United States Patent

Kasahara

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[54] **GAS-ALARMING DEVICE**

[72] Inventor: **Riichiro Kasahara,** Kobe, Japan

[73] Assignee: **New Cosmos Electric Company, Limited,** Osaka, Japan

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**340/237 R,** 340/384 R, 340/384 E

[51] **Int. Cl.**.....**G08b 17/10**

[58] **Field of Search** .340/237 R, 253, 384; 23/254 E, 23/255 E

[56] **References Cited**

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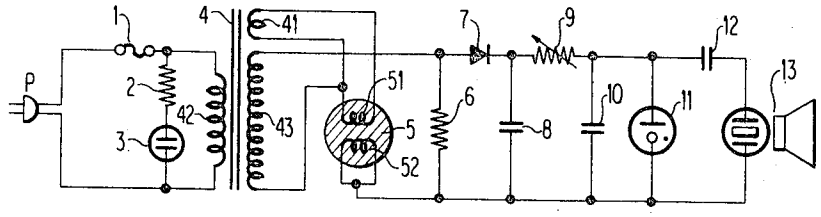
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Primary Examiner—John W. Caldwell
Assistant Examiner—Daniel Myer
Attorney—Craig, Antonelli, Stewart & Hill

[57] **ABSTRACT**

A gas-alarm device comprising a gas-detecting portion including an a.c. or d.c. power source, a semiconductor-type gas-detecting element consisting of a gas sensitive semiconductor substance, and an output resistor all connected in series so that a voltage depending on the concentration of the gas appears across the output resistor; a circuit portion for converting said voltage across the output resistor of the gas-detecting portion into a d.c. voltage, a saw-tooth wave oscillating portion including a capacitor, a current limiting resistor series connected to said capacitor, both connected across said d.c. voltage, and a discharge tube, such as a neon lamp, having a negative resistance characteristic and connected in parallel with said capacitor; and a sound emitting device, such as a speaker; whereby the frequency and intensity of the alarm output sound are made variable depending on the concentration of the gas and the adjustment of said current limiting resistor as desired.

