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[54] **THERMALLY ACTIVATED WARNING SYSTEM**

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[52] **U.S. Cl.** ..... **340/237 R;** 128/142.6

[51] **Int. Cl.²** **G08B 21/00;** A62B 7/10

[58] **Field of Search** .... 340/237 R, 235, 279, 227 C; 128/146.2, 1 R, 202, DIG. 17, 191, 193, 142, 142.4, 142.6; 337/416; 55/274

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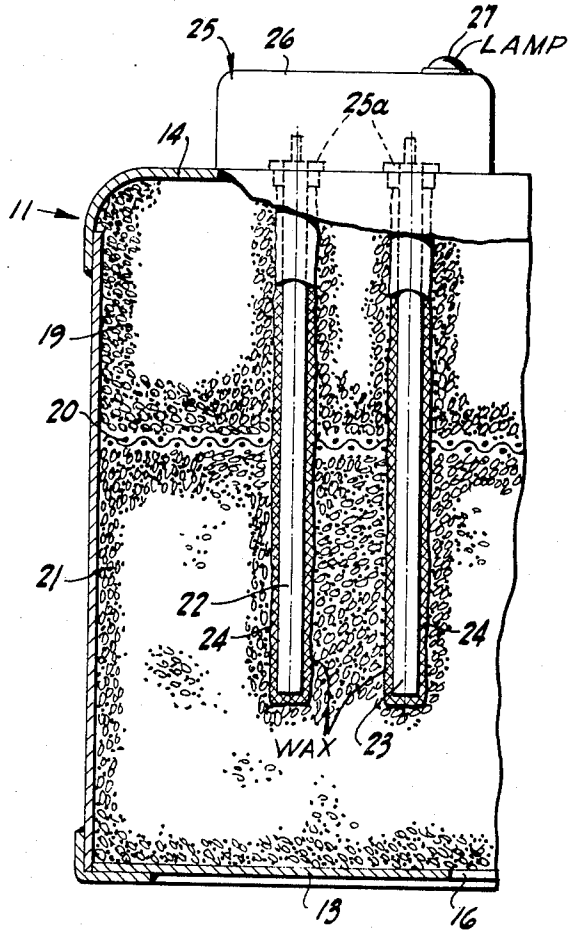
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[57] **ABSTRACT**

An electrically actuated safety alarm system for detecting the presence of toxic gases for use alone or in combination with a conventional gas filter breathing apparatus. Spaced electrodes, at least one of which is coated with an electrically insulating material of low melting point (e.g., wax) project into an electrical conducting medium (e.g., activated charcoal) in a container and is connected in series with signaling means with an audio and/or visual signal. Chemical means in the container reacts with the toxic gases to generate heat and melt the wax to complete the electrical circuit between electrodes through the charcoal and activate signaling means to generate the signal.

