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(54) **Electronic narcotic gas detecting device**

(57) An electronic narcotic gas detecting device having a gas detecting circuit (3) with a gas sensor (4) for generating an output signal (Vout) related to the presence and/or concentration of at least one narcotic agent;

a driver element (20) receiving the output signal (Vout) and generating a derived signal; and an alarm and signaling signal (7) activated by the gas detecting circuit (3) via the derived signal.

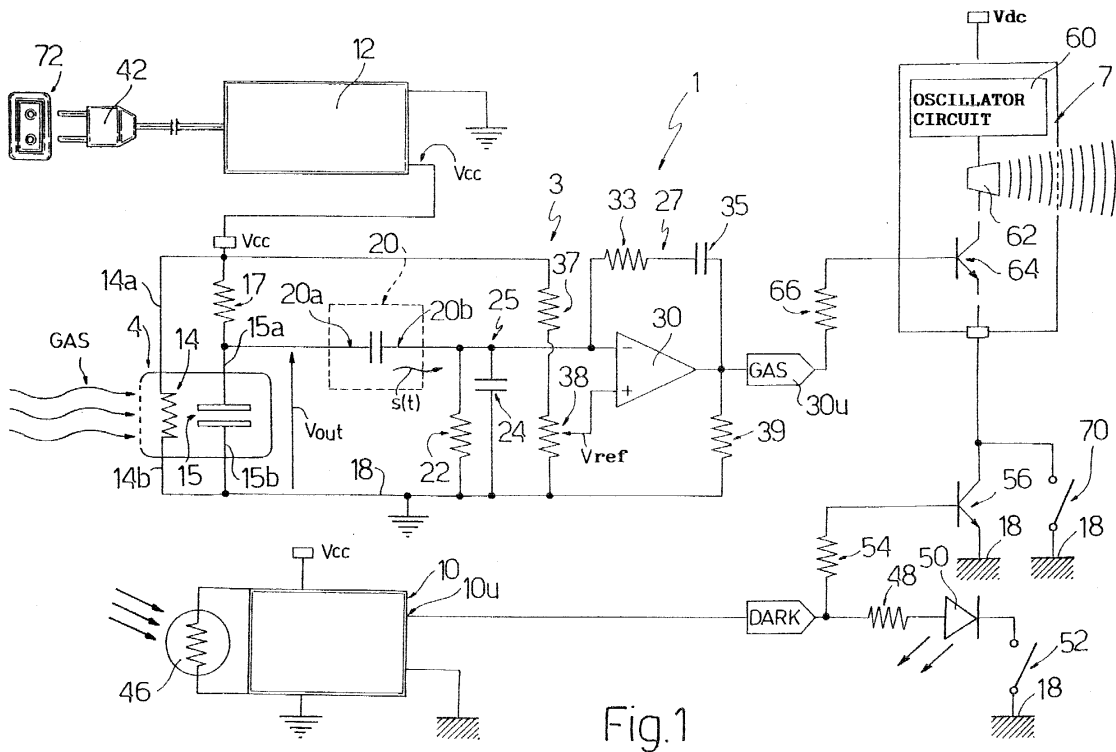


Fig.1

## Description

[0001] The present invention relates to an electronic narcotic gas detecting device.

[0002] Recent crime news reports have featured more than one instance of burglaries being committed with the aid of narcotic gas to drug both occupants and guard dogs.

[0003] As is known, being burgled is in itself a traumatic experience, to which drugging adds further danger by the crime being committed with the occupants fully unconscious and therefore totally incapable of defending themselves.

[0004] It is not yet clear whether certain narcotic gases, when used in large amounts, are harmful, or even lethal, in the case of particularly sensitive victims.

[0005] A demand therefore exists for an electronic narcotic gas detecting device for use in the home.

[0006] Though certain types of narcotic gases are suspected, there is no firm proof as yet that they are actually used or to indicate how they are administered.

[0007] It is therefore a further object of the present invention to provide an electronic narcotic gas detecting device which is sensitive to a number of potentially narcotic substances.

[0008] According to the present invention, there is provided an electronic narcotic gas detecting device as claimed in Claim 1.

[0009] A preferred non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a simplified electric diagram of an electronic narcotic gas detecting device in accordance with the present invention;

Figure 2 shows a casing for housing the Figure 1 device.

