USPTO coversheet:
Collaborative deferred-fee provisional patent application pilot program for COVID-19 invention, 85 Fed. Reg. 58038 (September 17, 2020)

Identification number	DFPUB_62706972
Date of filing	09/22/2020
Date available to public	09/30/2020
First inventor	Koren
Title of invention	Mask with flow-controlled UV light intensity sterilization
Assignee (if any)	None Provided
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ABSTRACT

A mask has separate curved tubular conduit flow paths extending from a distal port to a muffler at a face mask. Germicidal UV lights irradiate the flow paths. The muffler includes baffles and a vortex generator. A vented intake with a vortex generator covers each distal port. The muffler and intake block UV light emission to the user and ambient environment. A sensor detects a flow rate parameter. LED illumination is controlled by a controller implementing PWM according to sensor output, with maxximum sustained illumination during peak flow rate and no illumination during when flow ceases.

Fig.1

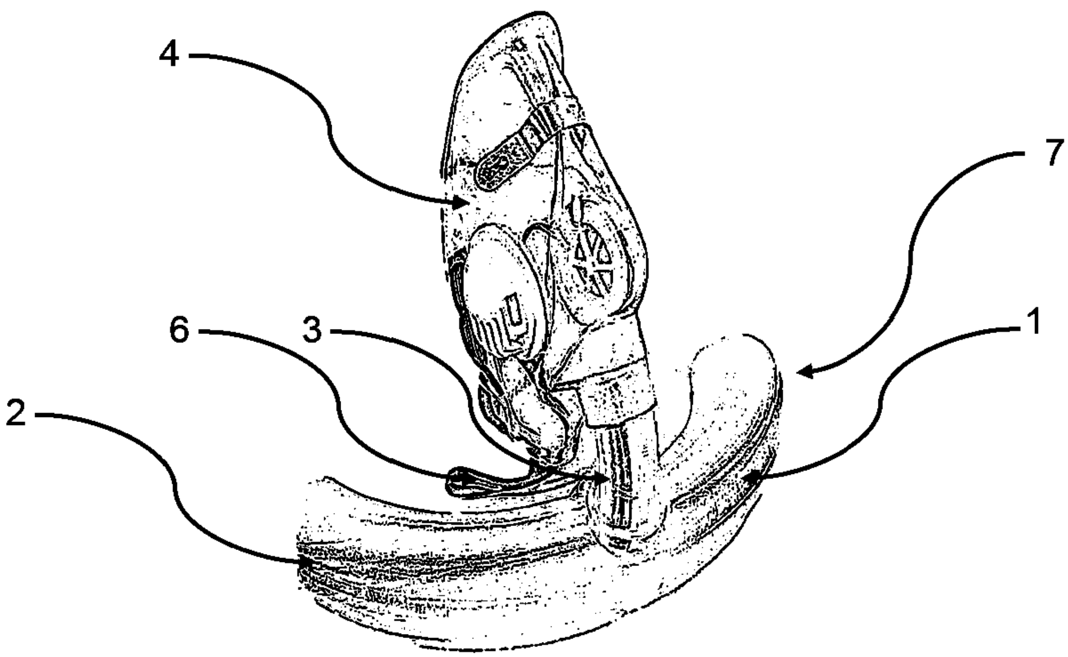


Fig. 2

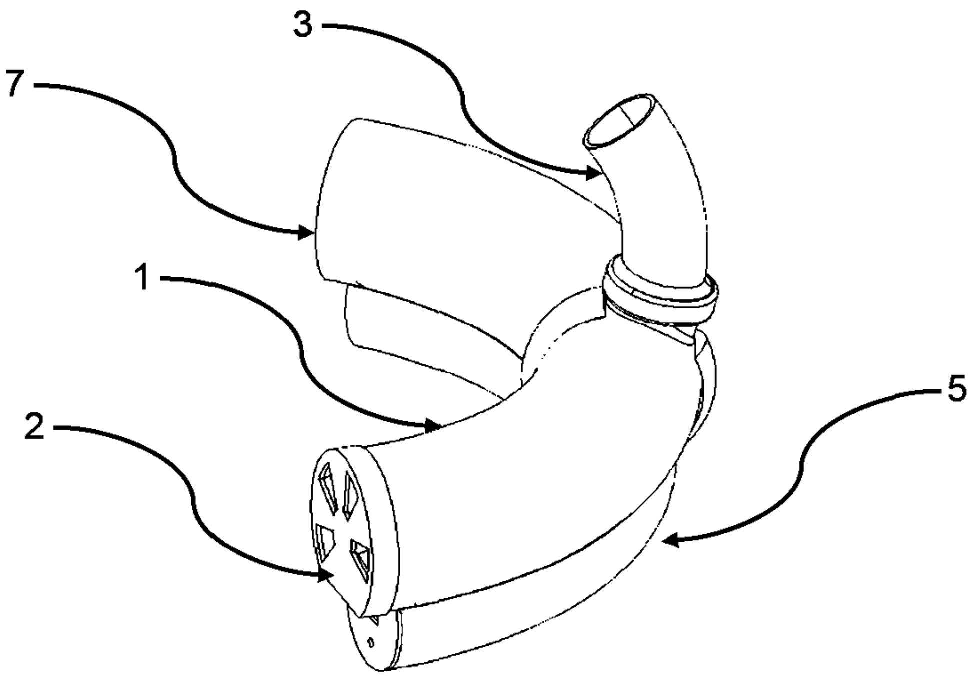


Fig.3

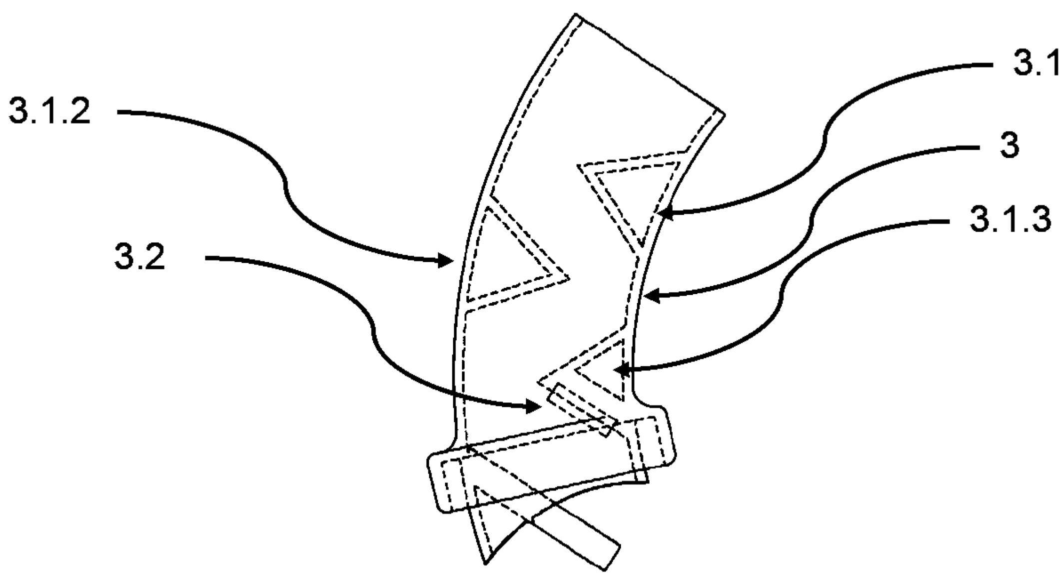


Fig.4