19 Claims, 5 Drawing Figures



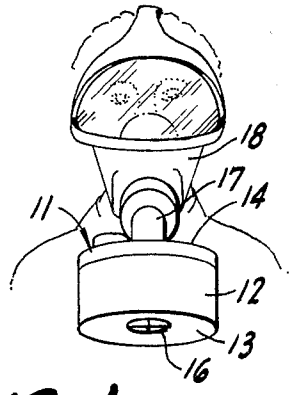


FIG. 1

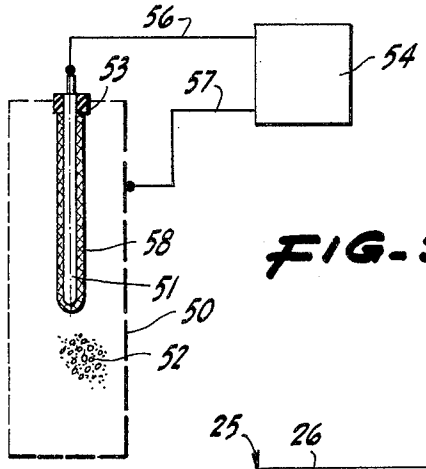


FIG. 5

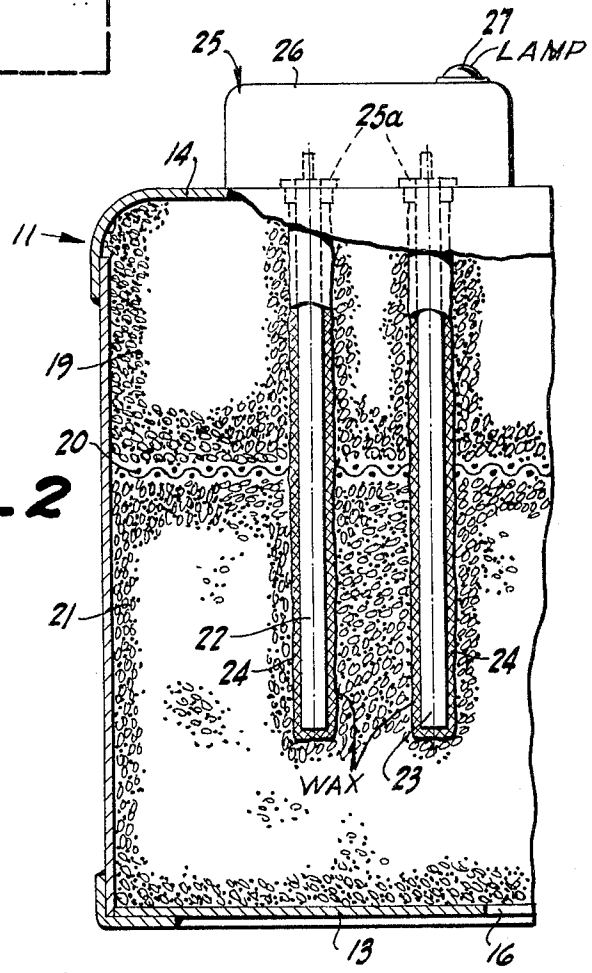
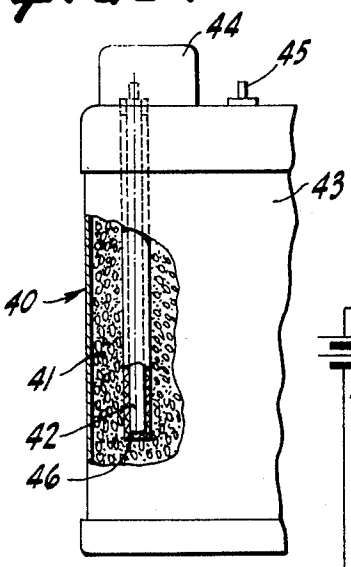


FIG. 2

FIG. 4



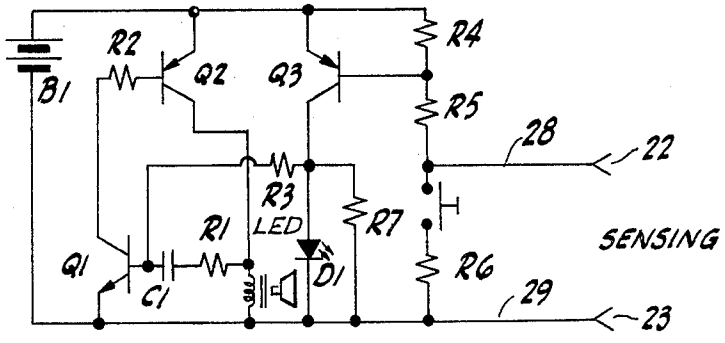


FIG. 3

THERMALLY ACTIVATED WARNING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to an electrically actuated safety alarm system for detecting the presence of a threshhold level of predetermined toxic gases. This alarm system includes a signal of an audio or visual type. It can be used alone as an alarm system, say, in a chemical plant or mine or used in conjunction with a conventional gas filter breathing apparatus.

