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Inventor(s)	HUR; Sang-Hoon et al.

GAS DETECTION DEVICE

Abstract

A gas detection device comprises a pump module for drawing in air; a sensor module including a plurality of unit sensors detecting a gas included in the air; a driving module driving the pump module and the sensor module; and a case including a main body mounted to allow at least one among the pump module, the sensor module, and the driving module to be detachable and a cover connected to the main body to allow the at least one among the pump module, the sensor module, and the driving module to be exposed.

Inventors: **HUR; Sang-Hoon (Seoul, KR), LEE; Jae-Hwan (Seoul, KR), AHN; Je-Phil (Seoul, KR)**

Applicant: **Honeywell International Inc.** (Charlotte, NC)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 18/409,508, filed, Jan. 10, 2024, which is a division of U.S. patent application Ser. No. 17/576,371, filed Jan. 14, 2022 (now U.S. Pat. No. 11,906,496, issued Feb. 20, 2024), which is a continuation of U.S. patent application Ser. No. 16/134,308, filed Sep. 18, 2018 (now U.S. Pat. No. 11,255,833, issued Feb. 22, 2022), which claims priority to Korean Patent Application No. 10-2017-0120286 filed on Sep. 19, 2017, each of which is hereby incorporated herein by reference.

BACKGROUND
[0002] The present disclosure relates to a gas detection device.
[0003] Various gases may be used in semiconductor process lines and industrial sites, and gas detection devices may be operated to prevent large-scale accidents due to gas leaks. Gas detection devices may be used to detect gas in a chamber in which a semiconductor process is performed, or a gas pipe or a valve connected to such a chamber. Alternatively, gas detection devices may be used to detect a gas leak at industrial sites. Generally, various kinds of gases can be used in the field, therefore, there is an increasing demand for gas detecting apparatus being capable of detecting various kinds of gases.
SUMMARY
[0004] An aspect of the present disclosure provides a gas detection device capable of simultaneously detecting different gases and allowing for efficient maintenance in such a manner that a sensor detecting a gas and a pump determining a flow rate of air flowing into the gas detection device are modularized to be simply replaced, without additional equipment.
[0005] According to an aspect of the present disclosure, a gas detection device comprises a pump module for drawing in air; a sensor module including a plurality of unit sensors detecting a gas included in the air; a driving module driving the pump module and the sensor module; and a case including a main body in which at least one among the pump module, the sensor module, and the driving module is mounted to be detachable and a cover connected to the main body to allow the at least one among the pump module, the sensor module, and the driving module to be exposed.
[0006] According to an aspect of the present disclosure, a gas detection device comprises a case including a main body having a first accommodation space and a second accommodation space and a cover rotatably connected to the main body to allow the first accommodation space and the second accommodation space to be opened and closed; a pump module mounted in the first accommodation space to be slidably detachable and insertable and drawing in air; a sensor module mounted in the second accommodation space to be slidably detachable and insertable and detecting a gas included in the air; and a driving module provided on a rear of the first accommodation space and the second accommodation space and driving the pump module and the sensor module.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0007] The above and other aspects, features, and advantages of the present disclosure will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

[0008] FIGS. **1***a* and **1***b* are schematic views of a processing apparatus including a gas detection device according to an exemplary embodiment;

[0009] FIG. **2** is a schematic block diagram of a gas detection device according to an exemplary embodiment;

[0010] FIGS. **3** to **5** are perspective views illustrating an exterior of a gas detection device according to an exemplary embodiment;

[0011] FIGS. **6**A and **6**B are views illustrating a gas detection device according to an exemplary embodiment;

[0012] FIG. **7** is an exploded view of a gas detection device according to an exemplary embodiment;

[0013] FIGS. **8** and **9** are views illustrating a gas detection device according to an exemplary embodiment;

[0014] FIGS. **10**A to **10**C are views illustrating a method of replacing a sensor module in a gas detection device according to an exemplary embodiment;

[0015] FIGS. **11**A to **11**C are views illustrating a method of replacing a pump module in a gas detection device according to an exemplary embodiment;

[0016] FIGS. **12**A and **12**B are views illustrating an exterior of the sensor module included in a gas detection device according to an exemplary embodiment;

[0017] FIG. **13** is an exploded view illustrating the sensor module included in a gas detection device according to an exemplary embodiment;

[0018] FIGS. **14**A and **14**B are views illustrating a flow of air in the sensor module according to an exemplary embodiment; and

[0019] FIG. **15** is a view illustrating the pump module included in a gas detection device according to an exemplary embodiment.

