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(54) Title: METHOD AND DEVICE TO MONITOR INFECTIOUS PATIENTS

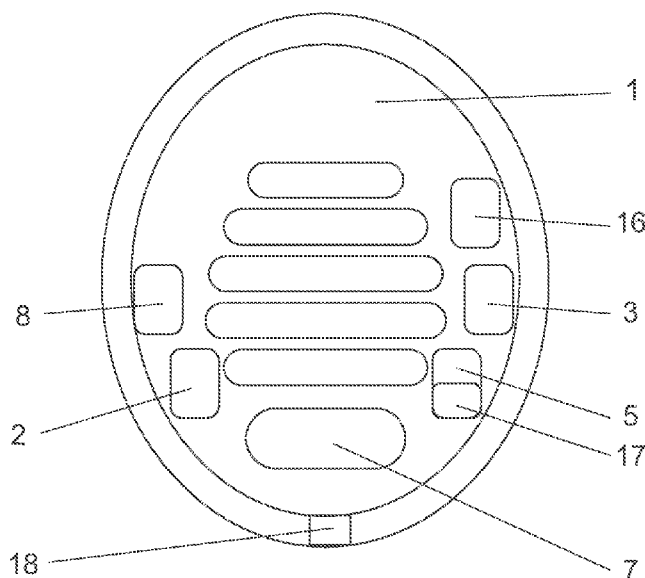


Figure 2

(57) Abstract: A face mask based personal monitoring assembly is provided including a face mask having a compliance sensor for detecting whether or not the face mask is operatively positioned on a person at any relevant time, a cough monitoring system for operatively monitoring occurrences of coughing of a predetermined minimum severity, and an ambient carbon dioxide concentration sensor operatively relating the carbon dioxide concentration to a projected number of potential recipients that could have exhaled carbon dioxide within a predetermined locality within which a wearer of the mask is present. Communication means communicate the outputs of the relevant sensors to a local or remote computer or data processing device that is programmed to produce an output indicating directly or indirectly the risk of infection of one or more of the said potential recipients or the risk of the spread or burden of a disease caused by the bacteria or viruses.

WO 2015/166444 A1

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*

METHOD AND DEVICE TO MONITOR INFECTIOUS PATIENTS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from United Kingdom patent application number 1407666.5 dated 01 May 2014, which is incorporated by reference herein.

5

FIELD OF THE INVENTION

This invention relates to a method and device for monitoring infectious patients, their mask adherence, and for tracking and modelling the burden of communicable diseases such as tuberculosis (including highly drug resistant forms), and influenza typically, but not necessarily, using wireless assimilation of several parameters.

10

More especially, but not exclusively, the invention relates to a method and device for modelling the extent of infectious risk posed by a single infected individual.

15

BACKGROUND TO THE INVENTION

It is commonly acknowledged that many infectious diseases are transmitted from an infected person to others, typically in close proximity to the infected person, by way of bacteria or viruses carried in airborne droplets originating with the infected person consequent on that person coughing, sneezing, talking, or otherwise generating airborne droplets that can come into contact with a potential recipient.

20

The chances of a potential recipient actually receiving one or more airborne droplets that could lead to infection depend on a large number of surrounding circumstances and conditions. These include the severity and frequency of the activity giving rise to the creation of the airborne droplets; the distance that the potential recipient is away from the infected person; and ambient conditions such as the rate and direction of any air flow in the immediate vicinity of the infected person and the potential recipient. The number of potential recipients will, of course, depend on the concentration of persons in the immediate vicinity of the infected person as well as on other environmental conditions in which the infected person and potential recipients find themselves.

30

A method and device for monitoring infectious patients may be used to model how much infectious risk a single individual represents or identify highly infectious patients who can undergo targeted infection control and thus limit transmission.

5 Mathematical modelling of the spread of infectious diseases is the subject of ongoing research (Grassly & Fraser. 2008 "Mathematical models of infectious disease transmission" Nature Reviews Microbiology 6, 477–487). However, these are generally high level epidemiological models for disease spread on a population level. A classical model was described by Wells and Riley in the 1950's (Riley RL, Wells WF, Mills CC, Nyka W, McLean RL "Air hygiene in
10 tuberculosis: quantitative studies of infectivity and control in a pilot ward" Am Rev Tuberc 1957; 75: 420–31) and has remained the cornerstone for research into assessing infectious risk.

Published international patent application number WO2008097307 discloses a facemask having a collection facility for capturing expelled droplets emanating from a mouth or nose of a wearer
15 of the mask in order to trap any bacteria or viruses contained in such droplets for further analysis at a remote monitoring facility in order to determine the infection of the wearer. Various different combinations of physiological sensors are proposed without any particular selection being described.

20 The preceding discussion of the background to the invention is intended only to facilitate an understanding of the present invention. It should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was part of the common general knowledge in the art as at the priority date of the application.

