## CLAIMS

1. A respiratory humidification system comprising:

an inspiratory limb comprising a first segment with a first heater wire, a second segment with a second heater wire, the first and second heater wires being configured to heat respiratory gases flowing through the inspiratory limb, and a temperature sensor positioned at or near a patient end of the second segment, wherein the first and second heater are electrically coupled, the first heater wire forming a first heater circuit and the first and second heater wires together forming a second heater circuit;

a control module comprising a hardware processor configured to be in electrical communication with the temperature sensor and the first and second heater wires, the hardware processor configured to execute software instructions which cause the processor to selectively control power provided to the first and second heater circuits, wherein the processor is configured to control heating of the respiratory gases using:

the first heater circuit to meet a power demand for the first heater circuit needed to maintain a temperature profile in the inspiratory limb; and

the second heater circuit to meet a power demand for the second heater circuit needed to reduce or eliminate a difference between a set point temperature and a patient end temperature measured by the temperature sensor.

2. The respiratory humidification system of claim 1, wherein the processor is configured to determine the power demand for the first heater circuit and to operate in open loop control mode.

3. The respiratory humidification system of claim 1 or 2, wherein the power demand for the first heater circuit is set to a particular duty cycle used for control of the first heater circuit.

4. The respiratory humidification system of claim 3, comprising a flow sensor in a flow path of the system and the processor is configured to measure a flow rate of the respiratory gases, wherein the particular duty cycle is a fixed duty cycle value determined at least in part by a flow rate of the respiratory gases measured by the flow sensor.

5. The respiratory humidification system of claim 3 or 4, wherein the particular duty cycle is determined using a model configured to be applicable in a majority of situations.

6. The respiratory humidification system of any one of claims 1 to 5, wherein the power demand for the first heater circuit is independent of ambient conditions.

7. The respiratory humidification system of any one of claims 1 to 6, wherein the power demand for the first heater circuit is configured to achieve a targeted temperature profile in the first segment.

8. The respiratory humidification system of claim 7, wherein the targeted temperature profile utilizes a greater amount of heating in the first heater circuit relative to the second heater circuit.

9. The respiratory humidification system of claim 7 or 8, wherein the targeted temperature profile in the first segment heats the respiratory gases in the first segment above the set point temperature.

10. The respiratory humidification system of any one of claims 1 to 9, wherein the power demand for the first heater circuit is based at least in part on the power demand for the second heater circuit.

11. The respiratory humidification system of any one of claims 1 to 10, wherein the power demand for the first heater circuit accounts for the power demand of the second heater circuit.

12. The respiratory humidification system of claim 10 or 11, wherein a duty cycle or power supplied to the first heater circuit is inversely related to a duty cycle or power supplied to the second heater circuit.

13. The respiratory humidification system of any one of claims 1 to 12, wherein the processor is configured to determine the power demand for the second heater circuit and to operate in a closed-loop control mode.

14. The respiratory humidification system of any one of claims 1 to 13, wherein the power demand for the first heater circuit is:

i) met by heating of the first heater circuit;

ii) partially met by heating of the first heater circuit and partially met by heating of the second heater circuit; or

iii) met by heating of the second heater circuit.

15. The respiratory humidification system of any one of Claims 1 to 14, wherein the processor is configured to use:

the second heater circuit as the principal means of controlling heating in the inspiratory limb; and,

the first heater circuit to provide supplemental heating.

16. The respiratory humidification system of any one of claims 1 to 15, wherein the hardware processor is further configured to be in communication with a surface temperature sensor positioned on a portion of the inspiratory limb and configured to measure a surface temperature of the inspiratory limb.

17. The respiratory humidification system of claim 16, wherein a duty cycle cap or limit for a duty cycle of or a power supplied to the first heater circuit and/or the second heater circuit is determined using the measured surface temperature of the inspiratory limb.

18. The respiratory humidification system of any one of claims 1 to 17, comprising an intermediate connector configured to couple the first and second segments of the inspiratory limb, the intermediate connector having a connector circuit configured to electrically connect the first and second heater wires.

19. The respiratory humidification system of any one of claims 1 to 18, wherein the first and second segments are exposed to different ambient environments, or a portion of the first segment that is adjacent to the second segment is exposed to the same ambient environment as the second segment.

20. The respiratory humidification system of any one of claim 19, configured to be used with an incubator, wherein the portion of the first segment and the second segment are inside the incubator and a remaining portion of the first segment is outside the incubator.