

5 **Claims:**

1. A hookah device for use with a hookah having an elongate stem and a water chamber with a first end of the stem attached to the water chamber, wherein the hookah device comprises:

10 a plurality of ultrasonic mist generator devices which are each provided with a respective mist outlet port;

a driver device which is connected electrically to each of the mist generator devices and configured to activate the mist generator devices, the driver device comprising a wireless communication system configured to
15 transmit and receive data between the driver device and a computing device such that the computing device can control the operation of the hookah device; and

a hookah attachment arrangement which is configured to attach the hookah device to a second end of the stem of the hookah, the hookah
20 attachment arrangement having a hookah outlet port which provides a fluid flow path from the mist outlet ports of the mist generator devices and out of the hookah device such that, when at least one of the mist generator devices is activated by the driver device, mist generated by each activated mist generator device flows along the fluid flow path and out of the hookah device to the
25 hookah,

wherein each mist generator device is releasably attached to the driver device so that each mist generator device is separable from the driver device.

30 2. The hookah device of claim 1, wherein the driver device is configured to control the operation of the mist generator devices in response to data received from the computing device.

3. The hookah device of claim 1 or claim 2, wherein the wireless
35 communication system comprises a Bluetooth (RTM) Low Energy microcontroller.

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4. The hookah device of any one of the preceding claims, wherein the wireless communication system is configured to transmit at least one of inhalation time data, pressure data, and temperature data to the computing device.

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5. The hookah device of any one of the preceding claims, wherein the wireless communication system is configured to receive firmware update data for updating the firmware of the hookah device.

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6. The hookah device of any one of the preceding claims, wherein the wireless communication system is configured to transmit data indicative of the status of each mist generator device to the computing device.

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7. The hookah device of any one of the preceding claims, wherein the computing device is a smartphone.

8. The hookah device of claim 7, wherein the smartphone comprises a companion mobile application.

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9. The hookah device of any one of the preceding claims, wherein the driver device is connected electrically to each of the mist generator devices by a data bus and the driver device is configured to identify and control each mist generator device using a respective unique identifier for the mist generator device.

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10. The hookah device of claim 1 or claim 2, wherein each mist generator device comprises:

an identification arrangement comprising:

an integrated circuit having a memory which stores a unique

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identifier for the mist generator device; and

5 an electrical connection which provides an electronic interface for communication with the integrated circuit.

11. The hookah device of any one of the preceding claims, wherein the microcontroller is configured to control each microchip and each respective
10 mist generator device to activate independently of the other mist generator devices.

12. The hookah device of claim 11, wherein the microcontroller is configured to control the mist generator devices to activate in a predetermined sequence.

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13. The hookah device of any one of the preceding claims, wherein the hookah device comprises:

a manifold having a manifold pipe which is in fluid communication with the mist outlet ports of the mist generator devices, wherein mist output from the
20 mist outlet ports combines in the manifold pipe and flows through the manifold pipe and out from the hookah device.

14. The hookah device of claim 13, wherein the hookah device comprises four mist generator devices which are releasably coupled to the manifold at 90°
25 relative to one another.

~~15. The hookah device of any one of the preceding claims, wherein each mist generator device is releasably attached to the driver device so that each mist generator device is separable from the driver device.~~

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~~165.~~ The hookah device of any one of the preceding claims, wherein each mist generator device comprises:

a mist generator housing which is elongate and comprises an air inlet port and the said mist outlet port;

35 a liquid chamber provided within the mist generator housing, the liquid chamber containing a liquid to be atomized;

5 a sonication chamber provided within the mist generator housing;
a capillary element extending between the liquid chamber and the
sonication chamber such that a first portion of the capillary element is within the
liquid chamber and a second portion of the capillary element is within the
sonication chamber;

10 an ultrasonic transducer having a generally planar atomization surface
which is provided within the sonication chamber, the ultrasonic transducer
being mounted within the mist generator housing such that the plane of the
atomization surface is substantially parallel with a longitudinal length of the mist
generator housing, wherein part of the second portion of the capillary element
15 is superimposed on part of the atomization surface, and wherein the ultrasonic
transducer is configured to vibrate the atomization surface to atomize a liquid
carried by the second portion of the capillary element to generate a mist
comprising the atomized liquid and air within the sonication chamber; and

20 an airflow arrangement which provides an air flow path between the air
inlet port, the sonication chamber and the air outlet port.

