to the heating element if the temperature of the heating element exceeds a temperature threshold.

13. A device according to any one of claims 7 to 12, wherein the device is an aerosol

generating device comprising a heating element, such as an electrically heating smoking device.

14. A device according to claim 13, wherein the aerosol generating device is configured to receive an aerosol-forming substrate, and wherein the expected duty cycle or range of duty cycles is configurable dependent on a characteristic of the aerosol-forming substrate.

15. An aerosol generating system, comprising:

an aerosol generating device comprising a heating element, and an aerosol generating article comprising an aerosol forming substrate, wherein the heater is configured to heat the aerosol forming substrate to generate an aerosol, and wherein the aerosol generating device comprises: a control circuit connected to the heating element, configured to maintain the temperature of the heating element at a target temperature by supplying pulses of electrical current to the heating element;

a detection circuit configured to monitor the duty cycle of the pulses of electrical current and, if the duty cycle of the pulses of electrical current differs from an expected duty cycle or range of duty cycles, to instruct the control circuit to reduce the target temperature or stop the supply of current to the heating element or limit the duty cycle or the pulses of electrical current.

16. A system according to claim 15, wherein the aerosol generating device is configured so that the expected duty cycle or range of duty cycles is dependent on a characteristic of the aerosol-forming substrate.

17. A computer program which, when run on programmable electric circuitry for an electrically operated aerosol generating device, causes the programmable electric circuitry to perform a method according to any one of claims 1 to 6.

18. A computer readable storage medium having stored thereon a computer program according to claim 17.