25 **SUMMARY OF THE INVENTION**

In accordance with a first aspect of this invention there is provided a face mask based personal monitoring assembly including a face mask having associated with it a compliance sensor for detecting whether or not the face mask is operatively positioned on a person at any relevant
30 time, the personal monitoring assembly including a cough or sneeze monitoring system for operatively monitoring occurrences of coughing or sneezing of a predetermined minimum severity, and an ambient carbon dioxide concentration sensor operationally relating the carbon dioxide concentration to a projected number of potential recipients that could have exhaled carbon dioxide within a predetermined locality within which a wearer of the mask is present,
35 communication means for communicating the outputs of the relevant sensors to a local or remote computer or data processing device that is programmed to produce an output indicating directly or indirectly the risk of infection of one or more of the said potential recipients or the risk of the spread or burden of a disease caused by trapped bacteria or viruses, or both.

Further features of the invention provide for the face mask or personal monitoring assembly to include unique identification data associating the face mask or personal monitoring assembly with a particular patient or a particular treatment facility; for the face mask or personal monitoring assembly to be provided with a geographical position indicating facility especially in the form of a global positioning system (GPS) or equivalent device; for the cough or sneeze monitoring system to include an auditory cough or sneeze monitoring microphone or chest vibration sensor; for the compliance sensor to be selected from one or more of an exhaled breath temperature sensor, a skin temperature sensor, a light sensor, an O₂/CO₂ partial pressure sensor, a face mask elastic band tension detector, a skin-mask contact pressure sensor, an ECG, a pulse oximeter, and a skin contact impedance monitor; for the face mask or personal monitoring assembly to include one or more environmental sensors selected from an ambient temperature sensor, an ambient humidity sensor, for there to be included a time and date clock; and for the face mask to be of a type having a facility for trapping expelled droplets emanating from a mouth or nose of a wearer of the mask in order to trap any bacteria or viruses contained therein.

It will be appreciated that ambient carbon dioxide concentration can be used as an indication of ventilation and the number of persons present in a locality simply by virtue of the quantity of carbon dioxide present in the air that is increased by exhaled air that generally has a content in the range of between about 4 and about 5.3% CO₂. Non-infected persons in the vicinity would add to the ambient carbon dioxide concentration accordingly depending on ventilation and overall air flow which can impact the airborne spread of disease. It is envisaged that a suitable algorithm may be employed to provide a suitable output depending on ambient conditions.

It will also be appreciated that the face mask based personal monitoring assembly may all be embodied in a facemask unit itself but, quite commonly, it will involve the use of at least one other sensor unit that may communicate with a facemask by a hardwired arrangement or by a short-range wireless communication.

In a first variation of the invention the computer or data processing device may be carried by the face mask or a unit that is in communication therewith and that forms part of the face mask based personal monitoring assembly itself. In such an instance the output from the computer or data processing device may simply be recorded in a memory or may be displayed on a suitable display visible typically as part of the facemask. The display may display a measure of the severity of the infection of the wearer of the mask or an indication as to an infection possibility posed by the wearer to potential recipients near the wearer or to the public at large, or any combination thereof. Any data recorded in the memory may be downloaded at a later time for

further processing, typically at a remote computer or data processing facility. The computer or data processing device may therefore include a portable computing component that may be in the form of a portable wired or wireless computing device such as an embedded micro-controller system, a cellular phone or other mobile communications device such as a smart
5 phone, a tablet computer such as an I-pad®, a portable digital assistant or any combination or equivalent thereof.

A data storage and/or transmission component is also preferably included such that data developed by the data processing means or computing means may be stored on a portable
10 computing component by way of an electronic memory that may form part of the data processing means or portable computing means. The electronic memory is optionally in the form of a memory card such as a secure digital (SD) card or equivalent or communicated via a wired connection such as by way of a USB or other physical port or transmitted using a suitable
15 wireless protocol over a short distance such as a Bluetooth® communication protocol or Wifi, or over a long distance such as by way of a GSM network, conveniently in the form of SMS messages.

In a second variation of the invention the computer or data processing device may be a remote device in which instance the facemask based personal monitoring assembly may have a
20 generally long-range wireless transmitter associated with it so that it is possible to transmit relevant data to a remote computer or data processing device.

The mask itself may be any suitable infection control mask that could be either a custom designed mask or a modified version of a standard infection control mask.
25

In accordance with a second aspect of the invention there is provided a method for tracking and modelling the dispersion of a communicable disease through simultaneous real-time assimilation of parameters developed in at least one face mask based personal monitoring assembly as defined above worn by an infected person and determining, through the
30 application of at least one selected algorithm, mathematical model or formula, the likelihood of onward transmission of the communicable disease or its future dispersion, or both including cough or sneeze frequency, face mask usage (patient adherence or compliance), index of surrounding potential recipients (measured via ambient CO₂ concentration) and geographical location.

