WHAT IS CLAIMED IS:

1. A medical tube comprising:

a first segment of the medical tube comprising:

a first structure forming a conduit configured to transport a humidified gas; and

a first heater wire circuit;

a second segment of the medical tube comprising:

a second structure forming a conduit configured to transport the humidified gas; and

a second heater wire circuit; and

an intermediate connector comprising a connection circuit that electrically couples the first heater wire circuit to the second heater wire circuit, the intermediate connector coupled to a patient end of the first segment of the medical tube and a chamber end of the second segment of the medical tube to form a single conduit for the humidified gas,

wherein at least a portion of the intermediate connector is covered by a portion of the first segment of the medical tube and/or a portion of the second segment of the medical tube such that the intermediate connector is internal to the medical tube,

wherein, in a first mode, electrical power passes through the connection circuit to provide power to the first heater wire circuit without providing power to the second heater wire circuit, and in a second mode, electrical power passes through the connection circuit to provide power to both the first heater wire circuit and the second heater wire circuit.

2. The medical tube of Claim 1, wherein the connection circuit comprises a diode.

3. The medical tube of Claim 1, further comprising a first sensor positioned at the patient end of the first segment.

4. The medical tube of Claim 3, wherein the first sensor is one of a temperature sensor or a humidity sensor.

5. The medical tube of Claim 1, further comprising a second sensor positioned at a patient end of the second segment of the medical tube.

6. The medical tube of Claim 5, wherein the second sensor is one of a temperature sensor or a humidity sensor.

7. The medical tube of Claim 1, wherein the first structure comprises an elongate tube comprising:

a first elongate member comprising a hollow body spirally wound to form at least in part the conduit having a longitudinal axis, a lumen extending along the longitudinal axis, and a hollow wall surrounding the lumen;

a second elongate member spirally wound and joined between adjacent turns of the first elongate member, the second elongate member forming at least a portion of the lumen of the elongate tube.

8. The medical tube of Claim 7, wherein the first elongate member forms in longitudinal cross-section a plurality of bubbles with a flattened surface at the lumen.

9. The medical tube of Claim 8, wherein adjacent bubbles are separated by a gap above the second elongate member.

10. The medical tube of Claim 8, wherein adjacent bubbles are not directly connected to each other.

11. The medical tube of Claim 8, wherein the plurality of bubbles have perforations.

12. A respiratory humidification system comprising:

an inspiratory limb comprising a first segment of the inspiratory limb having a first heater wire circuit, a second segment of the inspiratory limb having a second heater wire circuit, an intermediate connector having a connector circuit configured to electrically couple the first heater wire circuit to the second heater wire circuit, a first sensor positioned at a patient end of the first segment, and a second sensor positioned at a patient end of the second segment; and

a controller;

wherein the controller is adapted to selectively switch between a first mode and a second mode wherein in the first mode the controller provides electrical power

to the first heater wire circuit through the connector circuit and in a second mode the controller provides electrical power to the first and second heater wire circuits.

13. The system of any of Claims 12 , wherein the switching is done based on input from one or both sensors.

14. The system of Claim 13, wherein the input from one or both sensors includes one or more of temperature, flow, humidity, and power.

15. The system of any of Claims 12 , wherein the first and second modes are defined by a direction of current provided by a power source.

16. The system of any of Claims 12, wherein the controller is adapted to selectively switch between a first sensor reading mode and a second sensor reading mode wherein in the first sensor reading mode the controller reads a signal from the second sensor and in the second sensor reading mode the controller reads a signal from both the first sensor and the second sensor.

17. The system of any of Claims 12, wherein the first sensor and the second sensor are temperature sensors.

18. A connector comprising:

a first heater wire incoming connection configured to be electrically coupled to a first incoming heater wire;

a second heater wire incoming connection configured to be electrically coupled to a second incoming heater wire;

a first heater wire outgoing connection configured to be electrically coupled to a first outgoing heater wire and electrically coupled to the first heater wire incoming connection;

a second heater wire outgoing connection configured to be electrically coupled to a second outgoing heater wire and electrically coupled to the second heater wire incoming connection;

a first signal wire incoming connection configured to be electrically coupled to a first incoming signal wire;

a second signal wire incoming connection configured to be electrically coupled to a second incoming signal wire;