176. The hookah device of claim 165, wherein each mist generator device
further comprises:

25 a transducer holder which is held within the mist generator housing,
wherein the transducer element holds the ultrasonic transducer and retains the
second portion of the capillary element superimposed on part of the
atomization surface; and

30 a divider portion which provides a barrier between the liquid chamber
and the sonication chamber, wherein the divider portion comprises a capillary
aperture through which part of the first portion of the capillary element extends.

187. The hookah device of claim 165 or claim 176, wherein the capillary
element is 100% bamboo fiber.

35 198. The hookah device of any one of claims 165 to 187, wherein the airflow
arrangement is configured to change the direction of a flow of air along the air

5 flow path such that the flow of air is substantially perpendicular to the atomization surface of the ultrasonic transducer as the flow of air passes into the sonication chamber.

2019. The hookah device of any one of claims 165 to 198, wherein the liquid
10 chamber contains a liquid having a kinematic viscosity between 1.05 Pa•s and 1.412 Pa•s and a liquid density between 1.1 g/ml and 1.3 g/ml.

240. The hookah device of any one of claims 165 to 2019, wherein the liquid
15 chamber contains a liquid comprising approximately a 2:1 molar ratio of levulinic acid to nicotine.

221. The hookah device of any one of the preceding claims, wherein the driver device further comprises:

20 an AC driver which is configured to generate an AC drive signal at a predetermined frequency to drive a respective ultrasonic transducer in each mist generator device;

25 an active power monitoring arrangement which is configured to monitor the active power used by the ultrasonic transducer when the ultrasonic transducer is driven by the AC drive signal, wherein the active power monitoring arrangement is configured to provide a monitoring signal which is indicative of an active power used by the ultrasonic transducer;

a processor which is configured to control the AC driver and to receive the monitoring signal drive from the active power monitoring arrangement; and

30 a memory storing instructions which, when executed by the processor, cause the processor to:

A. control the AC driver to output an AC drive signal to the ultrasonic transducer at a predetermined sweep frequency;

B. calculate the active power being used by the ultrasonic transducer based on the monitoring signal;

35 C. control the AC driver to modulate the AC drive signal to maximize the active power being used by the ultrasonic transducer;

- 5 D. store a record in the memory of the maximum active power used by the ultrasonic transducer and the sweep frequency of the AC drive signal;
- E. repeat steps A-D for a predetermined number of iterations with the sweep frequency incrementing with each iteration such that, after the
- 10 predetermined number of iterations has occurred, the sweep frequency has been incremented from a start sweep frequency to an end sweep frequency;
- F. identify from the records stored in the memory the optimum frequency for the AC drive signal which is the sweep frequency of the
- 15 AC drive signal at which a maximum active power is used by the ultrasonic transducer; and
- G. control the AC driver to output an AC drive signal to the ultrasonic transducer at the optimum frequency to drive the ultrasonic transducer to atomize a liquid
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232. The hookah device of claim 221, wherein the active power monitoring arrangement comprises:
- a current sensing arrangement which is configured to sense a drive current of the AC drive signal driving the ultrasonic transducer, wherein the
- 25 active power monitoring arrangement is configured to provide a monitoring signal which is indicative of the sensed drive current.
243. The hookah device of claim 221 or claim 232, wherein the memory stores instructions which, when executed by the processor, cause the
- 30 processor to:
- repeat steps A-D with the sweep frequency being incremented from a start sweep frequency of 2900kHz to an end sweep frequency of 2960kHz.
254. The hookah device of claim 221 or claim 232, wherein the memory
- 35 stores instructions which, when executed by the processor, cause the processor to:

5 repeat steps A-D with the sweep frequency being incremented from a start sweep frequency of 2900kHz to an end sweep frequency of 3100kHz.

265. The hookah device of any one of claims 221 to 254, wherein the AC driver is configured to modulate the AC drive signal by pulse width modulation
10 to maximize the active power being used by the ultrasonic transducer.

276. A hookah comprising:
a water chamber;
an elongate stem having a first end which is attached to the water
15 chamber, the stem comprising a mist flow path which extends from a second end of the stem, through the stem, to the first end; and

a hookah device according to any one of the preceding claims, wherein the hookah attachment arrangement of the hookah device is attached to the stem of the hookah at the second end of the stem.
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287. A system comprising:
a plurality of hookah devices, each hookah device being a hookah device according to any one of claims 1 to 265; and
a computing device which is configured to communicate wirelessly with
25 each hookah device such that the computing device can control the operation of the plurality of hookah devices.