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[54] **AUTOMATIC FIRE ALARM DEVICE**

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[51] **Int. Cl.** **G08b 21/00**

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

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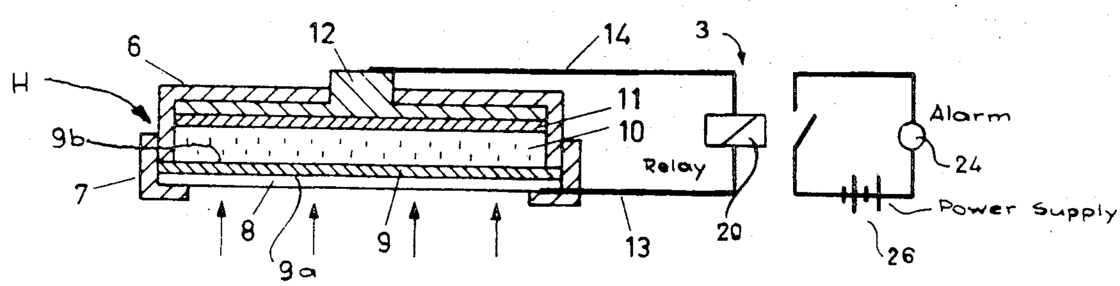
[57] **ABSTRACT**

Automatic fire alarm incorporating a device for detection of combustion gases comprising a detection cell having a cathode, an anode accessible to the combustion gases and an electrolyte arranged between the anode and cathode. The anode catalytically oxidizes the carbon monoxide contained in the combustion gases while giving off electrons. An electrical circuit is coupled with the anode and the cathode for current detection and alarm indicating purposes.

21 Claims, 3 Drawing Figures



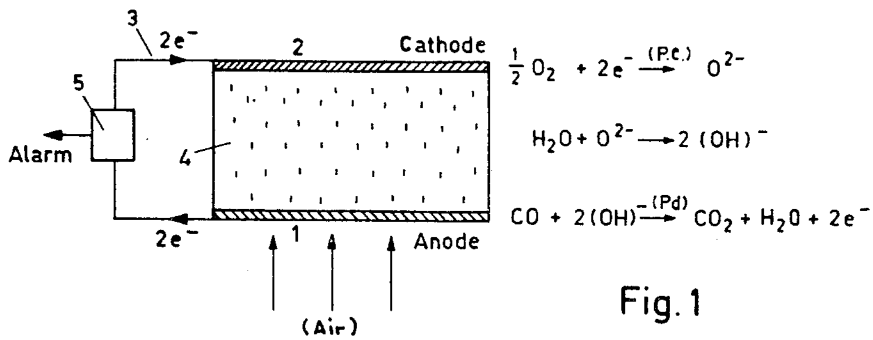


Fig. 1

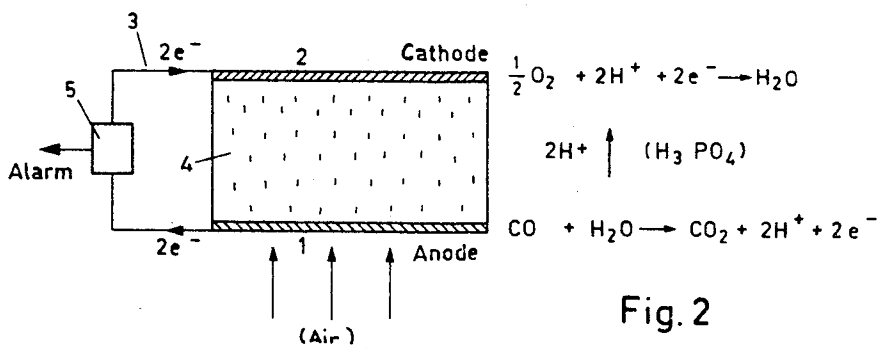


Fig. 2

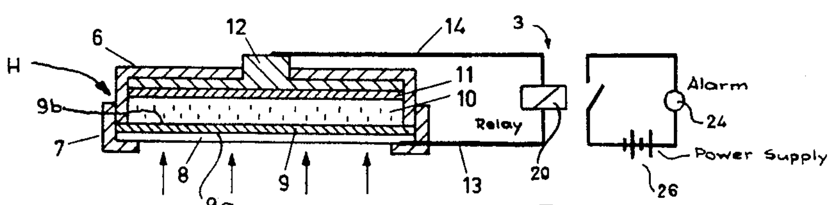


Fig. 3

AUTOMATIC FIRE ALARM DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved construction of automatic fire alarm incorporating a device for the detection of combustion gases.