35 Further features of this aspect of the invention provide for the simultaneous wireless real-time assimilation of several parameters via a suitable communications medium such as a SMS or alarm reminder system that can also be implemented to remind a patient to put on the device, to

warn the patient if the device is not fitted properly, or to alert the patient if that patient is in an area with high transmission potential.

5 Thus the method or device will concurrently and collectively monitor, store and/or transmit date and time stamped information collected from infectious patients, in terms of their geographical location, compliance with the use of a prescribed infection control mask, frequency of coughing or sneezing, and an estimate of ambient carbon dioxide concentration, which is a measure of rebreathed air and hence contact with other non-infected persons. The use of mathematical models will allow for a dynamic assessment of the infectious risk of the patient, the likely
10 trajectory of disease spread, as well as of their capacity to influence the spread of the corresponding infectious disease. Thus, the method or process will comprise a device that assimilates data that can be fed into a mathematical model, together with other parameters including clinical and microbiological characteristics, to determine trajectories of disease spread and burden. These data can also be used to alert the patient when in a setting with a high
15 likelihood of transmission, and thereby induce a behavioural change in the patient

Further features of the second aspect of the invention provide for the parameters to include inputs from multiple face masks as defined above; for the parameters to include one or more of cough or sneeze frequency and optionally cough or sneeze severity, compliance with the use of
20 a prescribed infection control mask, index of surrounding exposed potential recipients and air flow that is measured and correlated using carbon dioxide concentration in the immediate environment of a wearer of a mask, geographical location; for the method to include storing and/or transmitting date and time stamped data collected from infectious patients, preferably in terms of their geographical location.

25 The use of mathematical models will allow for a dynamic assessment of the infectious risk of a patient, the likely trajectory of disease spread, as well as the capacity to influence the spread of the relevant infectious disease. Thus, the method or process will comprise a device that assimilates data that can be fed into a mathematical model, together with other parameters
30 including clinical and microbiological characteristics, to determine trajectories of disease spread and burden. Diseases such as tuberculosis, including highly drug resistant forms, influenza, corona virus, etc. may thus be monitored and tracked.

In accordance with a third aspect of the invention there is provided a system for monitoring
35 infectious patients including a plurality of face mask based personal monitoring assembly as defined above and a central computerised server and data base for receiving, processing, and providing output on the spread of an infectious disease.

In order that the above and other features of the invention may be more fully understood, a more detailed description with particular reference to two variations of an embodiment of the invention will now follow with reference to the accompanying drawings.

5 BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:-

- 10 Figure 1 is a schematic side view of one embodiment of face mask according to the invention;
- Figure 2 is a rear view thereof;
- 15 Figure 3 illustrates an alternative physical arrangement of the various sensors and other components of a face mask based personal monitoring assembly;
- Figure 4 is a schematic block diagram of the circuitry within an embodiment of face mask based personal monitoring assembly according to the invention; and,
- 20 Figure 5 is a block diagram of a system utilising the face mask based personal monitoring assembly and method provided by the invention.

DETAILED DESCRIPTION WITH REFERENCE TO THE DRAWINGS

25 In one embodiment of the invention a face mask (1) has physiological sensors in the form of an auditory cough or sneeze monitoring microphone system (2), a compliance sensor (3) that can serve as a sensor to sense whether or not the mask is operatively positioned on a wearer and that may also measure physiological signals on the skin surface, like temperature, and an exhaled breath temperature sensor (4) that can also serve as a compliance sensor to sense
30 whether or not the mask is operatively positioned on a wearer.

The face mask (1) may be a conventional face mask of the general type used for controlling infection may have a filter that serves to trap airborne droplets that are expelled from the mouth or nose of a wearer from entering the atmosphere.

35 A computer device (5) that may also serve as a data processing means may be carried by the face mask as shown in Figure 1 or in a separate unit (6) that is in communication with the facemask as shown in Figure 3, whereby data can be processed into a form that can be used

by a built-in or a remote computer server to develop an indication as to the severity of the infection of the wearer of the mask or an infection danger posed by the wearer to potential recipients near the wearer and thus to the public at large. The computer device (5) could be any of those mentioned above. The computer device has a display (7) for displaying an indication of the severity of the infection of the wearer of the mask or an indication as to an infection possibility posed by the wearer to potential recipients near the wearer or to the public at large.

The face mask also has environmental sensors including a geographical position (GPS) device (11), an ambient carbon dioxide (CO₂) concentration sensor (12) in working relationship with a mathematical model that relates the carbon dioxide concentration to a projected number of potential recipients within a predetermined area and with a particular air flow. An ambient temperature sensor (13), an ambient humidity sensor (14), a light intensity sensor (15); and a time and date clock module (16) are also provided.

A data storage and/or transmission component (17) is included such that data developed by the computing means may be stored in an electronic memory in the form of a secure digital (SD) card.

