US 20140058234A1

(19) **United States**

(12) **Patent Application Publication**

Su et al.

(10) **Pub. No.: US 2014/0058234 A1**

(43) **Pub. Date: Feb. 27, 2014**

(54) **DEVICE FOR DETECTING BLOOD-OXYGEN LEVEL ASSOCIATED WITH ONE OR MORE MUCOUS MEMBRANE REGIONS**

(71) Applicant: **Chi Mei Medical Center**, Tainan City (TW)

(72) Inventors: **Ying-Chieh Su**, Tainan City (TW); **Jui-Wen Pan**, Hsinchu City (TW); **Bor-Shyh Lin**, Changhua County (TW)

(73) Assignee: **Chi Mei Medical Center**, Tainan City (TW)

(21) Appl. No.: **13/971,993**

(22) Filed: **Aug. 21, 2013**

(30) **Foreign Application Priority Data**

Aug. 22, 2012 (TW) 101130454

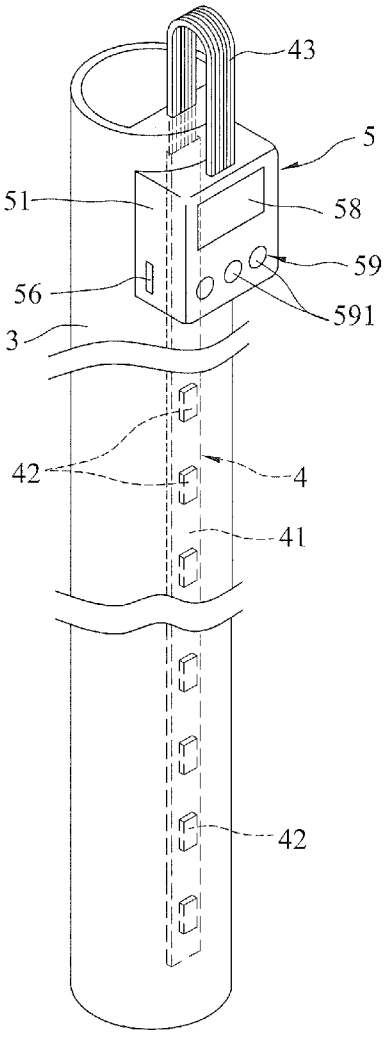
Publication Classification

(51) **Int. Cl.**
A61B 5/1455 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 5/14551*** (2013.01)
USPC **600/339**; 600/364

(57) **ABSTRACT**

A device adapted for insertion into one or more of an esophagus, a stomach, an intestine and a colon for detecting a blood-oxygen level associated with at least one mucous membrane region in said one or more of the esophagus, the stomach, the intestine and the colon is disclosed. The device includes a flexible and elongated main body, and a blood oxygen level detecting unit. The blood oxygen level detecting unit includes one or more blood oxygen level detecting modules disposed on the main body and capable of generating one or more signals associated with the blood oxygen level(s) of one or more mucous membrane regions nearby the blood oxygen level detecting module(s).