[0010] Number 1 in Figure 1 indicates as a whole an electronic narcotic gas detecting device comprising:

- a gas detecting circuit 3 having a gas sensor 4;
- an alarm and signaling circuit 7 (shown schematically) controlled by gas detecting circuit 3;
- a brightness detecting circuit 10 (shown schematically) cooperating with alarm and signaling circuit 7; and
- a power supply circuit 12 for supplying a regulated supply voltage **V<sub>d</sub>c** to gas detecting circuit 3, alarm and signaling circuit 7, and brightness detecting circuit 10.

[0011] More specifically, gas sensor 4, which is of known type, may comprise a tubular metal outer casing (not shown) housing a heating element 14 having first and second output terminals 14a, 14b, and a sensitive element 15 connected to heating element 14 and having first and second output terminals 15a, 15b. When pow-

ered, heating element 14 provides for heating sensitive element 15 to a predetermined operating temperature; and sensitive element 15 is also connected outside the casing, and has a resistance varying as a function of the presence and concentration of a number of substances to which element 15 is sensitive.

[0012] The sensors used are not necessarily specially designed for detecting narcotic gas, and may comprise sensors normally used for detecting other compounds, such as:

- fuel gas (e.g. hydrocarbons, methane, natural gas, LPG, hydrogen);
- chloro Fluoro carbides (CFC);
- solvents (e.g. alcohol, organic solvents); and
- toxic gases (e.g. carbon monoxide, ammonia).

[0013] Tests have shown sensors for detecting alcohol vapors, chloro Fluoro carbides (CFC) and fuel gases to be particularly sensitive to narcotic agents.

[0014] The gas sensors manufactured by FIGARO ENGINEERING, INC. OSAKA 562-8505 JAPAN, for example, may be used to advantage.

[0015] Gas detecting circuit 3 comprises a first resistor 17 having a first terminal connected to voltage source **V<sub>d</sub>c**, and a second terminal connected to the first terminal 15a of sensitive element 15, the second terminal 15b of which is connected to a reference potential (ground) 18.

[0016] Resistor 17 and sensitive element 15 thus form a resistive divider for distributing supply voltage **V<sub>d</sub>c**.

[0017] The voltage **V<sub>o</sub>ut** at sensitive element 15 is given by the equation:

$$V_{out} = V_{dc} \cdot (R_{15}) / (R_{15} + R_{17})$$

where  $R_{15}$  is the resistance value of sensitive element 15, and  $R_{17}$  the resistance value of resistor 17. Voltage **V<sub>o</sub>ut** varies according to the presence and concentration of narcotic gas, and represents the output signal of sensor 4.

[0018] Heating element 14 has the first terminal 14a connected to supply voltage **V<sub>d</sub>c**, and the second terminal 14b connected to reference potential 18, so that supply voltage **V<sub>d</sub>c** is applied directly to heating element 14.

[0019] Gas detecting circuit 3 comprises a divider element 20, the input of which is supplied with output signal **V<sub>o</sub>ut**. More specifically, in the example embodiment shown, divider element 20 comprises a capacitor having a first terminal 20a connected to first terminal 15a, and a second terminal 20b connected to a first terminal of a second resistor 22, the second terminal of which is connected to reference potential 18.

[0020] In an alternative embodiment (not shown), divider element 20 may comprise a numeric divider, in which case, output signal **V<sub>o</sub>ut** would be a digital signal.

**[0021]** A capacitor 24 is placed parallel to resistor 22 to form a resistive-capacitive RC band-pass filter 25 connected to the output of deriver element 20.

**[0022]** Gas detecting circuit 3 also comprises an integrating element 27 having an input connected to the output of deriver element 20. More specifically, in the example embodiment shown, integrating element 27 comprises an operational amplifier 30 having an inverting input (-) connected to terminal 20b of capacitor 20, and a noninverting input (+) supplied with a reference voltage **Vref**. Integrating element 27 also comprises a third resistor 33 having a first terminal connected to the inverting input (-), and a second terminal connected to a first terminal of a capacitor 35, the second terminal of which is connected to the output 30u of operational amplifier 30. The output of operational amplifier 30 also defines the output of gas detecting circuit 3.