The data is, in use, communicated via either a wired connection such as by way of a communications port or by wireless transmitter (18). Wireless transmission may be by way of suitable wireless protocol over a short distance such as a Bluetooth communication protocol or over a long distance such as by way of a GSM network (19). Use of the Internet (20) may also be made. The data may be received and retained by a common remote computerized server (21). The computerized server (21) may be provided with suitable mathematical models and algorithms in order to predict the potential spread of the disease based on data from numerous masks worn by various persons.

Whilst all of these items that are located at the facemask location can be embodied in the facemask itself as illustrated in Figures 1 and 2, many of them can be located in the separate unit (6) as illustrated in Figure 3. The distribution of these items between the facemask and any separate unit will depend largely on design considerations and convenience of manufacture of the various components as well as the suitability of incorporating the various sensors and other items in a facemask.

The method for tracking and modelling the dispersion of a communicable disease through simultaneous real-time assimilation of parameters developed in a face mask as described above worn by an infected person is thus also provided. The method involves determining, through the application of at least one selected algorithm or formula in a step indicated by

numeral (22), and fitting the output using mathematical modelling in a step indicated by numeral (23), the likelihood of onward transmission of the communicable disease or its future dispersion, or both, may be developed. The application of the algorithms or mathematical modelling may take place before the relevant data is communicated to a common computerised server or at
5 the common computerised server. Both of these possibilities are indicated in Figure 5.

The use of mathematical models allows for a dynamic assessment of the infectious risk of a patient, the likely trajectory of disease spread, as well as the capacity to influence the spread of the relevant infectious disease.

10 The parameters used in carrying out the method include inputs to the common computer server from multiple face masks as described above. The parameters include cough or sneeze frequency and severity or duration, compliance with the use of a prescribed infection control mask, index of surrounding exposed potential recipients and local air flow that is measured and
15 correlated using carbon dioxide concentration in the immediate environment of a wearer of a mask, and the storing and transmitting of date and time stamped data collected from infectious patients in terms of their geographical location.

The mathematical model may include the estimation of potential infectious risk based on cough
20 or sneeze frequency and duration, as well as proximity to potential hosts, and any other relevant environmental and physiological factors. Such a model may work by assigning points to each variable (e.g., CO₂ concentration), which correspond to an increasing risk of infection. These points can then be tallied and, if exceeding a pre-defined threshold, used to stratify patients according to their transmission potential or infectiousness. The outputs of such a model could
25 also be fed back to the patient to induce behavioural changes.

It is to be noted that cough detection and recording is the subject of on-going research (Smith J. 2007. Ambulatory methods for recording cough. *Pharmacology & Therapeutics*. 20(4): 313-318) and whilst the human ear can easily detect a cough, automatic methods are not as reliable
30 due to large variations in acoustic properties. Commercial cough counters are reported to have a low sensitivity (66-70%) and high specificity (98-95%) and large variations between subjects. False positives are mostly attributed to throat clearing and laughing. Current research methods applicable to tuberculosis are reported to have similar sensitivities (75.5%) and specificities (99.6%). Care should therefore be taken when selecting a cough monitor.

35 Societal values in terms of estimating the infectious capacity of patients and correspondingly mapping the potential spread of infectious diseases due to contact with them may be achieved thereby enabling targeted interventions for infection control to occur. This will also be very cost

effective, as costly new cases will be prevented and thus the invention will have commercial value. This information captured by a face mask based personal monitoring assembly may be used to research and model infectious disease transmission, inform infection management and control, advise active case finding strategies, and could therefore result in a reduced infectious disease burden. More importantly it could identify the most infectious persons so that they may be targeted for isolation or intervention. This is critical as the economic impact of infectious disease transmission is extensive.

Numerous variations may be made to the embodiment of the invention described above without departing from the scope hereof.

Throughout the specification and claims unless the contents requires otherwise the word 'comprise' or variations such as 'comprises' or 'comprising' will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

CLAIMS:

1. A face mask based personal monitoring assembly including a face mask having associated with it a compliance sensor for detecting whether or not the face mask is
5 operatively positioned on a person at any relevant time, the personal monitoring assembly including a cough or sneeze monitoring system for operatively monitoring occurrences of coughing or sneezing of a predetermined minimum severity, and an ambient carbon dioxide concentration sensor operationally relating the carbon dioxide concentration to a projected number of potential recipients that could have exhaled
10 carbon dioxide within a predetermined locality within which a wearer of the mask is present, communication means for communicating the outputs of relevant sensors to a local or remote computer or data processing device that is programmed to produce an output indicating directly or indirectly the risk of infection of one or more of the said potential recipients or the risk of the spread or burden of a disease caused by trapped
15 bacteria or viruses, or both.
2. A face mask based personal monitoring assembly as claimed in claim 1 in which the face mask is of the type having a facility for trapping expelled droplets emanating from a mouth or nose of a wearer of the mask in order to trap any bacteria or viruses contained
20 therein.
3. A face mask based personal monitoring assembly as claimed in either one of claims 1 or 2 in which the face mask or personal monitoring assembly includes unique identification data associating the face mask or personal monitoring assembly with a particular patient
25 or a particular treatment facility.
4. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the face mask or personal monitoring assembly is provided with a geographical position indicating device.
30
5. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the cough or sneeze monitoring system includes an auditory cough or sneeze monitoring microphone or chest vibration sensor.
- 35 6. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the compliance sensor is selected from one or more of an exhaled breath temperature sensor, a skin temperature sensor, a light sensor, an O₂/CO₂ partial pressure sensor, a face mask elastic band tension detector, a skin-mask