a first signal wire outgoing connection configured to be electrically coupled to a first outgoing signal wire and electrically coupled to the first signal wire incoming connection;

a second signal wire outgoing connection configured to be electrically coupled to a second incoming signal wire and electrically coupled to the second signal wire incoming connection;

a power diode electrically coupled to the first heater wire incoming connection and the second heater wire incoming connection, the power diode configured to allow current to flow from the second incoming heater wire to the first incoming heater wire and to prevent current to flow from the first incoming heater wire to the second incoming heater wire;

a sensor electrically coupled to the first signal wire incoming connection; and

a signal diode electrically coupled to the sensor and the second signal wire incoming connection, the signal diode configured to allow current to flow from the second incoming signal wire through the sensor to the first incoming signal wire and to prevent current to flow from the first incoming signal wire through the sensor to the second incoming signal wire.

19. A respiratory humidification system comprising:

a heater circuit comprising a first heater, a second heater, a first pair of switches, and a second pair of switches, and a power source; and

a control module;

wherein the control module is adapted to control flow of electrical current from the power source to the first heater by selectively opening and closing the first pair of switches and to control flow of electrical current from the power source to the second heater by selectively opening and closing the second pair of switches,

wherein the first pair of switches and the second pair of switches can be selectively opened and closed independent of one another, thereby providing independent control of the first and second heaters.

20. The respiratory humidification system of any of Claims 19, further comprising a main relay configured to interrupt delivery of electrical power from the power source to the first heater and the second heater.

21. The respiratory humidification system of any of Claims 19, wherein a combination of the first pair of switches and the second pair of switches is configured to selectively control flow of electrical power from the power source to the second heater, thereby providing gated control of the second heater.

22. The respiratory humidification system of Claim 21, further comprising a third pair of switches, the third pair of switches configured to switch between providing independent control of the first and second heaters and gated control of the second heater.

23. A respiratory humidification system comprising:

a heater circuit comprising a first pair of switches, a second pair of switches, a power source, a main relay, and a mode relay;

a logic module; and

a control module;

wherein the control module is adapted to provide control signals to the logic module to control flow of electrical current from the power source to the mode relay by selectively opening and closing the first and second pair of switches,

wherein the control module is adapted to provide a mode signal to the logic module, the mode signal comprising a first mode signal and a second mode signal,

wherein the first pair of switches and the second pair of switches can be selectively opened and closed independent of one another.

24. The respiratory humidification system of Claim 23, wherein the logic module is configured to trip the main relay when the logic module receives the first mode signal and the control module requests that the first and second pairs of switches be closed.

25. The respiratory humidification system of Claim 23, wherein the mode relay is configured to provide electrical connections to a first heater and a second heater.

26. The respiratory humidification system of Claim 25, wherein the control module is configured to provide independent control of the first and second heaters.

27. The respiratory humidification system of Claim 23, wherein the mode relay is configured to provide electrical connections to a segmented heater.

28. The respiratory humidification system of Claim 27, wherein the control module is configured to control flow of electrical current to a first segment of the segmented

heater and to control flow of electrical current to the first segment and a second segment of the segmented heater.

29. A respiratory humidification system comprising:

a heater circuit comprising a first pair of switches, a second pair of switches, a power source, a main relay, and a heater module;

a logic module; and

a control module;

wherein the control module is adapted to provide control signals to the logic module to control flow of electrical current from the power source to the heater module by selectively opening and closing the first and second pair of switches,

wherein the control module is adapted to provide a mode signal to the logic module, the mode signal comprising a first mode signal and a second mode signal,

wherein the first pair of switches and the second pair of switches can be selectively opened and closed independent of one another.

30. The respiratory humidification system of Claim 29, wherein the logic module is configured to trip the main relay when the logic module receives the first mode signal and the control module requests that the first and second pairs of switches be closed.

31. The respiratory humidification system of Claim 29, wherein the heater module comprises a first heater and a second heater.

32. The respiratory humidification system of Claim 31, wherein the control module is configured to provide independent control of the first and second heaters.

33. The respiratory humidification system of Claim 29, wherein the heater module comprises a segmented heater.

34. The respiratory humidification system of Claim 33, wherein the control module is configured to control flow of electrical current to a first segment of the segmented heater and to control flow of electrical current to the first segment and a second segment of the segmented heater.