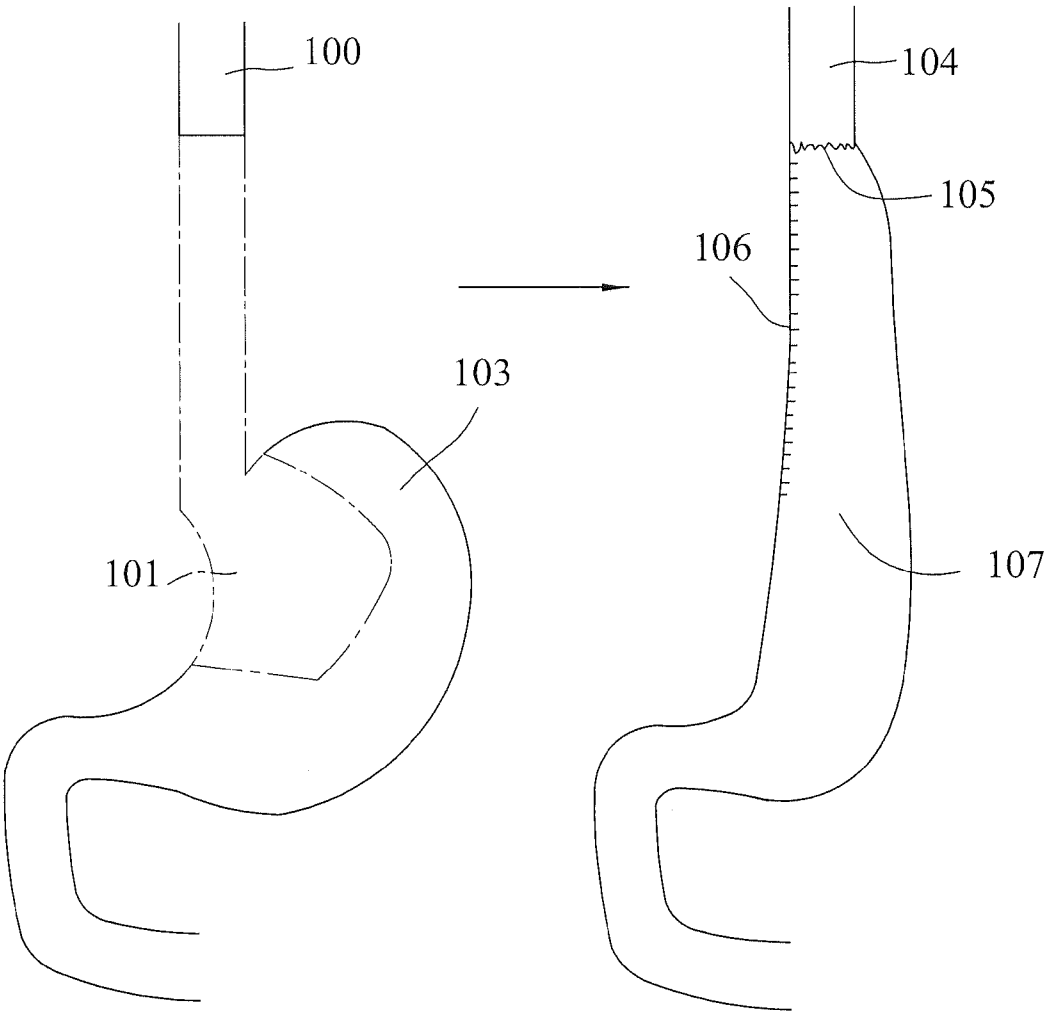


FIG.1

PRIOR ART

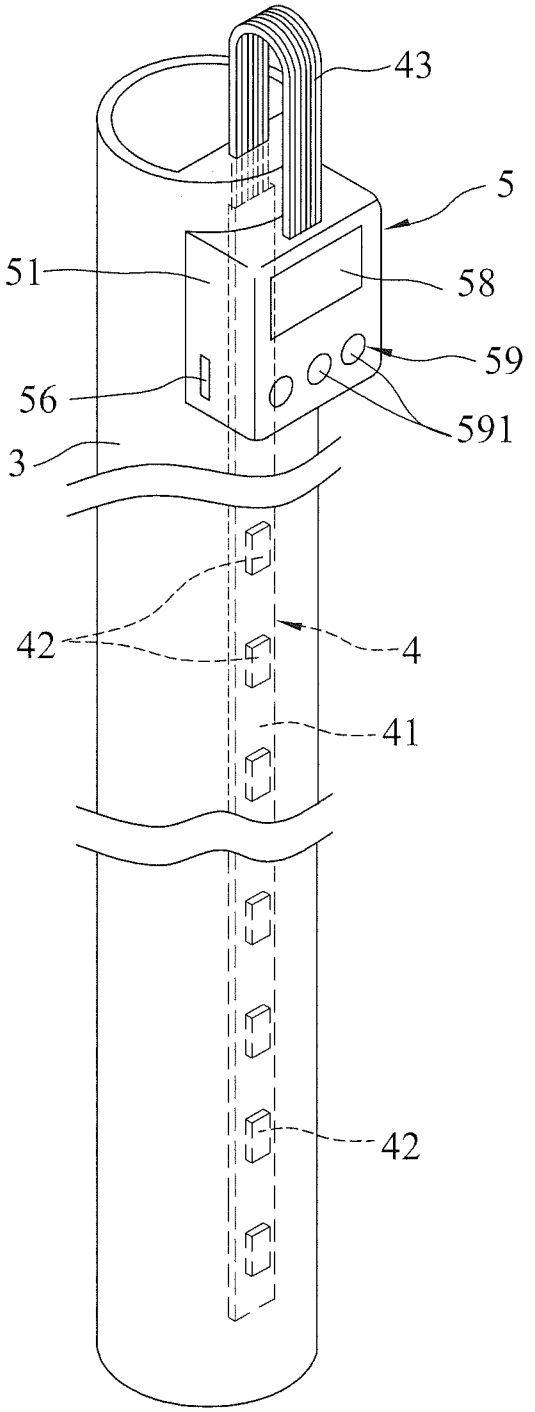


FIG.2

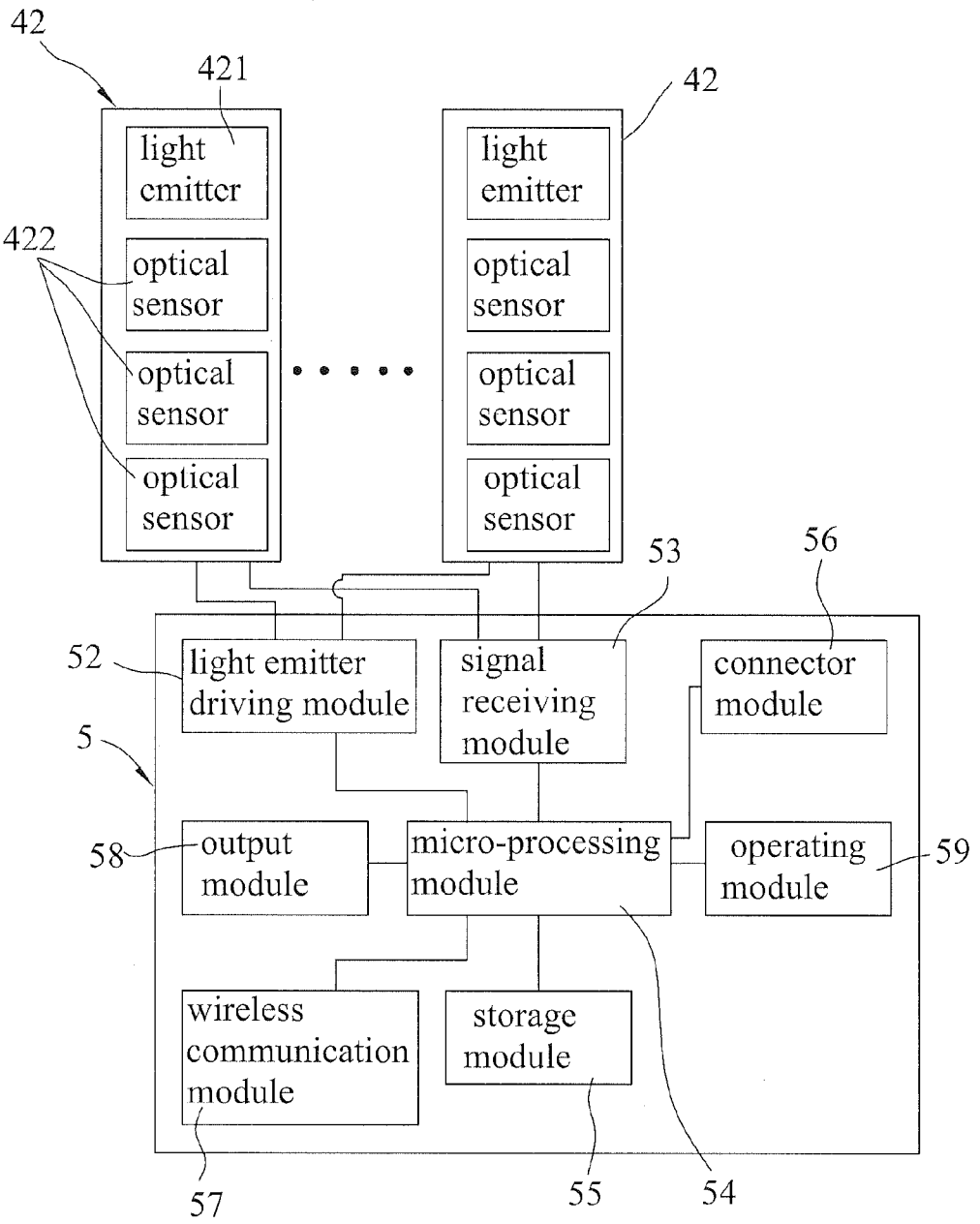

42
421
42
light emitter
light emitter
422
optical sensor
optical sensor
optical sensor
optical sensor
optical sensor
optical sensor
optical sensor
optical sensor
53
56
52
light emitter driving module
signal receiving module
connector module
5
58
output module
micro-processing module
operating module
59
wireless communication module
storage module
57
55
54