DETAILED DESCRIPTION

[0020] Hereinafter, exemplary embodiments in the present disclosure will be described with reference to the attached drawings.

[0021] The contents of the present disclosure described below may have a variety of configurations and propose only a required configuration herein, but are not limited thereto.

[0022] FIGS. **1***a* and **1***b* are schematic views of a processing apparatus including a gas detection device according to an exemplary embodiment.

[0023] With reference to FIG. **1***a*, a processing apparatus **1**A according to an exemplary embodiment in the present disclosure may include a gas supply source **10**, a valve **20**, a chamber **30**, and a gas detection device **40**A. In an exemplary embodiment, the chamber **30** may be provided as a semiconductor process apparatus in which a semiconductor process, such as an etching process, a deposition process, photolithography, or a cleaning process, is performed. The chamber **30** may be connected to transport paths **31** and **32**, transporting a substrate in which a semiconductor process is performed and may receive gases required for the process from the gas supply source **10**.

[0024] The gas supply source **10** may include first to fourth gas tanks **11** to **14**, storing different gases. In an exemplary embodiment illustrated in FIG. **1***a*, a case in which a total of four gas tanks **11** to **14** are included in the gas supply source **10** is taken as an example; however, this is merely an exemplary embodiment. A greater or smaller number of gas tanks may be included in the gas supply source **10**. Gases stored in the first to fourth gas tanks **11** to **14** may be supplied to the chamber **30** using an operation of the valve **20**.

[0025] In an exemplary embodiment illustrated in FIG. **1***a*, the gas detection device **40**A may include a first gas detection device **41**A and a second gas detection device **42**A. The first gas detection device **41**A may be connected to the valve **20** to determine whether a gas supplied to the valve **20** from the first to fourth gas tanks **11** to **14** has leaked. In the meantime, the second gas detection device **42**A may be connected to the chamber **30** to detect a concentration of each of different gases present in the chamber **30** or to determine whether a gas has leaked outwardly of the chamber **30**. That is, in an exemplary embodiment, both of the first gas detection device **41**A and the second gas detection device **41**B can sense the leakage of each of different gases.
[0026] In contrast, in an exemplary embodiment illustrated in FIG. **1***b*, a processing apparatus **1**B may include first to fourth gas detection devices **41**B to **44**B connected to the valve **20**, and fifth to eighth gas detection devices **45**B to **48**B can sense the leakage of gases in the chamber **30**. Each of the first to eighth gas detection devices **41**B to **48**B can sense only one kind of gas. For example, the first gas detection device **41**B and the fifth gas detection device **45**B can sense the same kind of gas, which is stored in the first gas tank **11** and supplied to the chamber **30** through the valve **20**.
[0027] The processing apparatus **1**B may include a larger number of gas detection devices than the processing apparatus **1**A, therefore, a large amount of manpower, time, and cost may be required for maintenance and repair. In an exemplary embodiment, each of the gas detection devices **41**A and **42**A can sense different kinds of gases, therefore, it is possible to save manpower, time, cost, and the like required for maintenance and repair.
[0028] FIG. **2** is a schematic block diagram of a gas detection device according to an exemplary embodiment.
[0029] With reference to FIG. **2**, a gas detection device **50** according to an exemplary embodiment may include a pump module **60**, a sensor module **70**, a driving module **80**, and the like. The pump module **60** may include a pump for drawing in air to be supplied to the sensor module **70**, as well as a flow rate sensor for measuring an amount of introduced air. The pump module **60** may be connected to ports provided in a case of the gas detection device **50** and may draw in and discharge air. In addition, the pump module **60** may supply air to the sensor module **70** through a path provided in the gas detection device **50**. For the sake of understanding, the path of the air and the path of the electric signal are shown separately, in FIG. **2**.
[0030] The sensor module **70** may include a plurality of unit sensors **71** to **74** for detecting gases included in air drawn in and supplied by the pump module **60**. In an exemplary embodiment, the sensor module **70** may include first to fourth unit sensors **71** to **74**, while the number of unit sensors **71** to **74** may be variously changed. Each of the unit sensors **71** to **74** may detect carbon monoxide, hydrogen, ammonia, hydrogen phosphate, and the like. In other words, each of the unit sensors **71** to **74** may detect different gases.
[0031] The driving module **80** may supply power required for an operation of the pump module **60** and the sensor module **70** and may control the operation thereof. The driving module **80** may include a controller **81**, a power supply unit **82**, and the like. The driving module **80** may display a type and a concentration of a gas detected by the sensor module **70** on a display **91** or may monitor an operational state of the pump module **60** and the sensor module **70** to display whether the pump module **60** and the sensor module **70** malfunction, on the display **91**. In the meantime, a user may transmit a command to control an operation of the gas detection device **50** to the driving module **80** through an input portion **92**.
[0032] The gas detection device **50**, according to an exemplary embodiment, may include the pump module **60**, the sensor module **70**, the driving module **80**, and the like, that have been modularized. The pump module **60** and the sensor module **70**, requiring relatively frequent replacement and inspection, as compared with the driving module **80**, may be disposed adjacent to a cover that is movable in a hinged manner or in a sliding manner. A user may open a cover of the gas detection device **50** and remove the pump module **60** and the sensor module **70** for inspection, or may easily replace the pump module **60** and the sensor module **70** with new products. Thus, it is possible to