4 Claims, 3 Drawing Figures



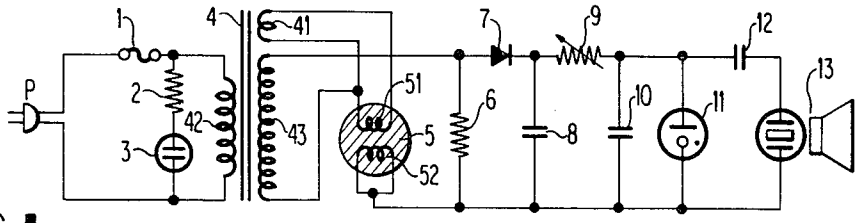


FIG. 1

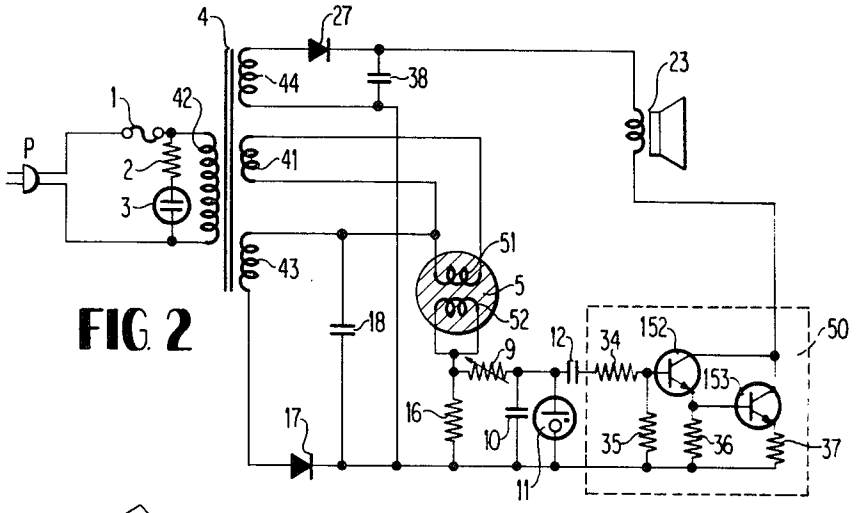


FIG. 2

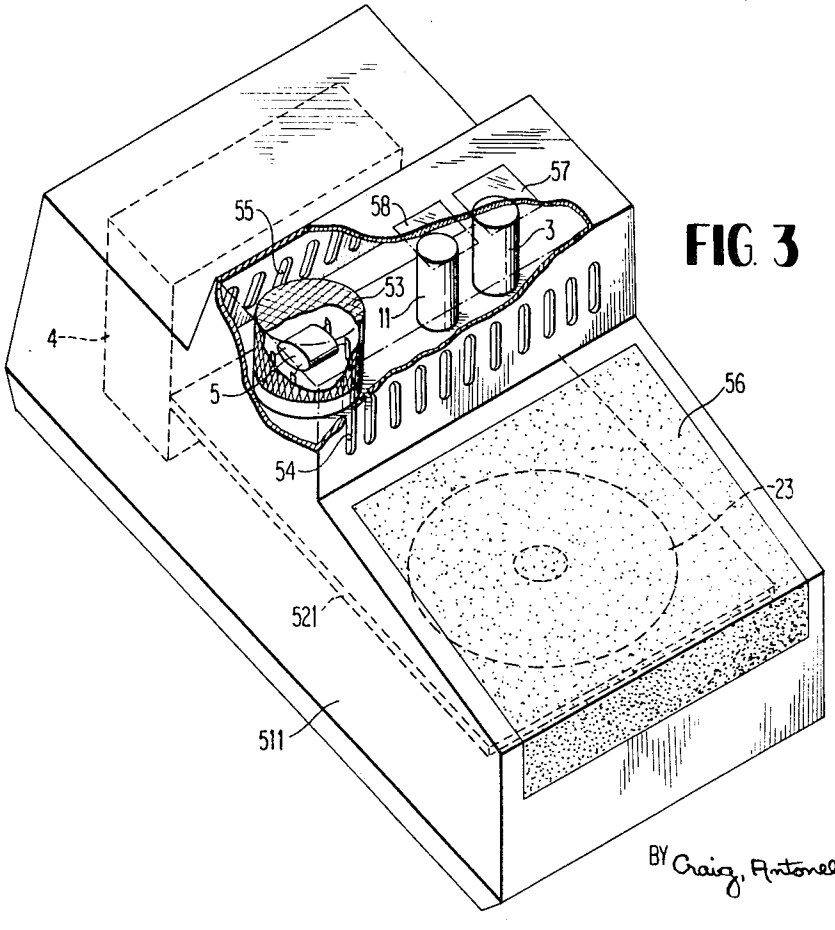


FIG. 3

INVENTOR
RIICHIRO KASAHARA

BY Craig, Antonelli, Stewart & Hill

ATTORNEYS

GAS-ALARMING DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to a gas-alarm device, and more particularly to a device wherein a concentration of gas is detected by a semiconductor-type gas-detecting element, and means is provided to generate an audio alarm having a frequency and intensity depending on the concentration of the gas when the concentration exceeds a predetermined amount.

This invention relates to an improvement over the invention disclosed in my copending U.S. application, Ser. No. 10,848, filed on Feb. 12, 1970, now U.S. Pat. No. 3,603,954.

Recently, various types of alarm devices, such as a burglar alarm device, a fire alarm device, or the like, employing buzzers and calling devices, such as a door-bell, have been widely employed in the home. However, if an ordinary buzzer or bell is employed for signaling the leakage of combustible or hazardous gas in a gas-alarm device, such as the device disclosed in the abovementioned copending U.S. application, it will be difficult to find the exact location of the gas and determine the exact reason why the buzzer or bell rings, and to take appropriate action to prevent the hazard caused by the leakage of the gas.