FIG.3

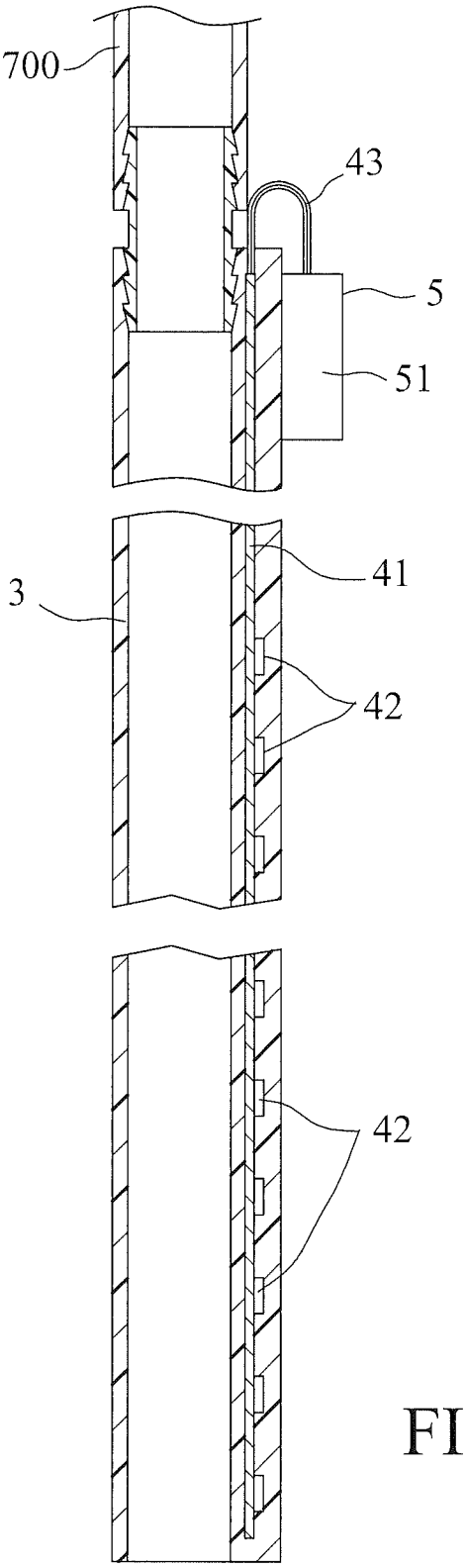


FIG.4

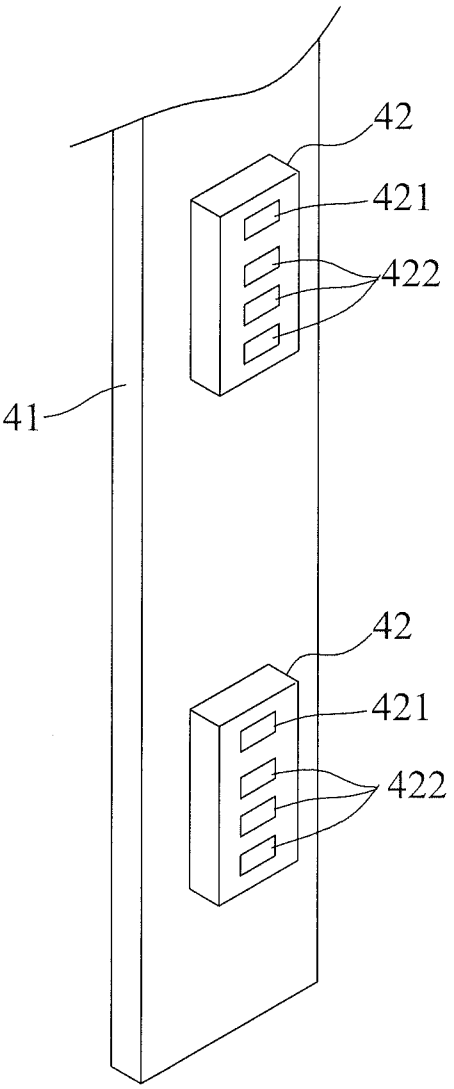


FIG.5

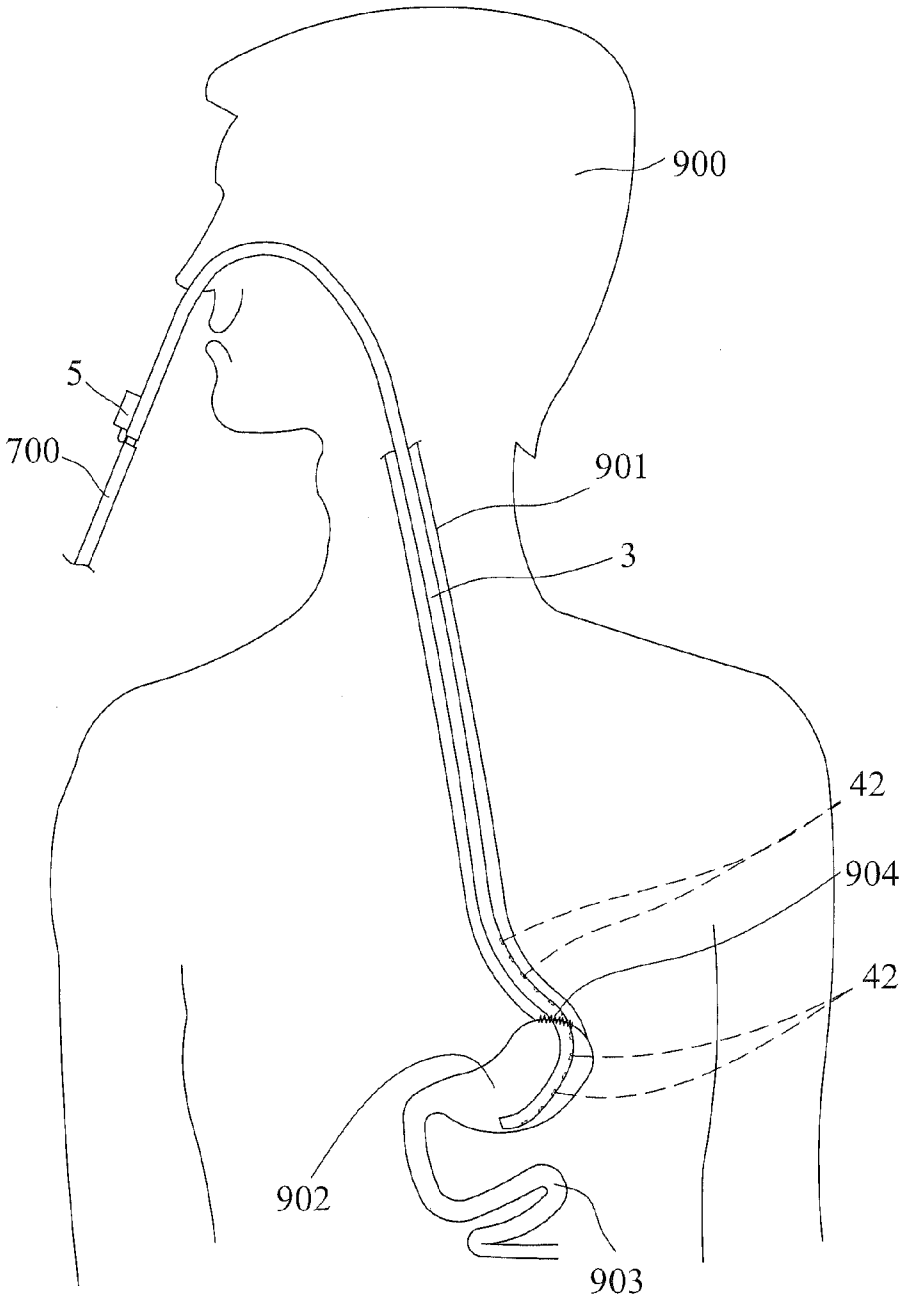


FIG.6

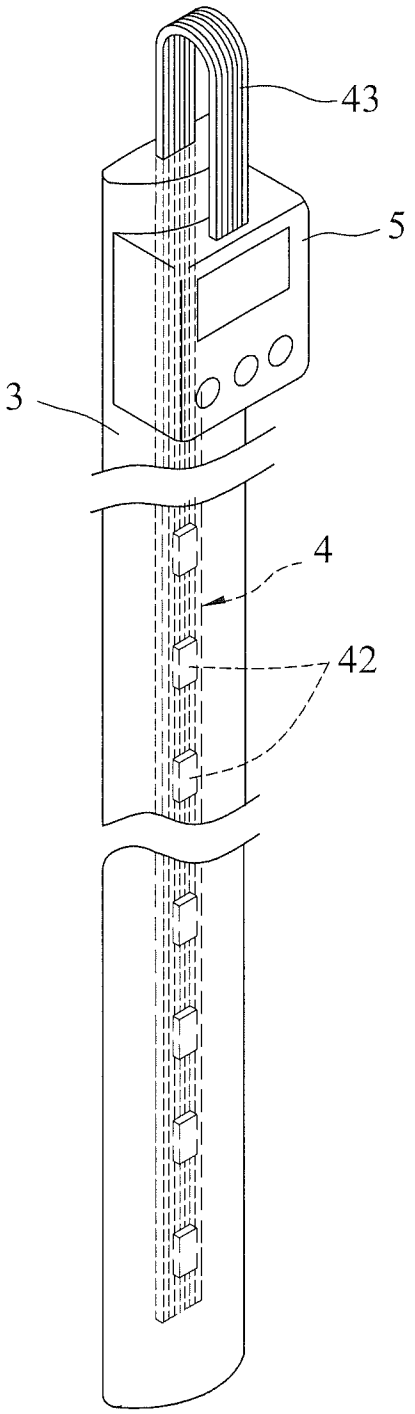


FIG.7

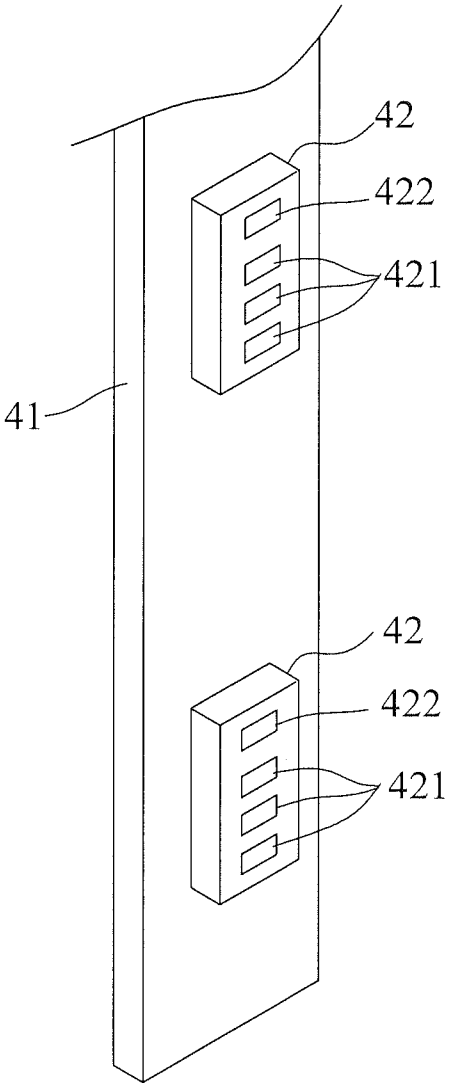


FIG.8

DEVICE FOR DETECTING BLOOD-OXYGEN LEVEL ASSOCIATED WITH ONE OR MORE MUCOUS MEMBRANE REGIONS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority of Taiwanese Application No. 101130454, filed on Aug. 22, 2012.

BACKGROUND OF THE INVENTION

[0002] 1. Technical field

[0003] The disclosure generally relates to a blood oxygen level detector, more particularly to a device for detecting blood oxygen level of internal organ(s).

[0004] 2. Description of the Related Art

[0005] When performing esophagectomy or gastrectomy, it is a norm to reattach the remaining esophagus to the stomach, to reattach the remaining stomach to the intestine or colon, or to reattach the esophagus to the intestine or colon. Referring to FIG. **1** for instance, the portion **101** comprising of part of the esophagus **100** and part of the stomach **103** illustrated by dashed lines is to be removed during esophagectomy, and then the remaining portion **104** of the esophagus **100** is reattached to the remaining portion **107** of the stomach **103**.

[0006] It is crucial to monitor post-esophagectomy or post-gastrectomy patients for mucosal blood delivery at the anastomosis **105** of the organs. Abnormal mucosal blood delivery may cause ischemia in tissues close to the anastomosis **105** and the closure line **106** of the stomach **103**, leading to inflammation or ischemic necrosis of the tissues or associated organs. Generally, medical staff will monitor the patient's vital signs and use drainage tubes to facilitate the detection of postoperative complications. But all of the observation items currently available, such as vital signs and drainage tubes, are delayed parameters. When these parameters show abnormality, the diagnosis is delayed already. In addition, the risks such as forming perforations in the tissues close to the anastomosis **105** and the closure line **106** of the stomach **103** will rise dramatically. There is an urgent need to establish a tool for tissue perfusion monitoring.