support efficient maintenance of the gas detection device **50**.
[0033] FIGS. **3** to **5** are perspective views illustrating an exterior of a gas detection device according to an exemplary embodiment.
[0034] With reference to FIG. **3**, a gas detection device **100** according to an exemplary embodiment may include a case **110**, a display **150**, an input portion **160**, and the like. A pump module drawing in and discharging air to detect a gas, a sensor module detecting a gas included in air drawn in, and a driving module driving the gas detection device **100** may be accommodated in the case **110**.
[0035] The case **110** may include a main body **111** and a cover **112** coupled to the main body **111**. The cover **112** may be provided on a front surface of the case **110**. In an exemplary embodiment, the display **150** and the input portion **160** may be provided in the cover **112**. The input portion **160** may include a plurality of mechanical input keys, or may include a touchscreen provided to be integrated with the display **150**. The cover **112** may be coupled to the main body **111** by a hinge portion **113** and may allow an interior of the main body **111** to be exposed by being rotated around the hinge portion **113**.
[0036] With reference to FIG. **4**, the gas detection device **100** according to an exemplary embodiment may include a fixing portion FX provided on a rear surface of the case **110**. The fixing portion FX may include a hole formed in the rear surface of the case **110** to a predetermined depth. A user may install an externally exposed ring, or the like, on a wall of a space or an apparatus in which the gas detection device **100** is disposed, thereby inserting the ring into the fixing portion FX to fix the gas detection device **100**.
[0037] With reference to FIG. **5**, the main body **111** and the cover **112** according to an exemplary embodiment may be coupled by a connection portion **112**A. The connection portion **112**A may be formed on a side of the cover **112** to allow the main body **111** to be connected and coupled to the cover **112** and to prevent the cover **112** from being opened during an operation of the gas detection device **100**.
[0038] In the meantime, a plurality of ports P**1** to P**3** may be provided on a bottom surface of the case **110**. In an exemplary embodiment, a first port P**1** may be provided as an inlet port through which air is introduced, while a second port P**2** may be provided as a discharge port through which air is discharged. Air introduced to the first port P**1** may be discharged from the second port P**2** through a sensor module mounted in the case **110**. An amount of air introduced to the first port P**1** and discharged from the second port P**2** may be determined by the pump module mounted in the case **110**.
[0039] In the meantime, the third port P**3** may be provided as a cable gland and may be provided for receiving power from an external device or receiving a signal from an external controller. A fourth port P**4** may be a Power-Over-Ethernet (POE) Port. For example, the gas detection device **100** can communicate with an external controller, and/or receive a power for operation through the fourth port P**4**. According to an exemplary embodiment, additional ports may be further provided on an exterior of the case **110**, in addition to the first to fourth ports P**1** to P**4**.
[0040] FIGS. **6**A and **6**B are views illustrating a gas detection device according to an exemplary embodiment.
[0041] In an exemplary embodiment illustrated in FIG. **6**A, a gas detection device **200**A may include a case **210**A, a pump module **220** mounted in the case **210**A, a sensor module **230**, a driving module **240**, and the like. In the meantime, a third port P**3** provided as a cable gland may be provided on a bottom surface of the case **210**A.
[0042] The case **210**A may include a main body **211**A and a cover **212**A, as well as a hinge portion **213**A connecting the main body **211**A to the cover **212**A. The cover **212**A may be rotatably connected to the main body **211**A by the hinge portion **213**A. When the cover **212**A is moved, the pump module **220**, the sensor module **230**, or the like, may be externally exposed. The pump module **220** and the sensor module **230** may be mounted in the main body **211**A to be detachable therefrom. Thus, a user may open the cover **212**A and may remove the pump module **220** or the