contact pressure sensor, an ECG, a pulse oximeter, and a skin contact impedance monitor.

- 5 7. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the face mask or personal monitoring assembly includes one or more environmental sensors selected from an ambient temperature sensor, an ambient humidity sensor and a light intensity sensor.
- 10 8. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which there is included a time and date clock.
- 15 9. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the face mask based personal monitoring assembly may all be embodied in a facemask unit itself or alternatively by way of at least one other sensor unit that may communicate with a facemask by a hardwired arrangement or a short-range wireless communication.
- 20 10. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the computer or data processing device is carried by the face mask or a unit that is in communication therewith and that forms part of the face mask based personal monitoring assembly itself.
- 25 11. A face mask based personal monitoring assembly as claimed in claim 10 in which the computer or data processing device has a suitable visible display for displaying a measure of the severity of the infection of a wearer of the mask or an indication as to an infection possibility posed by the wearer to potential recipients near the wearer or to the public at large, or any combination thereof.
- 30 12. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the computer or data processing device includes a portable computing component selected from an embedded micro-controller system, a cellular phone or other mobile communications device selected from a smart phone, a tablet computer, a portable digital assistant and any combination or equivalent thereof.
- 35 13. A face mask based personal monitoring assembly as claimed in any one of the preceding claims in which the computer or data processing device includes a remote computer or data processing device in which instance the facemask based personal

monitoring assembly has a generally long-range wireless transmitter associated with it for transmitting relevant data to the remote computer or data processing device.

14. A method for tracking and modelling the dispersion of a communicable disease through simultaneous real-time assimilation of parameters developed in at least one face mask based personal monitoring assembly as claimed in any one of the preceding claims worn by an infected person and determining, through the application of at least one selected algorithm, mathematical model or formula, the likelihood of onward transmission of the communicable disease or its future dispersion, or both including cough or sneeze frequency, face mask usage, index of surrounding potential recipients (measured via ambient CO₂ concentration) and geographical location.
15. A system for monitoring infectious patients including a plurality of face mask based personal monitoring assemblies as claimed in any one of claims 1 to 13 and a central computerised server and data base for receiving, processing, and providing output on the spread of an infectious disease.