Of course there are various types of gas-alarm devices which can indicate the exact location of gas-poluted areas, which devices employ visible indicators in addition to an audio alarm device. However, most of these devices are of complicated construction and are much too costly for home-use as a gas-alarm device.

SUMMARY OF THE INVENTION

Therefore, the primary object of the invention is to provide a gas-alarm device which can produce a sound that can be clearly discriminated from other kinds of alarm sounds.

Another object of the invention is to provide a gas-alarm device which can produce a sound, the tone of which is easily adjustable for insuring clear discrimination from other sounds.

Still another object of the invention is to provide a gas-alarm device wherein the concentration of gas leaking out of a conduit pipe or the like can be approximated from the tone of the alarm sound.

A further object of the invention is to provide a gas-alarm device wherein a gas detecting element of the semiconductor-type is employed, whereby reliable and sensitive operation is assured over a long working life for the device.

These and other objects of the present invention are achieved by a gas-alarm device of the type comprising a gas-detecting portion including an a.c. or d.c. power source, a semiconductor-type gas-detecting element consisting of a gas-sensitive semiconductor substance, for instance K_2O, CaF_2, Al_2O_3, Ba_2O_3 or SiO_2, and an output resistor across which a voltage depending on the concentration of the gas appears; and a saw-tooth wave oscillator portion consisting of a capacitor, a resistor series connected to a capacitor for limiting the charging current thereof, and a discharge tube such as a neon lamp connected in parallel with said capacitor, the starting and extinguishing voltages thereof being determined; whereby, when a gas is detected by the gas-detecting element, a voltage depending on the concentration of the gas appears across the output resistor, and the intensity and frequency of the saw-tooth wave oscillation in said saw-tooth wave oscillating portion can be controlled by the voltage appearing across the output resistor, so that the output sound obtained from a sounding device attached to said oscillator portion of the device is varied in its frequency and intensity depending on the concentration of the detected gas.

The nature, principle, and utility of the invention will be more clearly understood from the following detailed description relating to preferred embodiments thereof when read in conjunction with the accompanying drawings, wherein like parts are designated by like reference numerals.

BRIEF DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a circuit diagram showing a basic example of the gas-alarm device according to the present invention; and

FIG. 2 is a circuit diagram showing another example of the gas-alarm device which constitutes a second embodiment of the present invention.

FIG. 3 is a partly cut-out perspective view showing the mechanical structure of the embodiment shown in FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 showing a basic example of the gas-alarm device according to the present invention, the primary circuit of a transformer 4, including a primary coil 42, a neon lamp 3 for indicating the energization of the device, a series resistor 2 for the neon lamp 3, and a fuse 1, is connected through a plug connector P to the outside power line providing normal house current.

A gas-detecting element 5, connected to the secondary winding 43 of transformer 4, is so constructed that it includes a coil 51 for heating the element 5, made of for instance platinum, paradium or a platinum-iridium alloy, and an electrode 52 also having a coiled form and consisting of platinum or the like, both coils being embedded in a semiconductor body made of, for instance, Nb_2O_5, SnO_2, ZnO, or V_2O_5, which varies its resistivity when a gas is absorbed therein. Between the coiled heater 51 and the electrode 52, a spacer of insulating substance (not shown) is provided to maintain a desired length of gap therebetween. The gas-detecting element 5 thus constructed is connected in series with a voltage detecting resistor 6, between the output terminals of the secondary winding 43 of the transformer 4. The heater coil 51 is connected to a heater winding 41 of the transformer 4 which provides energization therefor, so as to heat the heater-electrode at the normal operating temperature of 50° to 300° C.