Automatic fire alarms either resort to the use of the physical changes arising during a combustion process, for instance the increase in temperature or the radiation transmitted by flames for the purpose of indicating an alarm, or attempt to detect the products of combustion resulting during a fire. Hence, it is known in this particular field of technology to detect the smoke which develops during combustion processes by optical absorption- or stray light fire alarm devices or to detect the combustion aerosols by means of ionization fire alarms. Other state-of-the-art fire alarm devices resort to the use of the changed conductivity of the combustion gases (formation of ions) and the increased water vapor content for fire detection purposes.

However, the aforementioned equipment is more or less subject to disturbances that can be triggered by occurrences which have nothing to do with a combustion process, for instance in the case of optical fire alarms by disturbing light effects, in the case of ionization fire alarms by dust, in the case of conductivity detectors by the ionization of air or for other causes. Due to such deception of the relevant fire detection devices in the aforementioned manner false alarms arise with such prior art equipment.

It has already been proposed to employ for fire detection purposes the carbon monoxide (CO) which is produced during any undesired or intentional combustion process. Such type equipment would operate in a particular foolproof manner since carbon monoxide occurs practically exclusively as a result of a combustion process, and therefore, constitutes an infallible indicator for a fire. Moreover, a warning concerning the presence of carbon monoxide is extremely desirable owing to the fact that it is poisonous.

Heretofore known CO-detectors generally function on the spectral-photometric principle or by means of a chemical reaction and the detection of the resultant products. However, these procedures are relatively cumbersome and the equipment operated in accordance therewith is not useable over longer periods of time, as such is required for automatic fire alarms. Additionally, such type equipment is relatively complicated, expensive and requires continuous maintenance.

SUMMARY OF THE INVENTION

Hence from what has been explained above it should be apparent that this particular field of technology is still in need of automatic fire alarm devices which are not associated with the aforementioned drawbacks and limitations of the state-of-the-art proposals. Therefore, it is a primary object of the present invention to provide a new and improved construction of automatic fire alarm device which affectively and reliably fulfills the existing need in the art and overcomes the aforementioned drawbacks and limitations of the heretofore proposed fire detection devices.

Another and more specific object of the present invention aims at the provision of an automatic fire alarm device which overcomes the aforementioned drawbacks and functions with increased sensitivity and in an

unmistakable operationally reliable manner over longer periods of time.

Yet a further significant object of the present invention relates to an improved automatic fire alarm which is relatively simple in construction, economical to manufacture, extremely reliable in operation, and requires minimum servicing and mainenance.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the inventive apparatus for the detection of combustion gases embodies an electrolytic cell having a cathode, an anode accessible to the combustion gases and an electrolyte arranged between the anode and cathode. The anode is capable of catalytically oxidizing the carbon monoxide contained in the combustion gases while giving off electrons. There is also provided an electrical circuit connected with the anode and cathode for current detection and alarm indicating purposes.

The invention resorts to the use of the well known experience that it is possible by means of so-called fuel cells to directly convert combustible liquids or gases, that is without interposing thermal engines, into electrical energy. In such type fuel cells generally organic substances, such as formal, formic acid or hydrazine are catalytically oxidized, for instance at a platinum anode. Between the anode and the cathode there thus prevails a potential difference which can be employed for generating energy. It has already been proposed to inversely employ the energy supply of such fuel cells for the analysis of the content of combustible material in liquids and gases. However, the known fuel cells are completely unsuitable as fire detectors owing to their complicated construction and low selective sensitivity to carbon monoxide. Hence, in order to develop the invention it was therefore necessary to find new materials for the individual elements and to arrive at and select an arrangement and construction designed such that the apparatus possessed optimum sensitivity to carbon monoxide with as little as possible expenditure in equipment and with as great as possible equipment life.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description above. Such description makes reference to annexed drawings wherein:

FIG. 1 schematically illustrates the functional principles of a fire alarm device employing a basic electrolyte;

FIG. 2 schematically illustrates the functional principles of a fire alarm device employing an acidic electrolyte; and