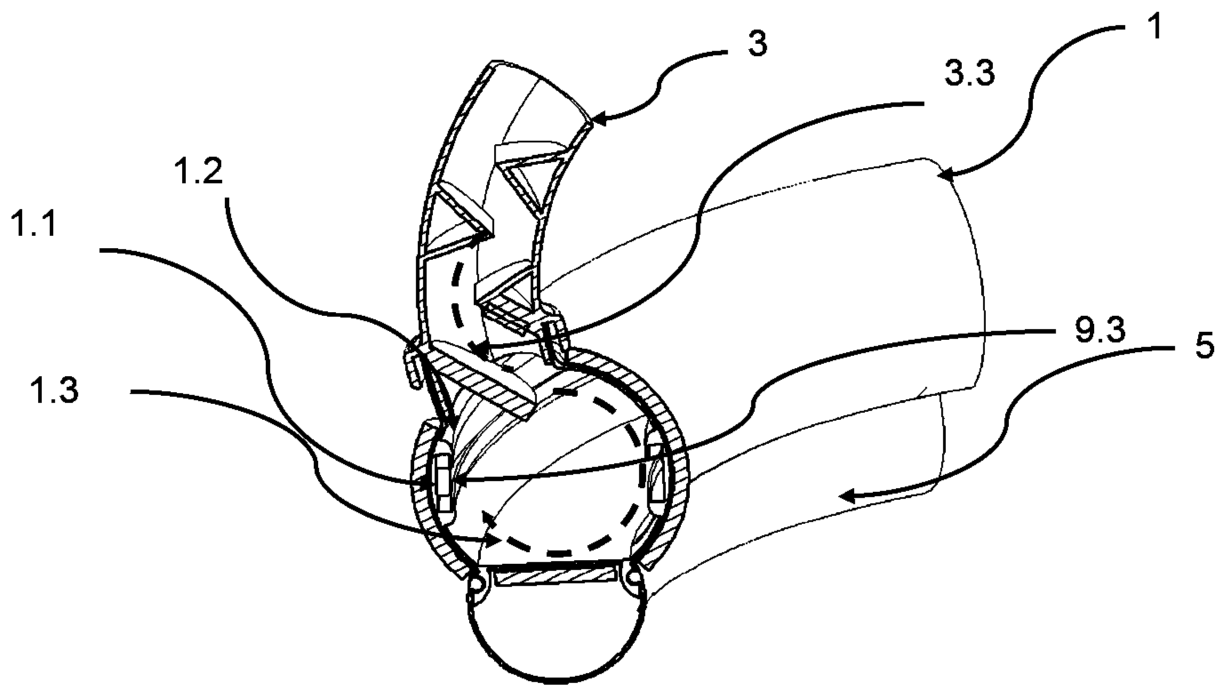


Fig.5

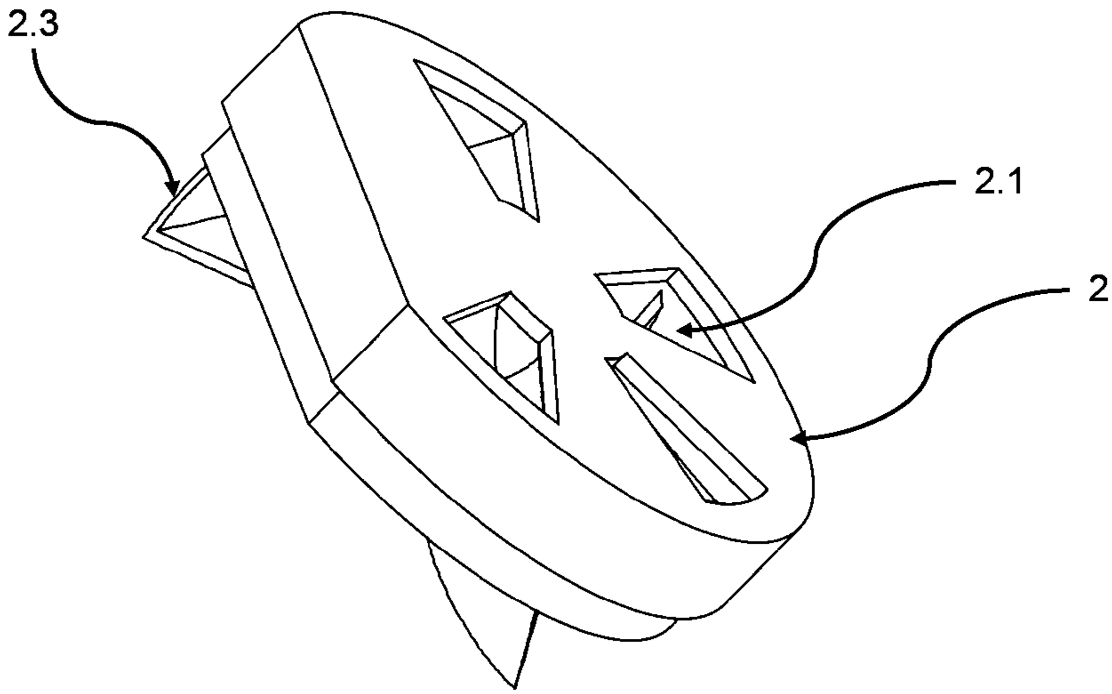


Fig.6

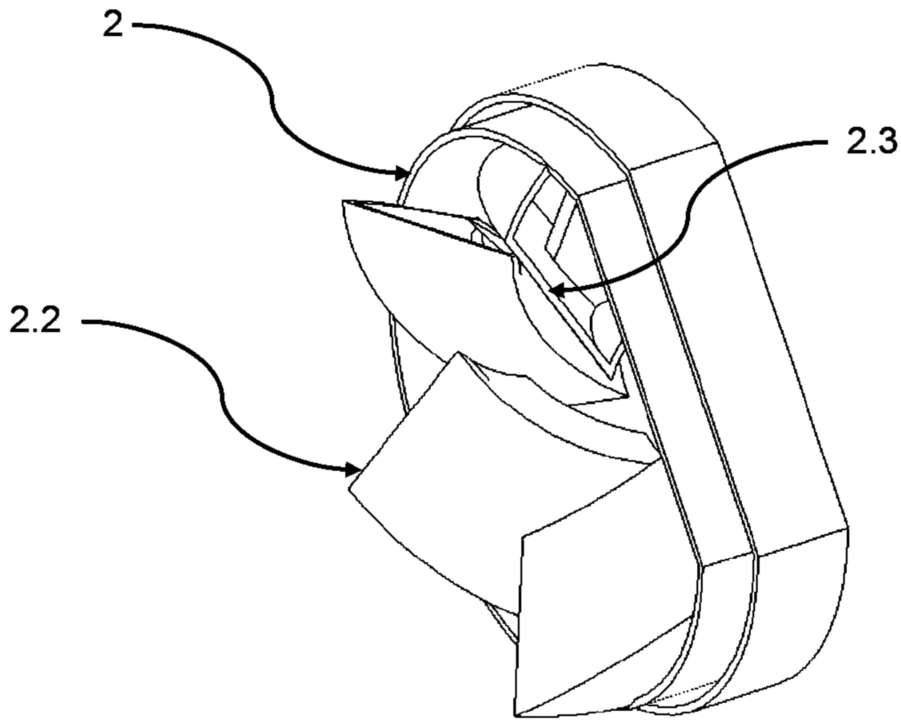


Fig.7

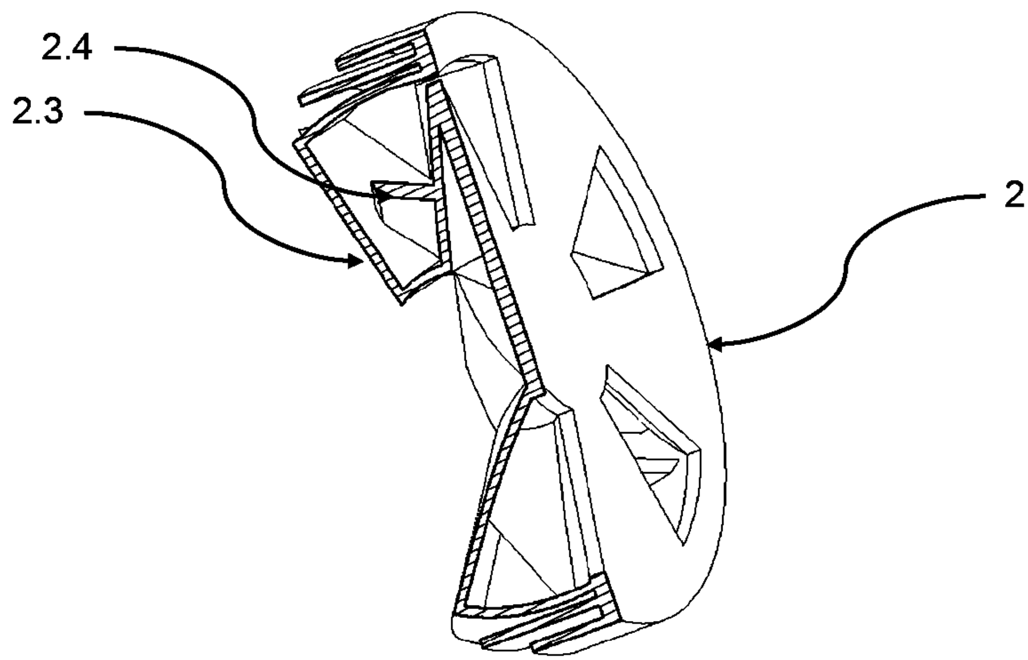


Fig.8

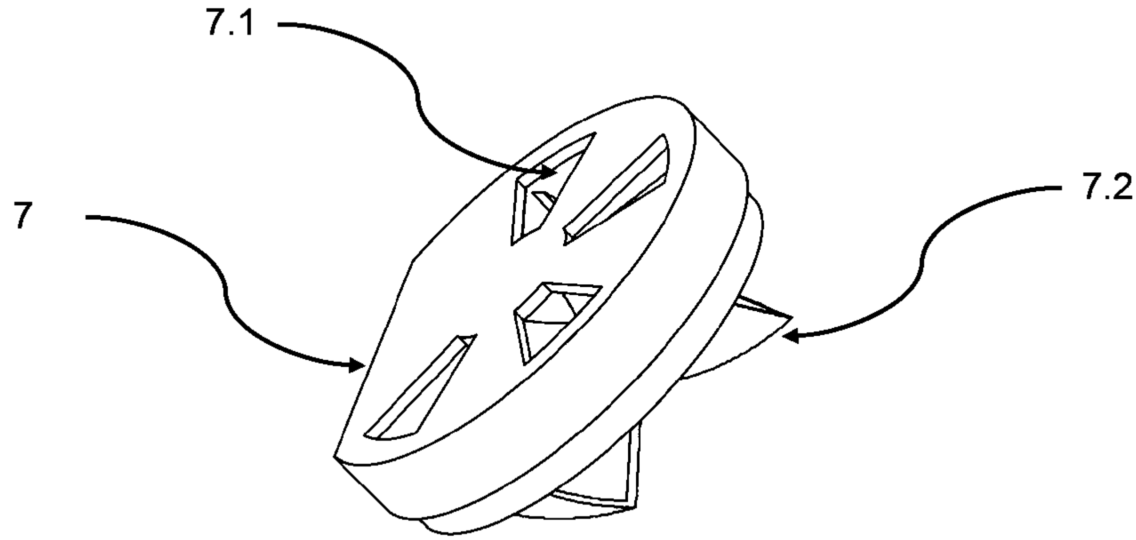
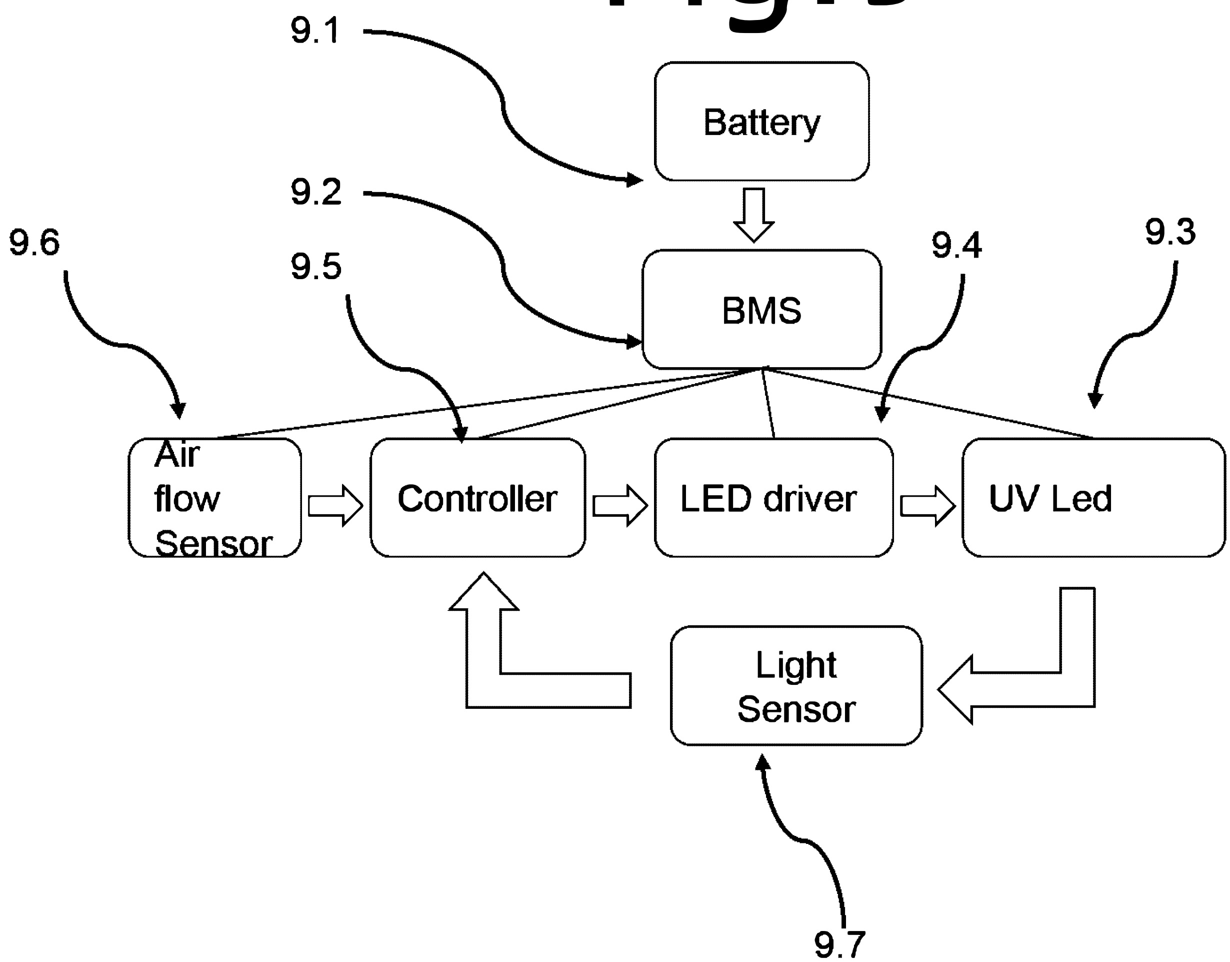
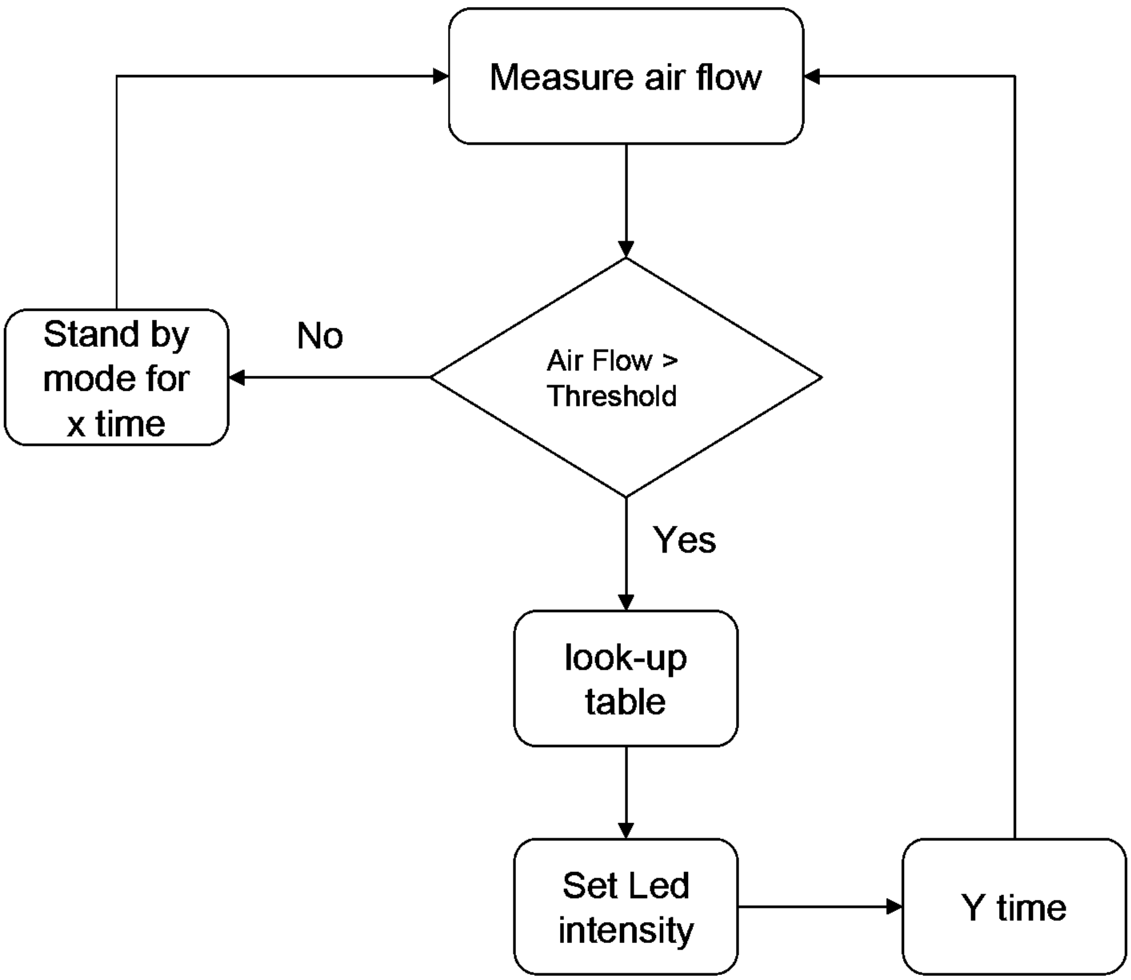