SUMMARY OF THE INVENTION

[0007] Some of the embodiments disclosed herein are to provide a device for measuring blood-oxygen level associated with one or more mucous membrane regions of a post-operative patient.

[0008] According to the present disclosure, there is provided a device adapted for insertion into one or more of an esophagus, a stomach, an intestine and a colon for detecting a blood-oxygen level associated with one or more mucous membrane regions in said one or more of the esophagus, the stomach, the intestine and the colon. The device comprises a flexible and elongated main body, and one or more blood oxygen level detecting units. Each blood oxygen level detecting unit includes one or more blood oxygen level detecting modules disposed on the main body and capable of generating one of more signals associated with the blood oxygen level(s) of one or more mucous membrane regions nearby the blood oxygen level detecting module(s).

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other features and advantages of the present disclosure will become apparent in the following detailed description of the preferred embodiment with reference to the accompanying drawings, of which:

[0010] FIG. **1** is schematic diagram for illustrating the procedure of esophagectomy;

[0011] FIG. **2** is a fragmentary perspective schematic view of the first preferred embodiment of a device for detecting a blood-oxygen level associated with one or more mucous membrane regions according to the present disclosure;

[0012] FIG. **3** is a block diagram, illustrating a micro-processing unit and blood oxygen level detecting modules of a blood oxygen level detecting unit of the first preferred embodiment;

[0013] FIG. **4** is a fragmentary sectional view of the first preferred embodiment;

[0014] FIG. **5** is a fragmentary perspective view of the blood oxygen level detecting unit according to the first preferred embodiment;

[0015] FIG. **6** is a schematic diagram, illustrating use of the first preferred embodiment on a postoperative patient;