FIG. 3 illustrates in sectional view the construction of the detection device of a fire alarm designed according to the teachings of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Considering now the drawing in the embodiment of exemplary apparatus depicted in FIG. 1 the ambient air has access to an anode 1. At the cathode 2 reactive oxygen ions are formed from the oxygen molecules of the air upon delivery of electrons from the electrical circuit 3. These reactive oxygen ions together with the water of the basic electrolyte 4 are converted into hydroxyl ions. Hence, the cathode 2 serves as hydroxyl-ion donor. These hydroxyl ions migrate to the anode 1 and at that location react in the presence of a catalyst, for instance palladium, with the carbon monoxide contained in the air into carbonic acid and water, wherein electrons are released which are again supplied to the electrical current circuit **3**. As long as carbon monoxide is contained in the air a current flow will be maintained in this current circuit 3, and this current flow can be ascertained by means of a suitable detector **5** and employed for triggering an alarm signal in known manner.

Now, with the equipment depicted in FIG. 2 employing an acidic, in other words an electrolyte containing hydrogen ions, the carbon monoxide contained in the air catalytically reacts at the anode 1 with the water contained in the electrolyte to form carbon dioxide and hydrogen ions while giving off electrons which can flow in the electrical current circuit 3 to the cathode **2**. The hydrogen ions are absorbed or taken up by the acidic electrolyte **4** and react at the cathode **2** with the oxygen which has diffused-in to form water while taking-up electrons from the current circuit **3**. The electrolyte may contain in this instance phosphoric acid.

Now in FIG. **3** there is illustrated in sectional view a practical exemplary embodiment of the invention. Here the automatic fire alarm or fire detection device comprises a plastic housing H formed of two housing portions or components **6** and **7**, the housing portion **7** being provided with an opening or otherwise suitably designed so as to have one side thereof accessible to the surrounding air. At this open side of the housing there is arranged a gas pervious membrane or diaphragm **8**, for instance a filter formed of pressed glass wool or glass frit or the like.

At the outside of this gas permeable membrane **8** there is provided a layer **9** formed of nickel powder coated with a noble or precious metal. Particularly suitable for this purpose are metals of the platinum group. In particular palladium has been found to possess advantageous capabilities for the catalytic oxidation of the carbon monoxide arriving at the diaphragm or membrane **8**. The metal powder is mixed with an ion exchanger and if necessary with an additional binder, for instance polystyrene. Basically ion exchangers of the most different composition have been found to provide favorable results. Particularly suitable as the ion exchanger is the known ion exchanger available on the market under the designation anion exchanger III, which contains a copolymer of styrene divinylbenzoyl with quaternary ammonium groups. However, the invention is in no way to be considered limited to such type ion exchanger since other ion exhangers have been likewise found to be suitable.

At the floor of the housing portion **6** there is located an electrode **12** which is coated at the inside with a layer of carbon, for instance carbon black, at which there is again applied a substance **11** which gives off hydroxyl ions. Particularly suitable for this purpose is a polymeric phtalocyanine of the transition metals, for instance the iron group (Fe, Ni, Co), yet also of Cu, Ag, Au and Hg.

Now, between the plate-shaped constructed electrodes there is located a thin felt layer **10** imbued with an electrolyte, for instance a potassium bicarbonate solution or cesium carbonate solution. Instead of using felt it would be possible to employ a different carrier material which can absorb the electrolyte, yet only slightly hinders the diffusion, as such is known for instance from electrolytic dry elements. The layer thickness amounts to only a few millimeters, as a rule less than 5 millimeters. With such substantially plate-shaped electrode arrangement and such slight electrode spacing, i.e., less than 5 millimeters, the internal resistance of the electrolytic cell is relatively small and the diffusion within the electrolyte is sufficiently rapid so that the current yield is sufficiently large so as to be already able to detect the slightest quantities of combustion gas. The voltage of the element in this case as a general rule is below 0.1 volts.

In order to reduce rate of evaporation or vaporization of the electrolyte there can be added thereto a certain quantity of gylcerine or a similar substance. In this way the life and useful time of the fire alarm can be considerably improved.

A further possibility of reducing evaporation of the electrolyte resides in designing the anode such that the outer side or face contains a hydrophobic binder such as indicated as **9*a*** which prevents the escape of the electrolyte, whereas the inside or inner face **9*b*** contains a hydrophylic binder which ensures for the requisite wetting or imbuing.