Fig.9



9.1
Battery
9.2
BMS
9.6
9.5
9.4
9.3
Air flow Sensor
Controller
LED driver
UV Led
Light Sensor
9.7

Fig.10


Measure air flow
Stand by mode for x time
No
Air Flow > Threshold
Yes
look-up table
Set Led intensity
Y time

MASK WITH FLOW-CONTROLLED UV LIGHT INTENSITY STERILIZATION

[0001] The present invention relates to face masks, and more particularly, to masks designed to disinfect inhaled airborne droplets, including aerosols, that may contain virus, bacteria and other pathogens. Such a mask is useful for limiting the spread of diseases such as severe acute respiratory syndrome (SARS) and Coronavirus 2019 (COVID-19), that occur in aerosols that remain suspended in the air for relatively long periods of time.

[0002] In addition, the present invention relates to face masks designed to disinfect exhaled breath. The mask subjects an exhaled stream to sterilization by radiation prior to exiting into the ambient atmosphere.

[0003] One challenge is a safe way to employ UVC radiation, because direct UVC exposure to human skin or eyes may cause injuries. For this reason a light barrier air duct is implemented to eliminate exposure to skin and eyes. The emitted UVC radiation illuminates the inhalation and exhalation streams, but not the user's skin.

[0004] The present invention uses Light-Emitting Diodes (LEDs) that emit a very narrow wavelength band of radiation. Currently available UV LEDs have peak wavelengths at 214 nm, 265 nm, and 273 nm, among others. One advantage of LEDs over low-pressure mercury lamps is that they contain no mercury. Another advantage is that power to LEDs may be controlled via pulse width modulation (PWM). However, small surface area and higher directionality of LEDs may make them less effective for germicidal applications, with narrow typical numerical aperture (NA), and beam spread of 30 to 120 degrees. This invention overcomes this problem, and aims for equal UV energy distribution on all air partials.

[0005] Another key problem is germicidal effectiveness, which is proportional to the exposure dose. Germicidal radiant exposure energy, typically is 2-8 millijoules per square centimeter, mJ/cm2, is required.

[0006] The invention is directed to overcoming one or more of the problems and solving one or more of the needs as set forth above.

SUMMARY OF THE INVENTION

[0007] To solve one or more of the problems set forth above, in an exemplary implementation of the invention, a mask with separate flow paths is provided. Each exemplary flow path is a curved tubular conduit extending from a face mask port to a distal port. These conduits are referred to herein as sterilization chambers. The separate flow paths converge at a muffler at the face mask port. The muffler includes a plurality of baffles, which prevent UV radiation from reaching the user and also baffle the flow and introduce a vortex in the flow. An air intake covers each distal port. Each intake includes air openings (e.g., vents), vortex generators and a light trap. The vortex generators are angled vanes that guide inlet flow through the intake in a helical path towards the face mask. The helical flow path and muffler increase the time of exposure of the inhaled gasses to the UV radiation. The vanes also introduce eddies and turbulence, the churining of which exposes much (if not all) of the inhaled gasses to the UV radiation. The light trap blocks UV light from being emitted out of the intake.

[0008] At least one LED in each flow path emits germicidal UV radiation. A sensor (e.g., pressure sensor) detects flow rate in one or each flow path. Power is supplied to the UV LEDs according to the sensor output. A microcontroller samples sensor output, and determines a power setting based upon the sampled sensor output. An LED driver, which may be integrated with the microcontroller or separate, provides sufficient current to illuminate each LED, while limiting the current to prevent damaging the LED. The microcontroller implements pulse width modulaiton (PWM), causing the LED driver to produce oscillating output, with a pulse that is on for part of each duty cycle. By varying (or "modulating") the pulsing width (the portion of the cycle during which the power is on, illuminating the LED), light output from each LED is controlled (i.e., increased or decreased). Increasing the pulsing width, increases light output from each LED for a cylce. Decreasing the pulsing width, decreases light output from each LED for a cylce. The pulsing width is determined from the sampled sensor output. A higher flow rate through the sterilization chamber is irradiated with increased light output from each LED for each cylce. A lower flow rate through the sterilization chamber is irradiated with decreased light output from each LED for each cylce. When flow rate through the sterilization chamber ceases, the LEDs are not powered, thereby conserving battery power. In all cases, battery consumption is limited to as much as is deemed necessary to irradiate a flow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The foregoing and other aspects, objects, features and advantages of the invention will become better understood with reference to the following description, appended claims, and accompanying drawings, where:

[0010] Fig 1. conceptually illustrates an exemplary mask (4) including a non-porous face mask, connected via a muffler (3) to a sterilization chamber (1).