**[0023]** Gas detecting circuit 3 also comprises a fourth resistor 37 having a first terminal connected to voltage source **Vdc**, and a second terminal connected to a first terminal of a trimmer 38, the second terminal of which is connected to reference potential 18. The movable terminal of trimmer 38 supplies the noninverting input (+) of operational amplifier 30 with voltage **Vref**; and a fifth resistor 39 is interposed between reference potential 18 and output 30u of operational amplifier 30.

**[0024]** Power supply circuit 12 is of known type and converts the alternating mains voltage (220 volts, 50Hz) at a pin 42 into regulated direct voltage **Vdc**, which may conveniently be +5 volts. Power supply circuit 12 may also be a static type and convert a direct voltage supplied by a battery (not shown) into regulated direct voltage **Vdc**.

**[0025]** Though of known type, brightness detecting circuit 10 comprises a photosensitive element (e.g. photoresistor) 46, and supplies an output 10u with a voltage which assumes a first value (e.g. close to **Vdc**) when the brightness detected by photosensitive element 46 is below a given threshold value, and a second value (e.g. close to zero) when the brightness detected by photosensitive element 46 is above the threshold value.

**[0026]** Output 10u of brightness detector 10 is connected via a resistor 48 to a first terminal of a bright light-emitting diode 50 having a second terminal connected to reference potential 18 via a (normally-closed) switch 52.

**[0027]** Output 10u of brightness detector 10 is also connected via a resistor 54 to the base terminal of an NPN transistor 56, the emitter of which is connected to reference potential 18, and the collector of which communicates with a terminal supplying alarm and signaling circuit 7. Transistor 56 acts as a switch and, when closed, permits supply to alarm and signaling circuit 7.

**[0028]** Alarm and signaling circuit 7 comprises an oscillator circuit 60 supplying an excitation signal for a transducer 62, in particular a piezoelectric transducer; and at least one internal switch (shown schematically by a transistor 64) which, when closed (with circuit 7

connected to power supply **Vdc**), activates oscillator circuit 60 to emit an alarm signal by means of transducer 62.

**[0029]** Gas detecting circuit 3 is connected at the output to switch 64 via a resistor 66, so that switch 64 is tripped by the output signal of gas detecting circuit 3.

**[0030]** An auxiliary (normally-open) switch 70 is located between reference potential 18 and the collector of transistor 56.

**[0031]** In actual use, to activate device 1, the user inserts plug 42 into a power socket 72 to supply gas detecting circuit 3, alarm and signaling circuit 7, and brightness detecting circuit 10.

**[0032]** In normal operating conditions (no narcotic gas), the output voltage to sensor 4 does not vary (or barely noticeably, due to drift of the sensor), the output of deriver element 20 is substantially zero, and the voltage applied to the inverting input (-) is barely positive, so that the voltage at output 30u is insufficient to close transistor 64, and alarm and signaling circuit 7 remains off.

**[0033]** In the event narcotic gas (GAS) is sprayed in the room equipped with electronic device 1, the narcotic gas spreads rapidly through the air and reaches sensor 4 in only a few seconds; the resistance of sensitive element 15 of the sensor struck by the narcotic gas molecules changes instantly: in particular falls, so that output signal **Vout** varies rapidly with time; the variation in signal **Vout** is detected by deriver element 20, which generates a derived signal  $s(t)$  approximately proportional to the rate of change of the output signal of sensor 4, i. e.  $s(t) = d(Vout)/d(t)$ ; and the (negative) output signal  $s(t)$  of deriver element 20 is applied to the inverting input (-) of operational amplifier 30, the output voltage of which increases to a saturation value **Vdc**.

**[0034]** Switch 64 is thus closed and a sound alarm signal emitted to indicate the presence of narcotic gas.

**[0035]** The user is thus alerted and may leave the room to take the appropriate steps before the gas takes effect.

**[0036]** Any voltage peaks in derived signal  $s(t)$  are eliminated by band-pass filter 25; and any oscillatory (e.g. sinusoidal) noise in derived signal  $s(t)$  is eliminated by equal portions of opposite sign of the signal canceling one another out in the integration operation.

**[0037]** When switch 70 is open, the alarm signal can only be emitted when a dark level is detected by circuit 10, in which condition, the output of circuit 10 is at a high voltage value and switch 56 is closed, thus permitting supply of circuit 7. Conversely, in bright conditions, the output of circuit 10 is at a low voltage value and switch 56 is open, thus cutting off supply to circuit 7.