The sensitivity can be further increased in that the rear wall of the housing portion **6** bearing against the cathode **12** is designed to be pervious to air. In this way the oxygen of the air can arrive directly at the cathode **12** without having to diffuse through the electrolyte, for instance the cathode can be formed of very finely divided silver, so-called Raney silver, which is applied to an oxygen pervious membrane. At the anode there is connected a current conductor **13** and at the cathode a current conductor **14** in order to be able to couple the fire alarm device with the electrical circuit **3** serving for current detection and alarm sounding purposes. The invention is not limited to any specific construction of the current detector and alarm sounding circuitry since many different constructional forms suitable for this purpose are wellknown in the art. In one very simple manifestation this electric circuit **3** can embody a relay **20** electrically coupled with the current conductors **13** and **14** as shown in FIG. **3**, the relay **20** cooperating with a work contact **22**, so that upon current flow through the relay **20** the work contact **22** is closed and a suitable alarm **24** is activated since it is now placed in circuit with a suitable power supply, such as battery **26**.

It has been found that by observing the described measures it is possible to produce a fire alarm which is capable of already positively detecting a carbon monoxide content below 100 ppm and which will not be normally excited into a state of producing a false alarm by contaminants in the air.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practised within the scope of the following claims. ACCORDINGLY,

What is claimed is:

1. An automatic fire alarm comprising a device for the detection of combustion gases, said device comprising a detection cell having a cathode, an anode accessible to the combustion gases, and an electrolyte arranged between the anode and cathode, said anode being capable of catalytically oxidizing carbon monoxide contained in combustion gases while giving off electrons, and an electrical circuit for current detection and indicating an alarm electrically coupled with said anode and said cathode.

2. The automatic fire alarm as defined in claim **1**, wherein said electrolyte possesses basic properties and said cathode is formed of material capable of delivering hydroxyl ions.

3. The automatic fire alarm as defined in claim **1**, wherein the electrolyte possesses acidic properties and said cathode is formed of a material capable of taking-up hydrogen ions.

4. The automatic fire alarm as defined in claim **1**, wherein the cathode possesses a polymeric phtalocyanine of a transition metal.

5. The automatic fire alarm as defined in claim **4**, wherein said cathode contains carbon black coated with a phtalocyanine of the iron group.

6. The automatic fire alarm as defined in claim **1**, wherein the anode contains a catalyst selected from a metal of the platinum group.

7. The automatic fire alarm as defined in claim **6**, wherein the anode contains as the catalyst palladium.

8. The automatic fire alarm as defined in claim **6**, wherein the anode contains nickel powder coated with a metal of the platinum group.

9. The automatic fire alarm as defined in claim **8**, wherein the nickel powder is applied to a gas permeable membrane.

10. The automatic fire alarm as defined in claim **2**, wherein the anode contains an ion exchanger.

11. The automatic fire alarm as defined in claim **10**, wherein the ion exchanger comprises a copolymer of styrene divinybenzyl with quaternary ammonium groups.

12. The automatic fire alarm as defined in claim **2**, wherein the electrolyte contains potassium bicarbonate.

13. The automatic fire alarm as defined in claim **2**, wherein the electrolyte contains cesium carbonate.

14. The automatic fire alarm as defined in claim **3**, wherein the electrolyte contains phosphoric acid.

15. The automatic fire alarm as defined in claim **1**, further including a porous layer arranged between the anode and cathode and imbued with the electrolyte.

16. The automatic fire alarm as defined in claim **1**, wherein the electrolyte has added thereto an evaporation-retarding substance.

17. The automatic fire alarm as defined in claim **16**, wherein the evaporation-retarding substance is glycerine.

18. The automatic fire alarm as defined in claim **1**, wherein said anode and cathode possesses a substantially plate-shaped configuration and are arranged at a spacing from one another which is less than 5 millimeters.

19. The automatic fire alarm as defined in claim **1**, wherein both the anode and cathode are designed to be accessible to the ambient air.

20. The automatic fire alarm as defined in claim **19**, wherein said cathode is formed of very finely divided silver applied to an oxygen pervious membrane.

21. The automatic fire alarm as defined in claim **1**, wherein said anode possesses at the side thereof confronting the electrolyte a hydrophilic substance and at the outside a hydrophobic substance.

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