[0016] FIG. **7** is a fragmentary perspective schematic view of the second preferred embodiment of a device for detecting a blood-oxygen level associated with one or more mucous membrane regions according to the present disclosure; and

[0017] FIG. **8** is a fragmentary perspective view similar to FIG. **5**, but according to the third preferred embodiment of a device for detecting a blood-oxygen level associated with one or more mucous membrane regions according to the present disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Before the present disclosure is described in greater detail, it should be noted that like elements are denoted by the same reference numerals throughout the disclosure.

[0019] With reference to FIG. **2** and FIG. **6**, the first preferred embodiment of a device for detecting a blood-oxygen level associated with one or more mucous membrane regions according to the present disclosure is adapted to be inserted into one or more of an esophagus **901**, a stomach **902**, an intestine **903** and a colon (not shown) of a patient **900** that has undergone esophagectomy, gastrectomy or a similar operation. The device is able to detect a blood-oxygen level associated with one or more mucous membrane regions in said one or more of the esophagus **901**, the stomach **902**, the intestine **903** and the colon, preferably near an anastomosis **904** of the organs so as to facilitate evaluation by medical staff of postoperative conditions of the patient **900**. Due to the structural configuration of the first preferred embodiment as will be described in greater detail below, the device may be connected to a connecting tube **700** and cooperatively function as a nasogastric tube or a drainage tube. It should be noted herein that the anastomosis **904** may be between the esophagus **901** and the stomach **902**, between the esophagus **901** and the intestine **903**, between the esophagus **901** and the colon, between the stomach **902** and the intestine **903**, between the stomach **902** and the colon, etc. For the purpose of illustration, the following description will be made with reference to a post-gastrectomy patient **900** whose stomach **902** has been partially removed with the remaining portion of the stomach **902** reattached to the esophagus **901**.