sensor module **230** from the main body **211**A to be extracted.
[0043] When the cover **212**A is opened, front surfaces of the pump module **220** and the sensor module **230** may be externally exposed. In order for a user to easily remove the pump module **220** and the sensor module **230** from the main body **211**A, the pump module **220** and the sensor module **230** may be fixed to the main body **211**A using a member having elasticity. A user may remove the pump module **220** or the sensor module **230** from the main body **211**A through only light pressure on the pump module **220** or the sensor module **230**. In the meantime, the pump module **220** may have a volume greater than that of the sensor module **230**.
[0044] In an exemplary embodiment illustrated in FIG. **6**B, the gas detection device **200**B may include a pump module **220**, a sensor module **230**, a driving module **240**, and the like, mounted in the case **210**B. A third port P**3**, provided as a cable gland, may be provided on a bottom surface of the case **210**B.
[0045] The case **210**B may include a main body **211**B providing a space in which the pump module **220**, the sensor module **230**, and the driving module **240** are mounted and may include a cover **212**B coupled to the main body **211**B. The cover **212**B may be coupled to the main body **211**B to be movable in a sliding manner and may include a slide portion **213**B so that the cover **212**B may be coupled thereto to be moved in a sliding manner. In an exemplary embodiment, the cover **212**B may be slidably moved in a direction of an upper portion of the main body **211**B to allow the pump module **220** or the sensor module **230** to be externally exposed.
[0046] FIG. **7** is an exploded view of a gas detection device according to an exemplary embodiment.
[0047] With reference to FIG. **7**, a gas detection device **300** according to an exemplary embodiment may include a case **310**, a pump module **320**, a sensor module **330**, a driving module **340**, and the like.
[0048] The case **310** may include a main body **311** having a first frame **311**A and a second frame **311**B, as well as a cover **312**. The first frame **311**A and the cover **312** may be connected to each other by a connection member, such as a hinge portion. An interior of the first frame **311**A may be covered or exposed by an opening and closing operation of the cover **312**. The second frame **311**B may be coupled to the first frame **311**A by a coupling member, such as a screw, and may provide a rear surface and a bottom surface of the main body **311**.
[0049] A plurality of ports P**1** to P**3** may be provided on a lower surface of the second frame **311**B. In an exemplary embodiment, a first port P**1** and a second port P**2** may be provided as an inlet port and a discharge port of air, respectively. A pump pipe **370** connected to the pump module **320** may be provided in the second frame **311**B. The pump module **320** may draw in air through the pump pipe **370**, so that the air may be supplied to the sensor module **330**. A pump **325** can be fixed by an elastic member, for example a spring, in the pump module **320**. A permanent magnet can be included in the pump **325**, and the pump **325** may be operated by electrical signal flowing through a coil provided adjacent to the permanent magnet.
[0050] In the meantime, the driving module **340** may be mounted in the second frame **311**B. The driving module **340** may be coupled to the second frame **311**B by a coupling member, such as a screw, or the like and may be connected to the pump module **320** or the sensor module **330** by a terminal **345** having a plurality of pins. The driving module **340** may supply driving power to the pump module **320** and the sensor module **330** and may control an operation of the pump module **320** and the sensor module **330**. In an exemplary embodiment, the driving module **340** may control the pump module **320** to adjust an amount of air flowing into the sensor module **330**, while the driving module **340** may output a type and a concentration of gases detected by the sensor module **330** to a display device **350**. A user may transmit various commands to the driving module **340** by an input portion **360** or an external controller connected to the gas detection device **300**.
[0051] The pump module **320** and the sensor module **330** may be mounted in the main body **311** so as to be detachable. The pump module **320** and the sensor module **330** may be mounted in a first

accommodation space S**1** and a second accommodation space S**2** provided in the main body **311**, respectively. In an exemplary embodiment, the driving module **340** may be disposed on a rear of the first accommodation space S**1** and the second accommodation space S**2**. The pump module **320** and the sensor module **330** may be electrically connected to the driving module **340** in the first accommodation space S**1** and the second accommodation space S**2**, respectively.