[0011] Fig 2. conceptually illustrates the exemplary sterilization chamber (1) coupled to muffler (3). The control electronics is located in compartment (5).

[0012] Fig 3. provides a section view of the exemplary muffler (3), which provides a light trap resulting from light barrier (3.1.1), (3.1.2) and (3.1.3) and vortex generator (3.3).

[0013] Fig 4. conceptually illustrates an exemplary air flow (1.3) moving through the sterilization chamber (1) into the muffler (3) and past the vortex generator (3.3). UV LED rails (1.1), which provide a UV light source, are located in LED rail holder (1.2). Sterilization chamber (1) is coated with a UV reflective coating such as aluminum foil, or other well-known coating such as metal particle mix polymers.

[0014] Fig 5. conceptually illustrates an exemplary air intake (2), which consists of air openings (2.1) and vortex generators (2.2), which spin the air towards a chamber (1). Air intake (2) may be nonreflective or coated with black or a non-reflective material.

[0015] Fig 6. conceptually illustrates an exemplary air intake light trap (2.3) embedded within vortex generators (2.2), to block UV light generated by UV led rails (1.1).

[0016] Fig 7. conceptually illustrates an exemplary light trap (2.4) structure, which is embedded within vortex generators (2.2).

[0017] Fig 8. conceptually illustrates an exemplary the counter intake (7), which has an exact mirror structure of air intake (2), which includes air openings (7.1) and vortex generators (7.2), which counter spin the air towards a chamber (1).

[0018] Fig. 9 provides a high level block diagram that conceptually illustrates exemplary components of the mask. Rechargeable battery (9.1) is connected to battery management system BMS (9.2). The purpose of the BMS is to manage the battery charging life cycle and protection. All circuits are powered by the BMS (9.2). An air flow sensor (9.6) and processing controller (9.5) set the led driver power (9.4) feeding the LED rails (9.3). BMS (9.2) regulates power voltage supplied to the processor and LED driver, and manages battery charging. BMS (9.2) may include an interface (e.g., USB port) for battery charging.

[0019] FIg. 10 provides a high level flow chart of an exemplary method of controlling LED intensity based on the reading from the air flow sensor. The flow chart shows the loop where periodic airflow measurements (sensor outputs) are performed (sampled) by a controller. In the exemplary method, sensor outputs correlate to power settings for LED rails. The controller determines the power setting from a value in the look-up table corresponding to the sampled sensor output. Other methods of adjusting power settings according to sample sensor output, include applying a function (e.g., an empirical distrubution function) to calculate a power setting based upon sampled sensor output. Such other methods may be used in accordance with the invention. Indeed, the invention is not limited to any particular method of determining a power setting based upon sampled sensor output.

[0020] An advantage of this configuration is that the UV light is turned off when the user does not breath or doesn’t use the mask. This allows for a long life cycle with a relatively small battery.

DETAILED DESCRIPTION

[0021] With reference to Fig. 1, the invention includes three main parts. A. a non-porous face mask (4) B. sterilization chamber(1), C. electronics and control bay (5).

[0022] As shown in Fig. 1, an elastic band 6 is used to hold the non-porous face mask 3 that is coupled to the sterilization chamber 1 over the nose and mouth of the human user with an airtight manner.

[0023] The electronics bay and battery pack 5 is used to provide the means for control and power the UVC LED strip necessary to operate the mask.

[0024] Referring to Fig.2, the air enters the sterilization chamber via two air intakes (2) and (7). The premiere function of the air intakes (2) and (7) is to create an air vortex (like a mini tornado). This vortex is induced by natural air flow passing through the air intakes towards the sterilization chamber in a spiral manner. Two vortex flows are generated by the two air intakes. Both rotate in the same or a similar manner. The main function of the dual vortex is to ensure equal distribution of UV light exposure of each air molecule moving through the chamber. The vortex spins in one direction when inhaling the air through the mask and opposite direction when exhaling the air out.

[0025] Referring to Fig.3 the air moves towards the mask through a muffler (3). When exhaling two vortices are generated by muffler (3) and the exhaust travels through the sterilization chamber (1) towards intakes (2) and (7) and then out of the mask. In this direction the air passes through UV light as with the inhaling operation.

[0026] The muffler occupies a section of the flow path near the mask (4). The muffler is comprised of several baffles 3.11 and 3.12 and 3.13. The illustrated baffles are triangular in cross section, but the invention is not limited to any number or shape baffle structures for reducing flow velocity. The purpose of the muffler to block UV radiation from going out, while allowing baffled air movement.

[0027] A key feature of this invention is that the air is radiated by UV light energy proportionally to the air flow velocity. It allows the maximum battery operation time to deliver the minimum required UV light energy to ensure sterilization of the air with most efficient volume to sterilization energy.