Gas filter breathing apparatus typically include canisters with layers of material of the following types, alone or in combination: (a) granular material for sorbing toxic gases, (b) catalyst for converting a toxic gas, such as carbon monoxide to a harmless one such as carbon dioxide, or (c) a reagent for reacting with the toxic gas and neutralizing its toxicity. Such canisters generally are effective only at relatively low levels of toxic gas (e.g., 1 percent or less). Thus, low capacity chin-type canisters are recommended for use at toxic gas levels below 0.5 percent. At higher levels of toxic gases, the material in the canister either is dissipated in a relatively short period of time or sorbs only part of the toxic gas. Thus, in an emergency, particularly where a lethal spill or leak of a hazardous gas occurs, the gas mask wearer does not realize that his cartridge canister has become saturated until he detects the odor during inhalation. By that time, such inhalation may cause permanent health damage or even death. The wearer may not have sufficient time to leave the hazardous area and return to fresh air as breathing the toxic gas may cause unconsciousness.

Many of the above filter systems rapidly generate heat at high concentration of toxic gases. One warning system presently employed is that such heat causes the air inhaled by the wearer of the mask to be uncomfortably hot. However, this may be too late resulting in the above harmful effects. In addition, the wearer is likely to be so pre-occupied with performance of his emergency function that he may not notice the heating of the canister until it is too late to leave the area. If the canister is of the type that fits on the back of the gas mask wearer, the wearer is further handicapped in noticing increased temperature of the canister especially if he is under stress.

Another type of warning system for gas filter breathing apparatus utilizes a window indicator in the canister. Normally, in such a window indicator, two pieces of paper of different color are located side by side in the window. One paper is treated chemically to change color as it absorbs moisture. When it has changed sufficiently in color to match the paper this should indicate that the chemical sorbent has lost or will shortly loose its effectiveness. In order to make a proper observation of the colors, it is necessary that the window indicator be observed in daylight. In addition, because of the position of the window indicator, it is very difficult, if not impossible, for the wearer to observe the indicator when the mask is being worn. Also, this system is not able to instantaneously signal the gas mask wearer when the level of toxicity exceeds the capacity of the gas mask. There is a need for a simple audio, visual or combination audio/visual warning system which can instantaneously signal the gas mask wearer of his sudden exposure to high levels of toxic gases.

There is believed to be no effective warning system in public use which can be positioned in various environments such as chemical plants which are rapidly activated by the sudden release of toxic gases. There is a need for such systems of an audio/visual type to warn not only those persons exposed to the toxic gases in the immediate vicinity of the alarm system but also those persons within hearing distance of the alarm system who would shortly be exposed to the gases if they do not immediately leave the premises.

SUMMARY OF THE INVENTION AND OBJECT

The electrically actuated safety alarm system of the present invention is used for detecting the presence of a selected threshhold level of predetermined toxic gases to indicate a dangerously high concentration of such gases. The alarm system includes a container and spaced apart electrodes with an electrically conductive medium (e.g., activated charcoal) disposed between the electrodes. Chemical means for generating heat on contact with the toxic gases in the container is disposed in gaseous communication with the surroundings and in thermal communication with at least one of the electrodes. At least one of the electrodes is coated with an inert material, preferably wax, in the region of the electrically conductive medium to provide a barrier against contact between that electrode and the medium. The coating is characterized by high electrical resistance and a melting point less than the temperature of heat generated in the canister by contact of a threshhold level of the toxic gas and the chemical means. Signaling means is connected in series with the electrodes to activate an audio and/or visual signal when the coating is melted responsive to a dangerously high concentration of toxic gases. This activation is caused by a substantial drop in the resistance between electrodes. The electrically conductive medium is preferably activated charcoal which thereby also serves as the heat generating chemical means when sorbing certain toxic gases. Also, such chemical means may be a coating on or impregnated into such charcoal granules either catalytic or directly reactive with the toxic gases or may be a layer having the same properties partitioned from the charcoal.

The above alarm system may be in conjunction with chemical filter breathing apparatus or independently as by mounting on a wall of a chemical plant.

Generally, it is an object of the present invention to provide an electrically actuated safety alarm system for detecting and signaling the presence of a selected threshhold of predetermined toxic gases.