[0052] The pump module **320** and the sensor module **330** may be mounted in the first accommodation space S**1** and the second accommodation space S**2**, respectively, in a sliding manner in a first direction. In addition, the pump module **320** and the sensor module **330** may be slidably removed from the main body **311** in the first direction to be extracted. When the gas detection device **300** is not normally operated, or regular management work is required, a user may open the cover **312** to easily remove the pump module **320** and the sensor module **330** from the main body **311**. Thus, it is possible to efficiently manage the gas detection device **300**. When either the pump module **320** or the sensor module **330** malfunctions, only a module that is malfunctioning may be replaced, thereby reducing repair costs and time.

[0053] FIGS. **8** and **9** are views illustrating a gas detection device according to an exemplary embodiment.

[0054] With reference to FIG. **8**, a gas detection device **400** according to an exemplary embodiment may include a case **410**, a pump module **420**, a sensor module **430**, and the like. As illustrated in FIG. **8**, the case **410** may include a main body **411** and a cover **412**, while the cover **412** may be coupled to the main body **411** so as to be moved around the main body **411**. In an exemplary embodiment illustrated in FIG. **8**, when the cover **412** is opened, the pump module **420** and the sensor module **430** mounted in the main body **411** may be externally exposed.

[0055] Subsequently, with reference to FIG. **9**, the pump module **420** and the sensor module **430** may be detachable from the main body **411** in a sliding manner. A slide member SL enabling the pump module **420** or the sensor module **430** to be moved in a sliding manner may be provided in the main body **411**. For example, a user can remove the pump module **420** from the main body **411** by pulling the pump module **420** using a protrusion or hole on the front surface of the pump module **420**. Therefore, without an additional equipment, the user can easily replace or repair the pump module **420** or the sensor module **430** by separating the pump module **420** or the sensor module **430** from the main body **411** by hand.

[0056] An inlet INP supplying air to the sensor module **430** and an outlet OUTP discharging air circulated in the sensor module **430** may be connected to the sensor module **430** and provided in the main body **411**. The inlet INP and the outlet OUTP may be connected to an inlet and an outlet provided on a rear of the sensor module **430**, respectively.

[0057] In the meantime, a pipe **475** connected to the pump module **420** may be provided in the main body **411**. The pump module **420** may include a pump **425** connected to the pipe **475** to draw in external air into the gas detection device **400**. The air drawn in by an operation of the pump module **420** may flow into the sensor module **430** through the inlet INP and may be circulated in the sensor module **430** to be discharged from the outlet OUTP.

[0058] FIGS. **10**A to **10**C are views illustrating a method of replacing a sensor module in a gas detection device according to an exemplary embodiment.

[0059] With reference to FIG. **10**A, a cover **512** may be opened to replace a sensor module **530**. In an exemplary embodiment illustrated in FIG. **10**A, the cover **512** is illustrated being opened by a hinge portion provided on an upper surface of a main body **511**, but the present disclosure is not limited thereto. In another exemplary embodiment, the cover **512** may be opened by the hinge portion provided on a side surface or a lower surface of the main body **511**, or may be opened by being slidably moved.

[0060] Subsequently, with reference to FIGS. **10**B and **10**C, in a state in which the cover **512** is opened, a user may remove only the sensor module **530** from the main body **511**. In an exemplary embodiment, the sensor module **530** may include a plurality of unit sensors capable of detecting

different gases. For example, the sensor module **530** may include a first unit sensor detecting silane gas (SiH4), a second unit sensor detecting hydrogen fluoride (PH3), a third unit sensor detecting ammonia, and a fourth unit sensor detecting hydrogen (H2).