[0028] The air flow sensor (3.2) is located within the muffler (3) to constantly measure accurate air flow speed in both directions, when inhaling and exhaling, in order to create required light intensity according to the measured air flow.

[0029] In sum, an exemplary mask according to principles of the invention includes separate flow paths, that divide inhaled and exhaled gas to facilitate irradiation by germicidal UV lights. Each exemplary flow path is a curved tubular conduit (sterilization chamber) extending from a face mask port to a distal port. The separate flow paths converge at a muffler at the face mask port. The muffler includes a plurality of baffles, which prevent UV radiation from reaching the user and also baffle the flow and introduce a vortex in the flow. An air intake covers each distal port. Each intake includes air openings (e.g., vents), vortex generators and a light trap. The vortex generators are angled vanes that guide inlet flow through the intake in a helical path towards the face mask. The helical flow path and muffler increase the time of exposure of the inhaled gasses to the UV radiation. The vanes also introduce eddies and turbulence, the churining of which exposes much (if not all) of the inhaled gasses to the UV radiation. The light trap blocks UV light from being emitted out of the intake.

[0030] At least one LED strip in each flow path emits germicidal UV radiation. A sensor (e.g., pressure sensor) detects flow rate in one or each flow path. Power is supplied to the UV LEDs according to the sensor output. A microcontroller determines or estimates flow rate based upon sensor output. An LED driver, which may be integrated with the microcontroller or separate, provides sufficient current to illuminate each LED, while limiting the current to prevent damaging the LED. The microcontroller implements pulse width modulaiton (PWM), causing the LED driver to produce oscillating output, with a pulse that is on for part of each duty cycle. By varying (or “modulating”) the pulsing width (the portion of the cycle during which the power is on, illuminating the LED), light output from each LED is controlled. Increasing the pulsing width, increases light output from each LED for a cylce. Decreasing the pulsing width, decreases light output from each LED for a cylce.

CLAIMS

1. A germicidal mask, comprising: a non-porous face mask attachable to face of a user so to provide an airtight fit thereover; a built-in sterilization chamber for killing undesirable pathogens or microorganism contained therein when user is inhaling and exhaling, disinfection by UV LED rails radiating UV light, said UV light controlled by airflow processing system, to ensure minimum required energy for passing air, dual vortex generators coated with black or non UV reflective material, blocking UV light from user and ambient, closed loop constantly measuring air flow and LED emitted light intensity to ensure required amount of radiated energy for full sterilization of the air , said sterilization chamber is coated with reflective coating.

2. The germicidal mask according to claim 1, wherein said sterilization chamber further comprises at least two vortex spinning, each vortex is independent from each other.

3. The germicidal mask according to claim 1, wherein said air flow control the UV light intensity for saving battery energy and providing minimum required UV light power for air flow sterilization.

4. The germicidal mask according to claim 1, wherein UV light is turned off when user do not breath or not use the mask, there is no airflow measured.

5. The germicidal mask according to claim 1, wherein UV light is proportional to the amount of air breath being passed through the mask.

6. The germicidal mask according to claim 1, wherein UV light is measured in real time and required power is verified, so the breathing air gets required energy for disinfection.

7. The germicidal mask according to claim 1, wherein the main chamber is curved allowing comfortably wearing under the chin around the neck.

8. The germicidal mask according to claim 1, wherein curved chamber air intake from the shoulder area.

CERTIFICATION AND REQUEST FOR COVID-19 PROVISIONAL PATENT APPLICATION PROGRAM

(Page 1 of 1)

First Named Inventor:	Doron Koren
Title of Invention:	MASK WITH FLOW-CONTROLLED UV LIGHT INTENSITY STERILIZATION
Contact information to include in database (optional)	Mark Young, 1638 Camden Ave., Jacksonville, FL 32207, 904-996-8099, myoungpa@gmail.com

APPLICANT HEREBY MAKES THE FOLLOWING CERTIFICATIONS AND REQUESTS THAT THE USPTO INCLUDE THE DESCRIPTION OF THE ACCOMPANYING PROVISIONAL PATENT APPLICATION IN A PUBLIC DATABASE.

1. The description of the accompanying provisional patent application concerns a product or process relating to COVID-19 and such product or process is subject to an applicable FDA approval for COVID-19 use.
2. The accompanying application is in the English language.
3. The accompanying application is being filed in DOCX format via the USPTO's Patent Center filing system, together with this form.
4. The applicant understands that while the required filing fee for the accompanying provisional application may be deferred by acceptance into this program, the appropriate filing fee must be paid in order for a subsequent U.S. nonprovisional application to claim the benefit of the filing date of the accompanying provisional application. Applicant recognizes that the filing fee due in the future may be more than the current fee due and that by deferring payment of the filing fee, there may be an increase in the total fee due.
5. Applicant authorizes and requests that the description, including the specification and any drawings, claims and/or abstract of the accompanying provisional patent application, as well as this form, be included in a searchable online public database.
6. Applicant understands that inclusion in the public database is a publication of the description and this form.

Signature /Mark J. Young/	Date 09/22/2020
Name (Print/Typed) Mark J. Young	Practitioner Registration Number 39436

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

■ *Total of 1 forms are submitted.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.