Across the voltage detecting resistor 6, there are connected in series a diode 7 and a capacitor 8, and across the capacitor 8 another capacitor 10 is series connected with a charging current limiting resistor 9. The capacitor 10 is further connected in parallel with a gas-discharge tube 11, such as a neon lamp, and also with a series connected d.c. blocking capacitor 12 and a speaker 13 of, for instance, a crystal type or an electromagnetic type.

The operation of this embodiment of the invention will now be described in detail.

Through the coiled heater 51 of the gas detecting element 5, a constant current is supplied from the heater winding 41 of the transformer 4, and the semiconductor body of the detecting element 5 is maintained at a suitable substantially constant temperature. When gas or smoke is absorbed in the semiconductor substance of the gas-detecting element 5, the electric resistance of the gas-detecting element 5 is reduced abruptly, and the a.c. voltage across the voltage detecting resistor 6 increases sharply. The voltage across the resistor 6 is rectified by the diode 7 and a d.c. voltage proportional to the voltage across the resistor 6 is obtained across the capacitor 8. The d.c. voltage in turn charges the capacitor 10 through the charging current adjusting resistor 9.

With the above-described connection of the gas alarm device, when gas is absorbed in the gas-detecting element 5, the a.c. voltage across the resistor 6 increases and as a result, the d.c. voltage across the capacitor 10 also goes up. If the d.c. voltage across the capacitor 10 exceeds a threshold voltage specific to the neon lamp 11, the neon lamp 11 starts discharging the capacitor 10 so that the voltage across the capacitor 10 is reduced, and a saw-tooth wave oscillation is created in the circuit including the capacitor 10 and the neon lamp 11. That is, since the series resistor 9, capacitor 10, and the neon lamp 11 constitute an oscillator of a well known type utilizing a discharge tube, a saw-tooth oscillation appears across the capacitor 10.

The signal voltage of the saw-tooth wave is applied through the d.c. blocking capacitor 12 to the speaker 13, and the speaker 13 sounds the alarm indicating the existence of a detected leakage of gas.

In FIG. 2, another form of the gas alarm device constituting a second embodiment of the invention is shown. In the drawing, character P and numerals 1, 2, 3, 4, 41, 42, 43, 5, 51, 52, 9, 10, 11, and 12 designate those parts which correspond to parts similarly indicated in FIG. 1. However, in this embodiment, a voltage detecting resistor 16 and a diode 17 are connected in series with the gas-detecting element 5 across the winding 43, whereby a current rectified by the diode 17 flows through the element 5 and the resistor 16, and a smoothing capacitor 18 is provided therein for smoothing the resultant d.c. current. Accordingly, a d.c. voltage is created across the resistor 16, and this voltage increases abruptly when the gas-detecting element 5 absorbs a gas. As in the case of FIG. 1, this voltage is supplied to an oscillating circuit consisting of a series resistor 9, capacitor 10, and a neon lamp 11, and the output thereof is applied through a capacitor 12 and a resistor 34 to an amplifying circuit 50 consisting of transistors 152 and 153 and resistors 35, 36 and 37.

The output of the amplifying circuit 50 is supplied to a high efficiency electromagnetic speaker 23, so that the speaker 23 is thereby operated to sound an alarm. This transistor amplifier circuit is energized from a d.c. power circuit consisting of a secondary winding 44 of the transformer 4, a rectifying diode 27, and a smoothing capacitor 38.

In FIG. 3, which shows one example of the mechanical construction of the device described by reference to FIG. 2, enclose box 511 made of, for instance, plastic material, contains the transformer 4 and a printed-circuit board 521. The gas-detecting element 5 encapsulated in an explosion-proof wire-net casing 53, the neon lamp 3, the gas-discharge tube 11, and the electromagnetic speaker 23 are fixed on the upper face of the printed-circuit board 521, as sown in FIG. 3. Other circuit elements such as the transistors, the resistors, the capacitors and the diode are fixed on the lower face of the printed-circuit board 521. On the enclosure box 511, there is formed a protrusion to contain said gas-detecting element 5, and on both walls of the protrusion there are formed ventilation slits 54 and 55 for allowing the smoke to reach the gas-detecting element 5. On the other part of the protrusion there are provided a pair of transparent windows 57 and 58 for observing lights emitted from the neon lamp 3 and from the gas-discharge tube 11. A perforated metal screen 56 is provided over the electromagnetic speaker 23 to allow the sound to go therethrough.