[0061] A user may remove the sensor module **530** from the main body **511**, in a case in which the sensor module **530** or one of the unit sensors malfunctions or in a case in which at least a portion of the unit sensors is to be replaced with another unit sensor. For example, a user may replace the first unit sensor detecting silane gas (SiH4) with a fifth unit sensor detecting boron trifluoride (BF3). As such, in the gas detection device **500** according to an exemplary embodiment, a user may easily replace the unit sensors included in the sensor module **530** or an entirety of the sensor module **530** according to need. Thus, efficiency of management and maintenance of the gas detection device **500** may be maximized.

[0062] In an exemplary embodiment, a front surface of the sensor module **530** may protrude further than a front surface of the pump module **520** and may be disposed below the pump module **520**. The sensor module **530** may be more easily replaced than the pump module **520** from a structure described above. Referring to FIG. **10**B, the user can pull the sensor module **530** projected forward from the pump module **530** with a finger and remove the sensor module **530** from the main body **511**. This may be due to characteristics of the sensor module **530**, in that the sensor module **530** may be removed from the main body **511** more frequently than the pump module **520**, due to replacement of a unit sensor, inspection of a module, or the like. Thus, the sensor module **530** may be more conveniently removed from the main body **511**.

[0063] FIGS. **11**A to **11**C are views illustrating a method of replacing a pump module in a gas detection device according to an exemplary embodiment.

[0064] With reference to FIG. **11**A, a cover **512** may be opened to replace a pump module **520**. In an exemplary embodiment illustrated in FIG. **11**A, the cover **512** is illustrated as being opened by a hinge portion provided on an upper surface of a main body **511**, but the present disclosure is not limited thereto. In another exemplary embodiment, the cover **512** may be opened by the hinge portion provided on a side surface or a lower surface of the main body **511**, or may be opened by being slidably moved.

[0065] Subsequently, with reference to FIGS. **11**B and **11**C, the pump module **520** may be removed from the main body **511**. In an exemplary embodiment, the pump module **520** may be coupled to the main body **511** by an elastic member, such as a spring. The pump module **520** may protrude from an accommodation space of the main body **511** by applying force in a direction toward an interior of the body **511** to the pump module **520**. Subsequently, a user may extract the pump module **520** to completely separate the pump module **520** from the main body **511**.

[0066] In the meantime, a removal process of a sensor module **530** described with reference to FIGS. **10**A to **10**C may be applied to a removal process of the pump module **520**, or a removal process of the pump module **520** described with reference to FIGS. **11**A to **11**C may be applied to the removal process of the sensor module **530**.

[0067] FIGS. **12**A and **12**B are views illustrating an exterior of the sensor module included in a gas detection device according to an exemplary embodiment.

[0068] With reference to FIGS. **12**A and **12**B, a sensor module **600** according to an exemplary embodiment may include a slide coupling portion **602** provided on a surface of a case **601** to be coupled to a main body of a gas detection device, an inlet INP providing an intake path of air, and an outlet OUTP providing a discharge path of air. In an exemplary embodiment, a diameter of the outlet OUTP and a diameter of the inlet INP can be different from each other, in order to ensure a flow of air.

[0069] In the meantime, a terminal **603** required for connecting a driving module of the gas detection device to the sensor module **600** may be provided on a rear surface of the case **601**. Also, a fixing portion **604** required for fixing the sensor module **600** to a main body of the gas detection device may be provided on the rear surface of the case **601**. Unit sensors included in the sensor