[0020] Referring to FIGS. **2** to **5**, the device includes a flexible and elongated main body **3**, a blood oxygen level detecting unit **4** and a micro-processing unit **5**.

[0021] The main body **3** may be made from a material that permits passage of near-infrared light and/or red light, such as PVC (polyvinyl chloride) or silicone. In this embodiment, the main body **3** has a tubular configuration so as to be connectable with the connecting tube **700** to function as a nasogastric tube or a drainage tube, thereby allowing the device to serve dual functionalities.

[0022] The blood oxygen level detecting unit **4** includes a flexible circuit board **41**, a plurality of blood oxygen level detecting modules **42** mounted at the same side on the flexible circuit board **41**, and a signal line **43** connected electrically to the blood oxygen level detecting modules **42** via said flexible circuit board **41**.

[0023] The flexible circuit board **41** may be made of a plastic thin film, and may be formed through semiconductor manufacturing techniques with a plurality of conductive traces (not shown) that are electrically connected to the blood oxygen level detecting modules **42**. In this embodiment, the flexible circuit board **41** is embedded within the main body **3** along with the blood oxygen level detecting modules **42**, with the blood oxygen level detecting modules **42** being spacedly arranged along a longitudinal direction of the main body **3**, while the signal line **43** is partially embedded within the main body **3** with an exposed end connected electrically to the micro-processing unit **5**. It should be noted herein that the arrangement of the blood oxygen level detecting modules **42** is not to be limited to being longitudinally in other embodiments of the present disclosure.

[0024] Each of the blood oxygen level detecting modules **42** is capable of generating one or more signals associated with the blood oxygen level(s) of one or more mucous membrane regions nearby the blood oxygen level detecting module **42**. By providing the plurality of the blood oxygen level detecting modules **42**, a plurality of signals associated with a plurality of mucous membrane regions respectively nearby the blood oxygen level detecting modules **42** may be generated.

[0025] Specifically, each of the blood oxygen level detecting modules **42** includes one or more light emitters **421** capable of emitting near-infrared light and/or red light to the one or more mucous membrane regions nearby the blood oxygen level detecting module **42**, and one or more optical sensors **422** capable of sensing the near-infrared light and/or the red light diffused/reflected by the one or more mucous membrane regions nearby the blood oxygen level detecting module **42** so as to generate the one or more signals. In the first preferred embodiment illustrated herein, each blood oxygen level detecting module **42** includes one light emitter **421** and three optical sensors **422** that are arranged spacedly along the longitudinal direction of the main body **3**. The signals generated by the optical sensors **422** are transmitted to the micro-processing unit **5** via the flexible circuit board **41** and the signal line **43** for subsequent analysis, which will be described later.

[0026] In this embodiment, with the provision of multiple optical sensors **422**, measurement of the blood oxygen levels of different mucous membrane regions may be performed, and with the multiple optical sensors **422** arranged in the longitudinal direction of the main body **3**, measurement of the blood oxygen levels of different mucous membrane regions at different depths of the patient **900**'s gastrointestinal tract is possible.

[0027] The light emitter **421** may be a laser diode, a light emitting diode (LED), etc., and the optical sensors **422** may each be a silicon photodiode, an avalanche photodiode, a charge-coupled device, etc. Since the technique for measuring the blood oxygen level by sensing near-infrared light and/or red light is well known in the art, further details of the same are omitted herein for the sake of brevity.

[0028] The micro-processing unit **5** is disposed outside of the main body **3**, and includes a housing **51**, and a light emitter driving module **52**, a signal receiving module **53**, a micro-processing module **54**, a storage module **55** and a wireless communication module **57** that are disposed in the housing **51**, and an connector module **56**, an output module **58** and an operating module **59** that are mounted to and at least partially exposed from the housing **51**.

[0029] The light emitter driving module **52** is connected electrically to the light emitters **421** of the blood oxygen level detecting modules **42** via the signal line **43** and the flexible circuit board **41**, and is capable of driving each of the light emitters **421** to emit the near-infrared light and/or the red light. The signal receiving module **53** is connected electrically to the optical sensors **422** of the blood oxygen level detecting modules **42** via the signal line **43** and the flexible circuit board **41**, and is capable of receiving the signals generated by the optical sensors **422**. The micro-processing module **54** is electrically connected to the light emitter driving module **52**, the signal receiving module **53**, the storage module **55**, the connector module **56**, the wireless communication module **57**, the output module **58** and the operating module **59**.

[0030] The micro-processing module **54** controls operations of the light emitter driving module **52** and the signal receiving module **53**, and is programmable to control the manner in which the light emitter driving module **52** drives the light emitters **421**, and the manner in which the signal receiving module **53** receives the signals from the optical sensors **422**. In other words, the micro-processing module **54** is able to control the light emitter driving module **52** to independently drive the light emitter **421** of a specific one of the blood oxygen level detecting modules **42**, and to control the signal receiving module **53** to receive the signal generated by a specific one of the optical sensors **422** of the specific one of the blood oxygen level detecting modules **42**. The signal received by the signal receiving module **53** is then transferred to the micro-processing module **54**, which analyzes the signal thus received so as to generate blood oxygen level data associated with the blood oxygen level of the mucous membrane region nearby the specific optical sensor **422** of the specific blood oxygen level detecting module **42**. The blood oxygen level data is then stored in the storage module **55**, and is outputted for user notification by the output module **58**, which in this embodiment, is a display screen.

[0031] It should be noted herein that the present disclosure is not to be limited in terms of the manner in which the light emitters **421** and the optical sensors **422** are driven. For example, after driving the light emitter **421** of a specific blood oxygen level detecting module **42** to emit the near-infrared light and/or the red light, the optical sensors **422** of the specific blood oxygen level detecting module **42** may be driven individually and sequentially according to the order of their proximity to the light emitter **421**.