**[0038]** When closed, switch 70 short-circuits transistor 56 to connect circuit 7 continuously to the supply voltage, regardless of the output value of circuit 10 and, hence, the brightness level detected.

**[0039]** In dark conditions, bright LED 50 is turned on to perform the auxiliary function of a night-light, which is deactivated when switch 52 is opened.

**[0040]** The device according to the present invention may conveniently be formed on a rectangular printed circuit 80 (Figure 2) supporting all the electronic components 81 (shown schematically) of the device. Printed circuit 80 may be housed in a grippable, hollow, parallelepiped-shaped insulating casing 82, which also conveniently comprises a gas inlet (not shown), and an integral parallelepiped-shaped appendix 84 fitted on the end with two elongated metal elements 85 defining the terminals of plug 42.

**[0041]** As will be clear from the foregoing description, the device according to the present invention provides for fast, effective detection of narcotic gas.

**[0042]** The device according to the present invention also provides for detecting a large number of narcotic agents, some of which are listed below by way of non-limiting examples:

- . diethyl ether -  $C_4H_{10}O$ ;
- . chloroform -  $CHCl_3$ ;
- . chlorobutanol -  $C_4H_7Cl_3O$ ;
- . cyclopropane;
- . ethyl chloride;
- . halothane -  $C_2HBrClF_3$ ;
- . isofluorane -  $C_3H_2ClF_5O$ ;
- . enfluorane -  $C_3H_2ClF_5O$ ;
- . methoxyfluorane -  $C_3H_4Cl_2F_2$ .

**[0043]** Deriver element 20 also provides for releasing operation of gas detecting circuit 3 from the output voltage level of sensor 4. Applying the deriver function, in fact, provides for generating, at the output of element 20, a derived signal which is purely a function of the variation in signal **Vout**, and does not depend on the output voltage value of the sensor. The derived signal  $s(t)$  is then integrated and contributes towards activating alarm signal 7, so that the device according to the present invention operates differentially.

**[0044]** The output voltage value of the sensors used, in fact, is practically impossible to determine, by depending on a number of external factors (operating temperature, humidity, etc.), and may vary gradually over the first few days/weeks' operation of the sensor. For narcotic agent detection purposes, therefore, problems could arise if the output voltage of the sensor were to be compared directly with a reference value, owing to the reference value possibly being difficult to identify, and the output voltage drift of the sensor possibly resulting in malfunctioning of the device.

**[0045]** The output voltage drift of the sensor, on the other hand, produces no variation in the output voltage of the deriver element, by being extremely slow, and by  $d(Vout)/d(t)$  anyway remaining substantially equal to zero.

**[0046]** Clearly, changes may be made to the electronic device as described herein without, however, departing from the scope of the present invention.

**[0047]** For example, sensors other than the one de-

scribed above, which supplies a variation in resistance, and hence voltage, in the presence of a narcotic agent, may be used, e.g. sensors supplying any quantity varying in the presence of a narcotic agent.

**[0048]** One example of an alternative sensor is one generating an oscillating output signal varying in frequency in the presence of a narcotic agent.

**[0049]** Device 1, for example, may comprise an interface circuit for connection to, and use as a peripheral sensor in, a centralized alarm system.

**[0050]** The alarm system may be installed in a home or vehicle, e.g. a train carriage (in particular, a sleeping car) or camper.

**[0051]** Device 1 may also comprise a telephone dialing system for transmitting an alarm message to a remote control unit, so as to form part of a remote-control system.

## 20 Claims

1. An electronic narcotic gas detecting device, characterized by comprising:

- gas detecting means (3) having at least one gas sensor (4) for generating an output signal ( $V_{out}$ ) related to the presence and/or concentration of at least one narcotic agent; and
- alarm and signaling means (7) activated by the gas detecting means (3).

2. A device as claimed in Claim 1, characterized by comprising deriver means (20) receiving said output signal ( $V_{out}$ ) and generating a derived signal ( $s(t)$ );

said alarm and signaling means (7) being activated by the gas detecting means (3) via said derived signal ( $s(t)$ ).

3. A device as claimed in Claim 2, characterized in that said deriver means (20) comprise at least one capacitor.

4. A device as claimed in Claim 2, characterized in that said deriver means (20) comprise a numeric deriver; said output signal ( $V_{out}$ ) being digital.