module **600** may receive power required for driving by the terminal **603**, while the unit sensors may transmit a gas detection result to the driving module through the terminal **603**.
[0070] FIG. **13** is an exploded view illustrating the sensor module included in a gas detection device according to an exemplary embodiment.
[0071] With reference to FIG. **13**, a sensor module **600** according to an exemplary embodiment may include a sensor unit **610**, a first housing **620**, a second housing **630**, a third housing **640**, and a plate **650**, and the like. The first housing **620**, the second housing **630**, and the third housing **640** may provide a sensor housing required to configure the sensor module **600**.
[0072] The sensor unit **610** may include first to fourth unit sensors **611** to **614**. According to an exemplary embodiment, the number of unit sensors **611** to **614**, included in the sensor unit **610** may be variously changed. Each of the unit sensors **611** to **614** may include a gas cell detecting a gas, a sensor substrate on which the gas cell is mounted, an adapter, and the like. The unit sensors **611** to **614** may be mounted on the first housing **620**. In this process, a module substrate **625** provided on the first housing **620** may be naturally connected to the adapter of the unit sensors **611** to **614**. Thus, a user may simply change a type of a gas detected by the gas detection device in such a manner that the sensor module **600** is removed from the gas detection device, and then at least a portion among the unit sensors **611** to **614** is replaced with another unit sensor.
[0073] In the meantime, a non-volatile memory element may be provided on the sensor substrate of each of the unit sensors **611** to **614**. In an exemplary embodiment, the non-volatile memory element may be provided as an electrically erasable programmable read only memory (EEPROM) Information on the gas cell included in each of the unit sensors **611** to **614** and parameter information needed for an operation thereof may be stored in the non-volatile memory element. In a case in which the unit sensors **611** to **614** are mounted on the first housing **620** to be connected to the module substrate **625**, the information stored in the non-volatile memory element may be transferred to a driving module of the gas detection device, or the like, by the module substrate **625**. The driving module may control the unit sensors **611** to **614** based on the information stored in the non-volatile memory element.
[0074] The second housing **630** may be provided below the sensor unit **610**. A hole corresponding to each of the unit sensors **611** to **614** may be formed in the second housing **630**, while an inlet INP drawing in air and an outlet OUTP discharging air may be provided therein. The second housing **630** may be coupled to the first housing **620**. In an exemplary embodiment, a protruding portion for guiding a flow of air to the sensor unit **610** may be formed on an upper surface of the second housing **630**, which will be subsequently described with reference to FIG. **14**.
[0075] The third housing **640** may be provided on the first housing **620**. The third housing **640** may cover the module substrate **625** so that the module substrate **625** may not be externally exposed. The third housing **640** may include a slide coupling portion **602**, as illustrated in FIGS. **12**A and **12**B. In a case in which the first housing **620**, the second housing **630**, and the third housing **640** are coupled, the plate **650** may be attached to a front surface thereof, and the first housing **620**, the second housing **630**, the third housing **640**, and the plate **650** may be provided as a case **601**.
[0076] FIGS. **14**A and **14**B are views illustrating a flow of air in the sensor module according to an exemplary embodiment.
[0077] FIG. **14**A may be provided as a top view illustrating at least a portion of components included in a sensor module **600**. With reference to FIG. **14**A, the sensor module **600** according to an exemplary embodiment may include a plurality of unit sensors **611** to **614**. In addition, air introduced through an inlet INP may flow through unit sensors **611** to **614** to be discharged from an outlet OUTP. The unit sensors **611** to **614** may be mounted on a module substrate **625**, detect a gas included in the air introduced through the inlet INP, and transfer the result to a driving module of a gas detection device by the module substrate **625**.
[0078] The air introduced through the inlet INP may flow sequentially through the unit sensors **611** to **614** to be discharged from the outlet OUTP. In other words, the unit sensors **611** to **614** may be

disposed in series along a path of air flowing into the inlet INP and discharged from the outlet OUTP.

[0079] FIG. **14**B is a cross-sectional view taken along line I-I′ of FIG. **14**A. With reference to FIG. **14**B, the sensor module **600** according to an exemplary embodiment may include a second housing **630** disposed below the unit sensors **611** to **614**. The second housing **630** may be disposed adjacent to a gas cell included in each of the unit sensors **611** to **614** and may include a plurality of protruding portions **641** and **643**, protruding toward the unit sensors **611** to **614**. A direction of the air introduced to the inlet INP may be changed to be adjacent to the gas cell by the protruding portions **641** and **643** and may increase a gas detection probability and accuracy of the sensor module.

[0080] In the meantime, in the same manner as an exemplary embodiment illustrated in FIG. **14**B, each of the unit sensors **611** to **614** may include a detection cell including an electrolyte to detect a gas, or the like. In an exemplary embodiment, the gas detection device may be disposed so that a gas detection surface defined as a surface of the detection cell included in the unit cells **611** to **614** may be oriented in a direction of the ground. Thus, the electrolyte included in the detection cell may be naturally concentrated toward the gas detection surface by gravity, thereby improving gas detection performance.

[0081] FIG. **15** is a view illustrating the pump module included in a gas detection device according to an exemplary embodiment.

[0082] Referring to FIG. **15**, a pump module **700** may include a case **710**, a protrusion **711** and a hole **712** provided on a front surface of the case **710**, a pump **713** included in the case **710**, and an elastic member **714** for fixing the pump **713**. The pump module **700** may be removably included in the gas detection device.