[0032] The connector module **56** is adapted for electrically connecting an external device (not shown), such as a computer, for input of, e.g., instructions for programming the micro-processing module **54**, data to be stored in the storage module **55** for future access and/or execution by the micro-

processing module **54**, etc. The wireless communication module **57** may be controlled by the micro-processing module **54** to be wirelessly connected to a remote device, e.g., remote centralized equipment (not shown), for transmitting wirelessly the blood oxygen level data thereto. The operating module **59** is operable by a user to control the micro-processing module **54** so that user is provided with the control over the light emitter driving module **52**, the signal receiving module **53**, the storage module **55**, the wireless communication module **57** and the output module **58**. In this embodiment, the operating module **59** is shown to include several buttons **591**.

[0033] Turning now to FIGS. **3**, **5** and **6**, to use the device of this disclosure, the end of the main body **3** distal from the micro-processing unit **5** is inserted through the mouth or the nose of the patient **900** into the esophagus **901**, and is further extended toward the organs connected by the anastomosis **904**, such that the blood oxygen level detecting modules **42** of the blood oxygen level detecting unit **4** is respectively disposed adjacent to the mucous membrane regions nearby the organs. In the example illustrated in FIG. **6**, the main body **3** is inserted into the esophagus **901** and the stomach **902** such that the blood oxygen level detecting modules **42** are distributed from the esophagus **901** to the anastomosis **904** and to the stomach **902** so as to be able to measure the blood oxygen levels associated with the mucous membrane regions spreading for a predetermined distance from the esophagus **901** to the anastomosis **904** and to the stomach **902**.

[0034] After insertion of the main body **3** into the patient **900**'s body, the end of the main body **3** proximate to the micro-processing unit **5** may be connected to a connecting tube **700** so as to simultaneously function as a nasogastric tube or a drainage tube. Next, a medical staff may operate the operating module **59** to activate the micro-processing module **54** to begin the measurement of the blood oxygen levels, in which the light emitter(s) **421** of the blood oxygen level detecting module(s) **42** is (are) driven to emit the near-infrared light and/or the red light toward the esophagus **901**, the anastomosis **904** and/or the stomach **902** for diffusion/reflection thereby and for subsequent sensing by the optical sensor (s) **422** of the blood oxygen level detecting module(s) **42**. The micro-processing module **54** then analyzes the signal(s) generated by the optical sensor(s) and generates the blood oxygen level data associated with the desired mucous membrane region(s) nearby the optical sensor(s) **422**. The output module **58** may be utilized so as to notify the medical staff in real time of the acquired blood oxygen level data in order for the medical staff to evaluate the mucosal blood delivery at the anastomosis **904** and at the organs (i.e., the esophagus **901** and the stomach **902**) connected by the anastomosis **904**, thereby assisting in the early discovery of any related abnormal condition.

[0035] Since the device also functions as a nasogastric tube or a drainage tube, it can be left inside the patient **900**'s body to perform long-term monitoring of the blood oxygen levels nearby the anastomosis **904**. In addition, without repeated insertion/removal, the device effectively reduces patient discomfort, and promotes the possibility of early detection of leakage and graft failure.

[0036] It should be noted herein that while in the first preferred embodiment the main body **3** is designed to be tubular so as to be simultaneously usable as a nasogastric tube or a drainage tube, in practice, the main body **3** of this disclosure is not necessarily tubular, and may be designed into, for example, a solid, thin strip (as illustrated in the second preferred embodiment of FIG. **7**).

[0037] Furthermore, while in this embodiment the blood oxygen level detecting modules **42** are mounted to and connected electrically to the flexible circuit board **41**, and are altogether embedded within the main body **3**, and is electrically connected to the micro-processing unit **5** via the signal line **43**, which is connected to the flexible circuit board **41**, the use of the flexible circuit board **41** is not necessary, and in practice, the blood oxygen level detecting modules **42** may be directly connected to the signal line **43** and embedded within the main body **3** with a segment of the signal line **43** exposed from the main body **3** and connected electrically to the micro-processing unit **5**. Alternatively, the blood oxygen level detecting modules **42** may be mounted into an external surface of the main body **3** in a manner so as to be flush with the external surface.

[0038] Moreover, each of the multiple blood oxygen level detecting modules **42** of the first preferred embodiment is illustrated as including a light emitter **421** and three optical sensors **422** spaced apart from the light emitter **421** at different intervals. However, in practice, each blood oxygen level detecting module **42** may include a single optical sensor **422** and multiple light emitters **421** spaced apart from the optical sensor **422** at different intervals (as illustrated in the third preferred embodiment of FIG. **8**). As such, the device may still be able to measure the blood oxygen levels of mucous membrane regions at different depths in the patient **900**'s gastrointestinal tract. Alternatively, there may be only one blood oxygen level detecting module **42**, which includes one light emitter **421** and one optical sensor **422**, for measuring the blood oxygen level of a mucous membrane region at a desired depth in the patient **900**'s gastrointestinal tract.

[0039] It should further be noted herein that the micro-processing unit **5** may be made into a detachable component.

[0040] In conclusion, through the design of the flexible and elongated main body **3** bearing one or more blood oxygen level detecting modules **42** thereon, the present disclosure may be inserted and extended into one or more of the esophagus **901**, a stomach **902**, an intestine **903** and a colon of a post-esophagectomy or post-gastrectomy patient **900** or a patient **900** that has undergone a similar operation to facilitate long-term and real-time monitoring of the blood oxygen level of one or more mucous membrane regions nearby the blood oxygen level detecting module **42** so that medial staff may be able to quickly diagnose the healing/unhealing of the anastomosis **904** of the patient **900** without having the patient **900** experience the uncomfortable and potentially harmful process of repeatedly placing and removing a drainage tube. Additionally, by designing the main body **3** into a tubular structure, the device may also serve as a nasogastric tube or a drainage tube, which is both practical and convenient.