5. A device as claimed in any one of the foregoing Claims, characterized in that said sensor comprises at least one sensitive element (15) having a resistance varying as a function of the presence and/or concentration of said narcotic agent;

said electronic device comprising a resistive divider (17, 15) to which a regulated voltage ( $V_{dc}$ ) is applied; said sensitive element (15) forming part of said resistive divider; and the voltage ( $V_{out}$ ) at the sensitive element defining said output signal ( $V_{out}$ ).

6. A device as claimed in Claim 2, characterized by comprising integrating means (27) receiving the output signal of said deriver means (20) and generating at the output (30u) a signal for activating said alarm and signaling means (7). 5
7. A device as claimed in Claim 6, characterized in that said integrating means comprise at least an operational amplifier (30) having a first input (-) receiving the output signal of said deriver means (20), and a second input (+) receiving a reference voltage (Vref) ;  
said integrating means comprising a resistor (33) and a capacitor (35) in series and interposed between said first input (-) and the output (30u) of said operational amplifier (30). 10 15
8. A device as claimed in Claim 2, characterized by comprising filtering means (25) cooperating with the output of said deriver means (20). 20
9. A device as claimed in Claim 8, characterized in that said filtering means comprise a resistive-capacitive RC band-pass filter (22, 24). 25
10. A device as claimed in any one of the foregoing Claims, characterized by comprising disabling means (56, 54, 10) for disabling said alarm and signaling means (7) in the presence of a detected brightness level (46) above a given threshold. 30
11. A device as claimed in Claim 10, characterized by comprising disconnecting means (70) for disconnecting said disabling means (56, 54, 10). 35
12. A device as claimed in any one of the foregoing Claims, characterized by comprising lighting means (48, 50, 52) activated automatically in the presence of a detected brightness level (46) below a given threshold. 40
13. A device as claimed in Claim 12, characterized by comprising disconnecting means (52) for disconnecting said lighting means (48, 50, 52). 45
14. A device as claimed in any one of the foregoing Claims, characterized in that said gas sensor is an alcohol vapor sensor.
15. A device as claimed in any one of Claims 1 to 13, characterized in that said gas sensor is a chlorofluorocarbon (CFC) sensor. 50
16. A device as claimed in any one of Claims 1 to 13, characterized in that said gas sensor is a fuel-gas sensor. 55
17. A device as claimed in any one of the foregoing Claims, characterized by comprising a grippable, hollow insulating casing (82) housing all the electronic components of the electronic device; said insulating casing (82) comprising an integral appendix (84) fitted on the end with two elongated metal elements (85) defining a plug (42) by which to supply the device.
18. A device as claimed in any one of the foregoing Claims, characterized by comprising an interface circuit for connection to a centralized alarm system and by which to use said device as a peripheral sensor of the centralized system.
19. A device as claimed in any one of the foregoing Claims, characterized by comprising a telephone dialing system for transmitting an alarm message to a remote control unit of a remote-control system.