35. A respiratory humidification system comprising:

a hardware controller configured to be in communication with a first heater wire in a first segment of an inspiratory limb and with a second heater wire in a second segment of the inspiratory limb, wherein the first and second heater wires are

electrically coupled and configured to heat respiratory gases passing through the inspiratory limb, the first heater wire forming a first heater circuit and the first and second wire forming a second heater circuit,

wherein the hardware controller is configured to be in communication with a sensor positioned at a patient end of the second segment for measuring a patient end parameter,

wherein the hardware controller is further configured to only activate the first heater circuit when a difference between an output of the sensor and a patient end parameter set point is below a predetermined threshold and to only activate the second heater circuit when the difference between the output of the sensor and the patient end parameter set point is at or above the predetermined threshold,

wherein when only the first heater circuit is activated, the controller is configured to heat the first heater wire to a maximum surface temperature.

36. The respiratory humidification system of any of Claims 35, wherein the first and second heater wires are exposed to different ambient environments.

37. The respiratory humidification system of any of Claims 35-36, wherein the patient end parameter is temperature.

38. The respiratory humidification system of Claim 37, wherein the first and second heater wires are exposed to different ambient temperatures.

39. The respiratory humidification system of any of Claims 35-38, wherein power supplied to the first heater circuit is determined by a PID control scheme.

40. The respiratory humidification system of any of Claims 35-38, wherein power supplied to the second heater circuit is determined by a PID control scheme.

41. The respiratory humidification system of Claim 40, further comprising an intermediate connector having a connector circuit configured to electrically connect the first and second heater wires.

42. A respiratory humidification system comprising:

an inspiratory limb including a first segment with a first heater wire, a second segment with a second heater wire, and a temperature sensor positioned at a patient end of the second segment for measuring a patient end parameter, wherein the first and second heater wires are electrically coupled, the first heater wire forming a first

heater circuit and the first and second wire forming a second heater circuit, the first and second heater wires configured to heat respiratory gases passing through the inspiratory limb; and

a flow sensor in a flow path of the system and configured to measure a flow rate of the respiratory gases;

wherein the first and second heater wires and the temperature and flow sensors are configured to be in electrical communication with a hardware processor configured to execute software instructions which cause the processor to control the first and second heater circuits, wherein, when a difference between an output of the sensor and a patient end parameter set point is below a predetermined error threshold, the processor is configured to heat the respiratory gases using the first heater circuit until a maximum temperature is reached in the first heater wire, and when the difference between the output of the sensor and the patient end parameter set point is at or above the predetermined error threshold, the processor is configured to heat the respiratory gases using the second heater circuit, and

wherein the maximum power provided to the first heater circuit is a first maximum value or a second maximum value based on the flow rate, the first maximum value higher than the second maximum value.

43. The respiratory humidification system of Claim 42, wherein the maximum power is the first maximum value when the measured flow rate is higher than a flow rate threshold, and a second maximum value when the measured flow rate is below the flow rate threshold.

44. The respiratory humidification system of Claim 43, wherein the flow rate threshold is between about 2.4 lpm and about 5 lpm.

45. The respiratory humidification system of Claim 43, wherein the flow rate threshold is about 3.5 lpm.

46. The respiratory humidification system of Claim 42, wherein when the first maximum power is being provided to the first heater circuit and the measured flow rate decreases to a high flow to low flow threshold, the maximum power provided to the first heater circuit switches to the second maximum power, and when the second maximum power is being provided to the first heater circuit and the flow rate increases to a low flow to high

flow threshold, the maximum power provided to the first heater circuit switches to the first maximum power, the high flow to low flow threshold being lower than the low flow to high flow threshold.

47. The respiratory humidification system of Claim 46, wherein the high flow to low flow threshold is between about 2.4 lpm and about 5 lpm.

48. The respiratory humidification system of Claim 46, wherein the low flow to high flow threshold is about 6.5 lpm.

49. The respiratory humidification system of any of Claims 46 to 48, wherein a portion of the first segment of the inspiratory limb that is adjacent to the second segment is exposed to the same ambient environment as the second segment.

50. The respiratory humidification system of Claim 49, wherein the portion of the first segment and the second segment are inside an incubator and a remaining portion of the first segment is outside the incubator.

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.