Another object of the invention is to provide an alarm system of the above type which generates an audio or visual signal or a combination of the two.

It is a further object of the invention to provide an alarm system of the above type in combination with a chemical filter breathing apparatus to provide a warning to the wearer when the apparatus is insufficient to filter predetermined levels of toxic gases.

It is another object of the invention to provide an apparatus of the above type in which the electrical signal assembly is readily removed for repeated use after exhaustion of the chemical systems.

It is another object of the invention to provide an apparatus of the above type in which the alarm device is highly reliable, relatively inexpensive, and can be easily manufactured.

It is a further object of the invention to provide an alarm device of the above character which can be

adapted to chemical filter breathing apparatus already in the field.

It is a specific object of the invention to provide an alarm system with an audio signal which can (a) clearly warn the wearer of a chemical filter breathing apparatus of the danger of high concentrations of toxic gases even where he is pre-occupied with emergency functions and (b) signal other persons if the wearer becomes unconscious as a result of exposure to the gases.

It is another object of the invention to provide an alarm system which can be mounted for long-term usage in an area of potential danger for warning persons in the vicinity of the sudden release of toxic gases.

Additional objects and features of the invention will be apparent from the following description in which the preferred embodiments are set forth in detail in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a front view in perspective of a man wearing a chemical filter breathing apparatus with an alarm system according to the present invention.

FIG. **2** is an expanded front view partially broken away of a two probe electrode alarm system of the present invention.

FIG. **3** is a circuit diagram of an audio/visual assembly suitable for the present invention.

FIG. **4** is a side view partially broken away of a single probe electrode alarm system in accordance with the present invention.

FIG. **5** is a schematic view of another embodiment of a single probe electrode system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The chemical filter breathing apparatus portion of FIG. **1** is of a conventional chin type such as a type GMP produced by Mine Safety Appliances Company (MSA) of Pittsburgh, Pa. This device is recommended by MSA for respiratory protection against toxic gases and vapors in concentrations not in excess of 0.5 percent by volume. This breathing apparatus is illustrated in conjunction with an alarm system in accordance with the present invention. It includes an electrically conductive canister **11** consisting of a drawn steel oval-shaped body **12** which has been copper-plated. Bottom and top closure wall **13** and **14** are provided for closing the open lower and upper ends of body **12.** The bottom closure wall **13** is provided with a screen opening **16** which is sealable when the canister is not in use. In a conventional breathing apparatus, a filter, not shown, is mounted in the bottom of the canister for filtering particulate materials such as toxic dust and the like. A pipe **17** provides gas communication between an opening in the top wall **14** and facemask **18.** The canister body **12** defines an open gas passageway through the canister so that the respiratory tract of the wearer is in communication with air from the environment after filtering through the canister.

Referring to FIG. **2,** two different granular sorbent **19** materials are provided within the canister **11** arranged in layers. The top layer **19** is formed of hopcalite, a mixture of copper and manganese oxides, conventionally used in gas masks as a catalyst to oxidize carbon monoxide to carbon dioxide in the presence of oxygen in the air. A screen **20** is provided below the hopcalite and another screen, not shown, can be positioned thereabove to separate a suitable drying agent (e.g., anhydrous calcium chloride) serving to prevent moisture from reaching the hopcalite through inlet pipe **17.** A sorbent layer **21** of activated charcoal is provided below screen **20** which is conventionally used to sorb organic vapors such as carbon tetrachloride. Such. activated charcoal also serves as an electrically conductive medium for purposes of the present invention.

Portions of the above conventional chemical filter breathing apparatus are utilized as an integral part of the safety alarm system of the present invention by means of the following additional apparatus. Electrode means is provided in the form of spaced apart electrodes **22** and **23,** suitably formed of copper, project through sorbent material **19.** The electrodes are rigidly mounted to the canister wall with a portion of each one projecting outwardly therefrom. The probes are suitably mounted with a strong adhesive polymer, such as epoxy resin, with electrical insulating properties. The adhesive layer **20** extends a sufficient distance along the probe walls into the canister to prevent a short-circuit between the electrodes through the canister wall.