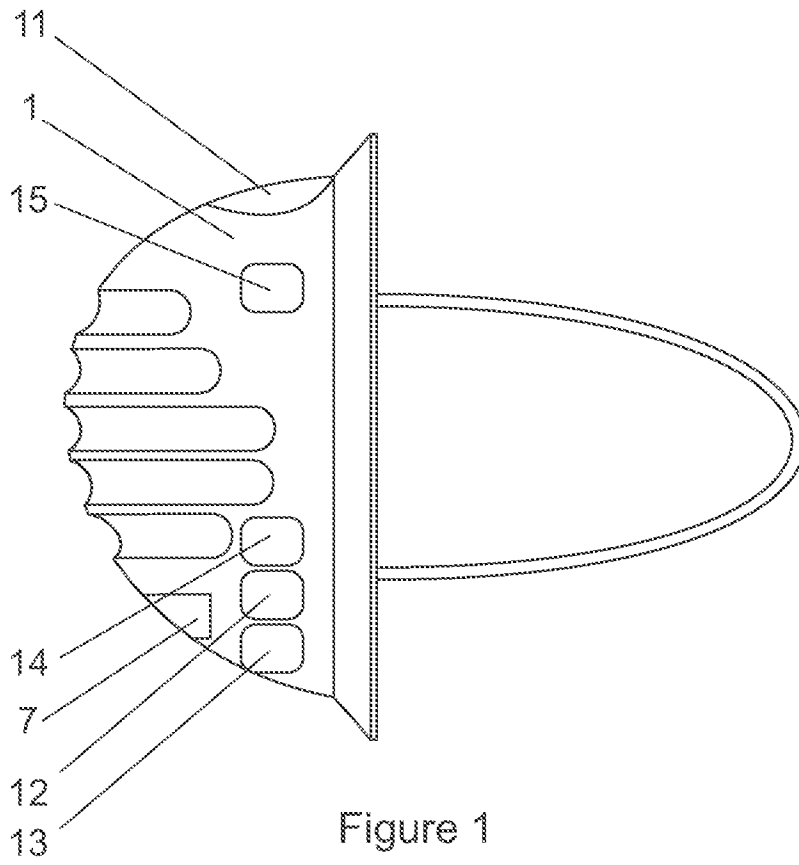


Figure 1

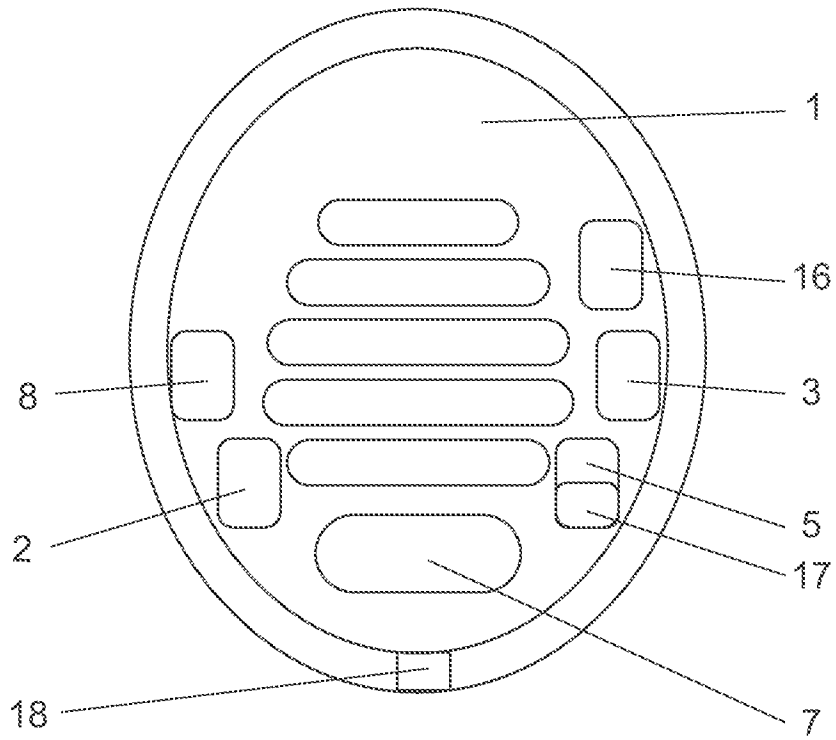


Figure 2

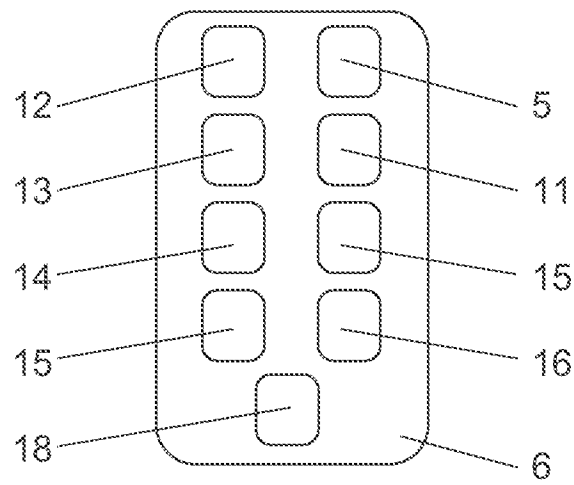
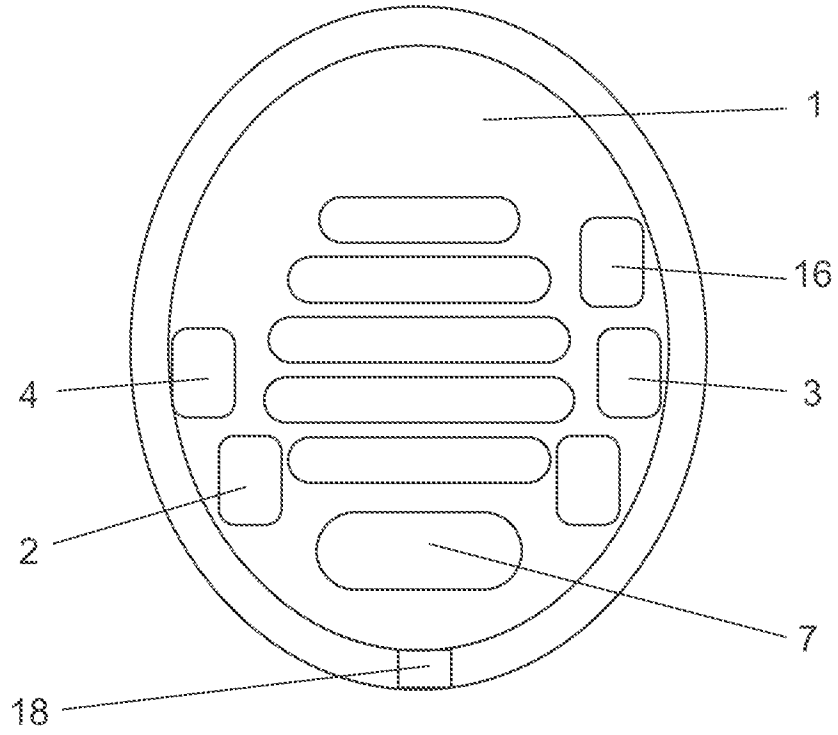