Since the indication neon lamp 3 can be observed from outside through the window 57 of the box 511, the energization of the gas-alarm device can be determined by observing the on-off condition of the lamp 3. Moreover, since the gas-discharge tube 11 can be observed from the window 58 of the box 511, the existence of the explosive gas can be detected also by observing the flickering light of the gas-discharge tube 11.

As is apparent from the above description, the embodiment of this invention can operate an electromagnetic speaker through the employment of the amplifier, and an alarm of intensified sound is thereby issued. Furthermore, a plurality of speakers located in various positions may be employed in this embodiment, and the speakers may be connected in series or in parallel. In addition, a plurality of gas-alarm devices of the type illustrated in FIG. 3 may be connected in common to a plurality of speakers.

As is made apparent from the description of the two embodiments of the invention, the oscillation frequency of the saw-tooth wave may be freely varied by suitably selecting the values of the charging current adjusting resistor 9 and the capacitor 10, and also by the discharging and blocking voltages of the discharge lamp 11, whereby the tone of the alarming sound can be adjusted as desired.

Furthermore, along with the increase in the gas concentration, the internal resistance of the gas-detecting element is lowered, and the voltage created across the resistor 6 is elevated, thus increasing the oscillation frequency of the saw-tooth wave oscillator as well as the intensity of the oscillation.

According to the gas-alarm device of this invention, an alarming sound of a desired tone can be obtained whenever gas or smoke is detected by the detecting element, and for this reason, it is made possible that the alarm is discriminated from the sounds emitted by other buzzers or bells, such as the burglar alarm buzzer or the like. In a case where a number of alarm devices are watched centrally, each of the alarms can be adjusted beforehand to have a tone different from the others, whereby the distinction of the alarming position may be facilitated.

In addition, since a semiconductor type gas-detecting element consisting of a gas-sensitive metal oxide element is employed as an essential component of this alarming device, the sensitivity of this gas-alarming device is excellent.

While I have shown and described two embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art, and I therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

What is claimed is:

1. In a gas-alarm device including a gas-detecting portion including a semiconductor-type gas-detecting element consisting of a gas-sensitive semiconductor substance having at least one electrode embedded therein and an output resistor series connected to said electrode, and a power source connected across the series combination of said element and said resistor so that a voltage depending on the concentration of the gas appears thereacross, the improvement comprising

a sounding device for producing an alarming signal and

a saw-tooth wave oscillator portion connected to said sounding device and responsive to said voltage dependent on the concentration of the gas, including a capacitor, a current limiting resistor series connected to said capacitor, and a discharge tube having a negative-resistance characteristic connected in parallel to said capacitor, so that the intensity of the alarming sound emitted by said sounding device is made variable depending on the concentration of the gas detected in said gas-detecting portion of the device.

2. A gas-alarm device according to claim 1, wherein said gas-detecting element comprises a gas sensitive semiconductor substance, a heater electrode and another electrode embedded in said semiconductor substance.

3. A gas-alarm device according to claim 2 wherein both said element and said resistor are connected in series across an a.c. power source so that an a.c. voltage depending on the concentration of the gas appears across said output resistor, and said gas-detecting portion includes a rectifying and smoothing circuit for converting said a.c. voltage appearing across the output resistor into a smoothed d.c. voltage.

4. A gas-alarm device according to claim 2 wherein both said element and resistor are connected in series across a d.c. power source so that a d.c. voltage depending on the concentration of the gas appears across said output resistor, and the series connected current limiting resistor and said capacitor of said saw-tooth wave oscillator are connected in series across said output resistor.

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