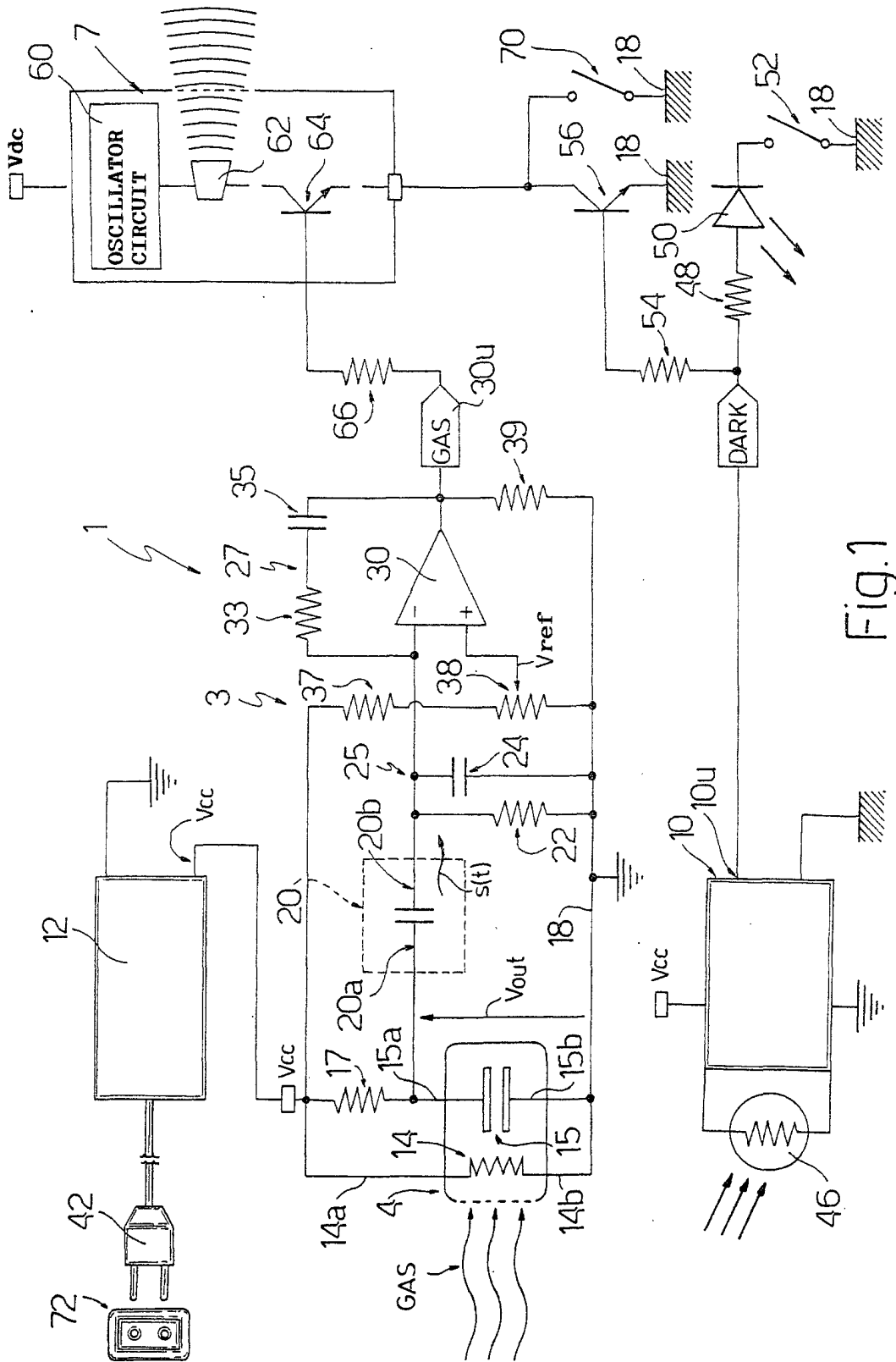


Fig.1

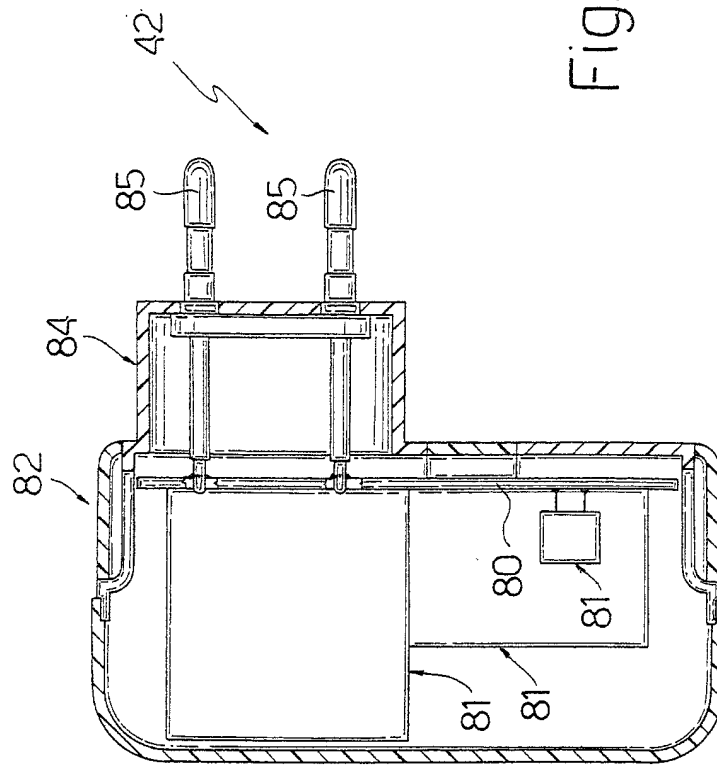


FIG. 2