[0041] While the present disclosure has been described in connection with what is considered the most practical and preferred embodiment, it is understood that this disclosure is not limited to the disclosed embodiment but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

What is claimed is:

1. A device adapted for insertion into one or more of an esophagus, a stomach, an intestine and a colon for detecting a blood-oxygen level associated with at least one mucous mem-

brane region in said one or more of the esophagus, the stomach, the intestine and the colon, said device comprising:

a flexible and elongated main body; and

a blood oxygen level detecting unit including at least one blood oxygen level detecting module that is disposed on said main body and that is capable of generating a signal, which is associated with a blood oxygen level of a mucous membrane region nearby said blood oxygen level detecting module.

2. The device as claimed in claim **1**, wherein said blood oxygen level detecting unit further includes a signal line that is connected to said blood oxygen level detecting module for transmitting the signal generated by said blood oxygen level detecting module.

3. The device as claimed in claim **1**, wherein said blood oxygen level detecting module includes at least one light emitter that is capable of emitting near-infrared light and/or red light to the mucous membrane region nearby said blood oxygen level detecting module, and at least one optical sensor that is capable of sensing near-infrared light and/or the red light diffused by the mucous membrane region nearby said blood oxygen level detecting module so as to generate the signal.

4. The device as claimed in claim **3**, wherein said blood oxygen level detecting module includes a plurality of said light emitters, said light emitters and said optical sensor being arranged spacedly.

5. The device as claimed in claim **4**, further comprising a micro-processing unit that is electrically connected to said blood oxygen level detecting unit, that is disposed outside of said main body, and that includes a light emitter driving module capable of driving each of said light emitters of said blood oxygen level detecting module to emit the near-infrared light and/or the red light, a signal receiving module capable of receiving the signal generated by said optical sensor of said blood oxygen level detecting module, and a micro-processing module electrically connected to said light emitter driving module and said signal receiving module for controlling operations thereof, that receives the signal from said signal receiving module, and that analyzes the signal thus received so as to generate blood oxygen level data associated with the blood oxygen level of the mucous membrane region nearby said blood oxygen level detecting module.

6. The device as claimed in claim **5**, wherein said micro-processing unit further includes an output module that is connected electrically to said micro-processing module for outputting the blood oxygen level data for user notification.

7. The device as claimed in claim **5**, wherein said micro-processing unit further includes a wireless communication module that is connected electrically to said micro-processing module for transmitting wirelessly the blood oxygen level data.

8. The device as claimed in claim **5**, wherein said micro-processing unit further includes an operating module that is connected electrically to said micro-processing module and that is operable by a user to control said micro-processing module.

9. The device as claimed in claim **3**, wherein said blood oxygen level detecting module includes a plurality of said optical sensors, said light emitter and said optical sensors being arranged spacedly.

10. The device as claimed in claim **9**, further comprising a micro-processing unit that is electrically connected to said blood oxygen level detecting unit, that is disposed outside of said main body, and that includes a light emitter driving module capable of driving said light emitter of said blood oxygen level detecting module to emit the near-infrared light and/or the red light, a signal receiving module capable of receiving the signal generated by each of said optical sensors of said blood oxygen level detecting module, and a micro-processing module electrically connected to said light emitter driving module and said signal receiving module for controlling operations thereof, that receives the signal from said signal receiving module, and that analyzes the signal thus received so as to generate blood oxygen level data associated with the blood oxygen level of the mucous membrane region nearby said blood oxygen level detecting module.

11. The device as claimed in claim **10**, wherein said micro-processing unit further includes an output module that is connected electrically to said micro-processing module for outputting the blood oxygen level data for user notification.

12. The device as claimed in claim **10**, wherein said micro-processing unit further includes a wireless communication module that is connected electrically to said micro-processing module for transmitting wirelessly the blood oxygen level data.

13. The device as claimed in claim **10**, wherein said micro-processing unit further includes a storage module that is connected electrically to said micro-processing module for storing the blood oxygen level data.

14. The device as claimed in claim **10**, wherein said micro-processing unit further includes an operating module that is connected electrically to said micro-processing module and that is operable by a user to control operation of said micro-processing module.

15. The device as claimed in claim **3**, wherein said main body is made from a flexible, light-transmissive material, and said blood oxygen level detecting module of said of said blood oxygen level detecting unit is embedded in said main body.

16. The device as claimed in claim **15**, wherein said blood oxygen level detecting unit further includes a flexible circuit board, on which said blood oxygen level detecting module is mounted, and a signal line connected to said blood oxygen level detecting module for transmitting the signal generated by said blood oxygen level detecting module, said circuit board and said blood oxygen level detecting module being embedded within said main body, said signal line being partially embedded within said main body.

17. The device as claimed in claim **1**, wherein said main body is tubular.

18. The device as claimed in claim **1**, wherein said blood oxygen level detecting unit includes a plurality of said blood oxygen level detecting modules that are spacedly arranged along a longitudinal direction of said main body for generating a plurality of signals associated with a plurality of mucous membrane regions respectively nearby said blood oxygen level detecting modules.

19. The device as claimed in claim **18**, wherein each of said blood oxygen level detecting modules includes at least one light emitter that is capable of emitting near-infrared light and/or red light to the mucous membrane region nearby said blood oxygen level detecting module, and at least one optical sensor that is capable of sensing near-infrared light and/or the red light diffused by the mucous membrane region so as to generate the signal.

20. The device as claimed in claim **19**, further comprising a micro-processing unit that is electrically connected to said

blood oxygen level detecting unit, that is disposed outside of said main body, and that includes a light emitter driving module capable of driving said light emitter of each of said blood oxygen level detecting modules to emit the near-infrared light and/or the red light, a signal receiving module capable of receiving the signal generated by said optical sensor of each of said blood oxygen level detecting modules, and a micro-processing module electrically connected to said light emitter driving module and said signal receiving module for controlling operations thereof, that receives the signal generated by said optical sensor of a selected one of said blood oxygen level detecting modules from said signal receiving module, and that analyzes the signal so as to generate blood oxygen level data associated with the blood oxygen level of the mucous membrane region nearby said optical sensor of the selected one of said blood oxygen level detecting modules.

* * * * *