[0083] In an exemplary embodiment, at least a portion of a case of the gas detection device may be opened to expose the pump module **700**, and the pump module **700** may be separated from the gas detection device for repair or replacement with a new module. In an exemplary embodiment, a user can remove the pump module **700** from the gas detection device, without any additional equipment. The protrusion **711** or the hole **712** on the front surface of the case **710**, may be provided for easy separation of the pump module. The user can easily separate the pump module **700** from the gas detection device without any additional tool or equipment by pulling the pump module **700** using the protrusion **711** or the hole **712**.

[0084] The pump **713** can be included in the case **710** in a state of being fixed by the elastic member **714**. In an exemplary embodiment, the pump **713** is fixed inside the case **710** by a plurality of elastic members **714**, and may not be contact with the inner wall of the case **710**. In the pump **713**, a permanent magnet may be provided, and at least one coil may be provided in the case **710** so as to be adjacent to the permanent magnet. When electric signal is supplied to the coil of the case **710**, the pump **713** vibrates due to the magnetic force from the magnetic field between the coil and the permanent magnet, and the pump **713** can draw an air from outside.

[0085] As set forth above, according to exemplary embodiments in the present disclosure, a gas detection device may allow a pump module and a sensor module, mounted in a main body, to be easily replaced and repaired using a cover provided to expose an interior of the main body, so that efficient maintenance thereof is possible. In addition, since unit sensors included in the sensor module or the pump module may be easily replaced, the gas detection device may be easily reconfigured based on specifications in accordance with a user's purpose.

[0086] While exemplary embodiments have been shown and described above, it will be apparent to those skilled in the art that modifications and variations could be made without departing from the scope of the present invention as defined by the appended claims.

Claims

1. A gas detection device, comprising: a case comprising a main body having a first frame and a second frame, wherein the first frame includes a first accommodation space and a second accommodation space; a pump and a pump case housing the pump, wherein the pump case is mounted in the first accommodation space to be detachable and insertable in a sliding manner and the pump draws in air; a sensor housing and a plurality of unit sensors mounted in the sensor housing, wherein the sensor housing is mounted in the second accommodation space to be detachable and insertable in the sliding manner and the plurality of unit sensors detect a plurality of gases included in the air; a driver coupled to the second frame by a first coupling member, the driver is configured to supply driving power to the pump and the plurality of unit sensors; and a cover connected to the main body and slidably moveable in a direction of an upper portion of the main body to allow one of the pump and the sensor housing to be externally exposed.

2. The gas detection device of claim 1, wherein the first frame and the second frame are connected to each other by one of a connection member and a second coupling member.

3. The gas detection device of claim 1, wherein the second frame provides a rear surface and a bottom surface of the main body.

4. The gas detection device of claim 3, wherein the case comprises a first port and a second port provided on the bottom surface of the main body, and wherein the first port and the second port are inlet port and outlet port of the air, respectively.

5. The gas detection device of claim 3, wherein the case comprises a fixing portion provided on the rear surface of the main body for fixing the main body to at least one of an external apparatus and an external wall.

6. The gas detection device of claim 1, wherein the driver is connected to the pump and the plurality of unit sensors by a terminal having a plurality of pins.

7. The gas detection device of claim 1, wherein the pump case and the sensor housing are moveable in a first direction, and wherein the main body comprises an elastic member pushing the pump case and the sensor housing in a second direction opposite to the first direction.

8. The gas detection device of claim 1, further comprising an input portion that includes a plurality of mechanical input keys for receiving an input from a user; and a display for displaying a state of at least one among the pump, the plurality of unit sensors and a gas detection result of the plurality of unit sensors.

9. The gas detection device of claim 8, wherein the input portion and the display are provided in the cover.

10. The gas detection device of claim 1, further comprising a module substrate in which a circuit processing an electrical signal generated by the plurality of unit sensors and a terminal outputting the electrical signal are formed, and wherein the module substrate is mounted in the sensor housing, the plurality of unit sensors being detachable from the sensor housing.

11. The gas detection device of claim 1, wherein the plurality of unit sensors comprise a first unit sensor, a second unit sensor, a third unit sensor, and a fourth unit sensor, wherein the first unit sensor, the second unit sensor, the third unit sensor, and the fourth unit sensor are of a same size and shape.