Figure 3

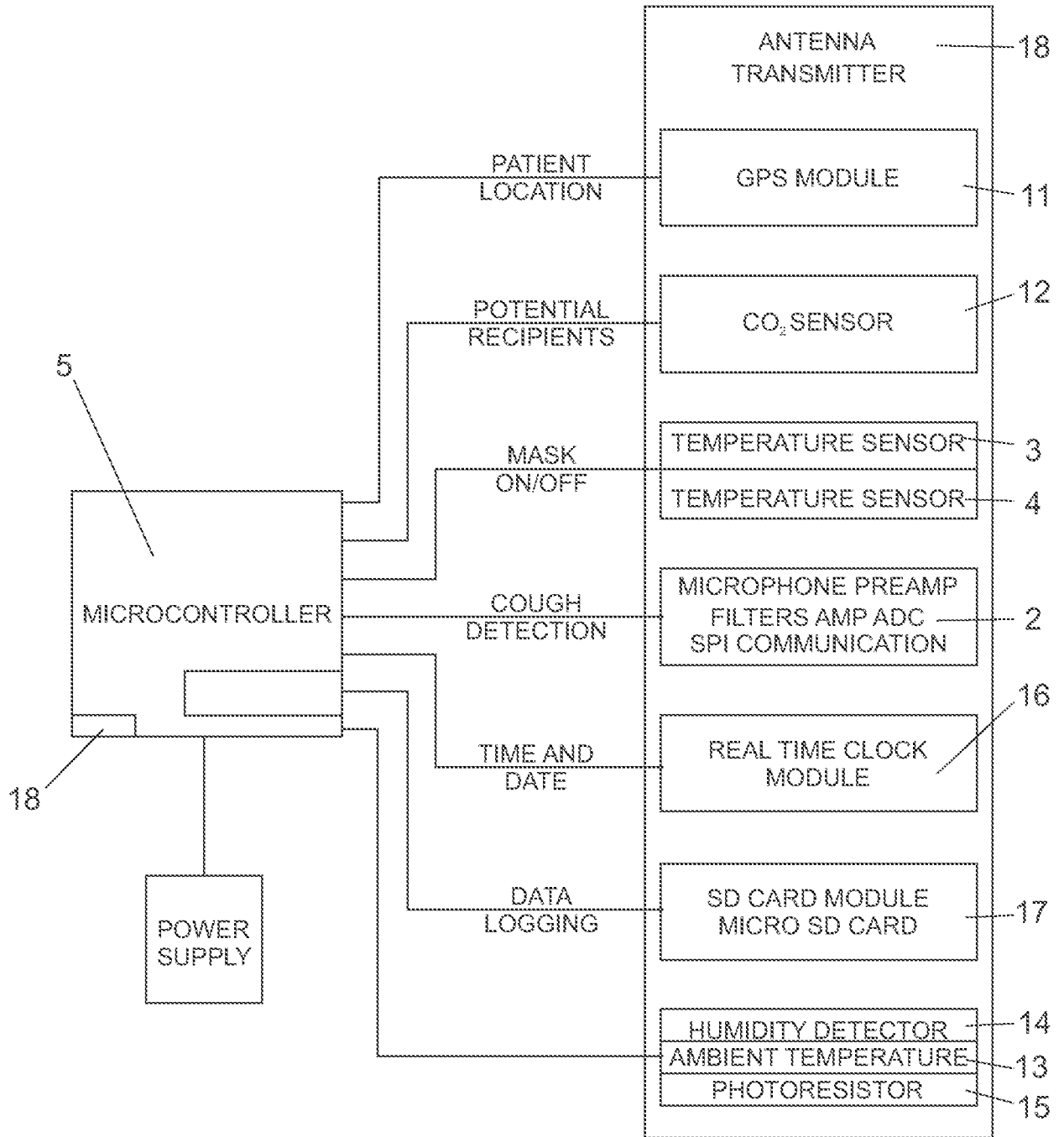


Figure 4

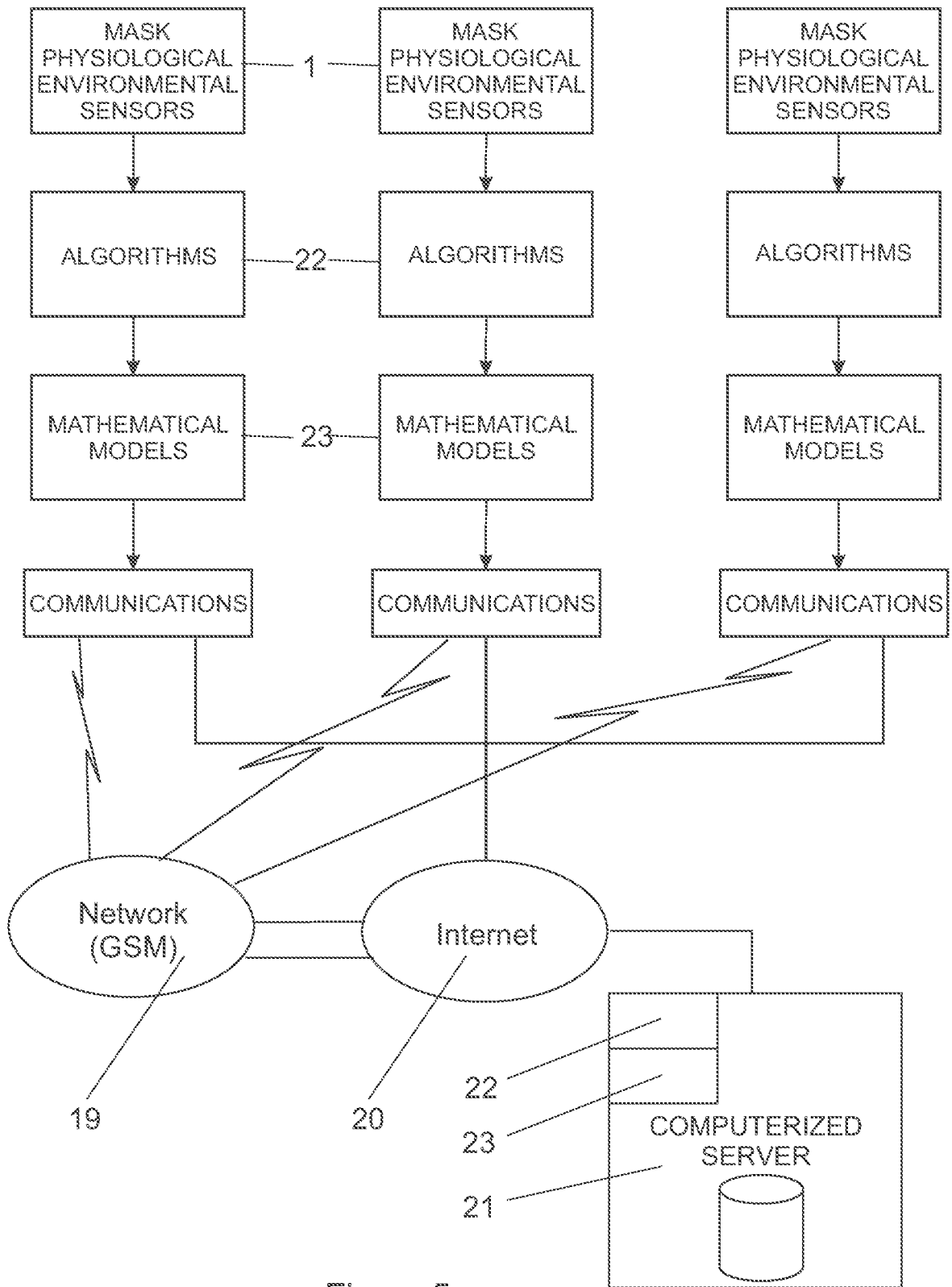


Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/053143

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/097 A41D13/11 A62B18/02 A61M16/06
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
A62B A41D A61B A61M G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007 105161 A (KONICA MINOLTA MED & GRAPHIC) 26 April 2007 (2007-04-26) figures 1,2,3 paragraphs [0017], [0018], [0022], [0029] - [0032]	1-15
A	WO 01/43804 A1 (COMPUMEDICS SLEEP PTY LTD [AU]; BURTON DAVID [AU]) 21 June 2001 (2001-06-21) figure 1 page 5, line 24 - page 6, line 7	1-15
A	US 2011/190594 A1 (HEIT JUERGEN [US] ET AL) 4 August 2011 (2011-08-04) figure 1 paragraphs [0048], [0073]	1-15
	-/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 29 July 2015	Date of mailing of the international search report 04/08/2015
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Vanderperren, Yves
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/053143

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012/103490 A1 (PREC CAPNOGRAPHY [US]; MCNEILL FRANKIE MICHELLE [US]) 2 August 2012 (2012-08-02) figure 1 paragraphs [0056], [0064] - [0065] -----	1-15
A	US 2009/227887 A1 (HOWARD C PETER [US] ET AL) 10 September 2009 (2009-09-10) figure 9 paragraphs [0048], [0068], [0083] -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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