Referring again to FIG. **2,** an inert coating **24,** suitably of wax, is formed into a complete layer about electrodes **22** and **23** particularly in the region of the electrically conductive medium, charcoal granules **21.** Coating **24** serves to provide a barrier against contact between said electrodes and charcoal granules. It is characterized by high electrical resistance and a melting point substantially above room temperature, say, at least 50°C or more, for reasons to be described hereinafter. The wax is characterized by chemical inertness, especially to water vapor, and is not hygroscopic. In general, the melting point of waxes increase with molecular weight. A typical molecular weight for suitable waxes is on the order of 2,000.

Suitable waxes of the above type contain esters derived from long-chain alcohols and long-chain acids. For example, beeswax is largely myricyl palitate while carnauba wax includes myricyl cerotate. Other suitable waxes include high molecular hydrocarbons, alcohols, and ketones. The melting point of the wax should be selected to be above the maximum temperature of the gaseous environment in which it is to be used (e.g., above 45°C in a temperate climate). On the other hand, the melting point should be below a temperature at which the exothermic reaction described hereinafter occurs. Suitable waxes and their melting points are given in the following table.

TABLE 1

Wax	Melting Point (°C)
Carbowax 4000 (a polyethylene glycol of molecular weight 3000–3700)	50–57
Ceramid	80
Chlorowax	101
Paradox	93
Paraffin (hydrocarbon)	50–57
Ceresin (hydrocarbon)	65
Microcrystalline Polyethylene Wax (Star S)	90
Carnauba yellow	86
Carnauba (Refined)	86
Montan	70
Beeswax	62
Candelilla	73

The initial ohmic resistance of the wax coating on the electrode is very high (e.g., greater than 10^8 ohms). After melting of the wax, the electrical circuit between the electrodes is completed through the carbon granules for a relatively low resistance (e.g., on the order of 1,000–100 ohms) for a net drop on the order of 10^6 ohms. As set forth hereinafter, the circuit of the signaling means is complete at the lower ohmic resistance.

Waxes are particularly effective coatings for the electrodes in accordance with the present invention because they are inexpensive, have high electrical resistance, melting points within the desired range, and are inert to most chemical reactants. It should be understood that other organic coating materials such as low-density polyethylene may be employed so long as they have the above desired characteristics.

An electrically conductive medium is disposed in the canister between the two electrodes. The medium is preferably a form of carbon as it is effective and inexpensive. For example, activated charcoal is already present as a sorbent layer in a conventional canister for a chemical filter breathing apparatus as set forth above. Thus, the two electrodes need only contact this pre-existing layer.

Chemical means is provided in the canister for generating substantial heat when contacted with selected threshhold levels of the predetermined toxic gases in an exothermic chemical reaction. Such chemical means is in gaseous communication with the outside of the canister and in thermal communication with at least one coated electrode. In the embodiment of FIG. **2**, such chemical means comprises sorbent **19** in a form of hopcalite which acts as a catalyst for the highly exothermic oxidation of carbon monoxide to carbon dioxide. As set forth above, the chemical means comprising sorbent **19** is disposed in a layer across the canister gas passageway for contact by air passing between the surroundings and facemask. When there are sufficiently high toxic gas levels in the surrounding environment (e.g., at least 0.4 percent by volume of carbon monoxide), sorbent **19** generates enough heat to the thermally conductive canister and contents to melt the wax coating in the compartment containing layer **21** of activated charcoal. It has been found that an excellent electrically conductive bridge is formed between the two electrodes through the carbon granules when the wax has melted exposing the electrodes. Conductivity is materially assisted by the phenomenon that the charcoal granules adjacent the electrodes adhere to the wax as it melts to expose the electrodes.

Referring again to the drawing, signaling means generally denoted as **25** includes electrical circuitry contained in housing **26.** The circuitry is electrically insulated within the housing. The signaling means **25** includes an internal socket or other suitable clamping mechanism for receiving the electrodes into the circuit. Signaling means **25** can be detached from the electrodes when desired as after the chemical reagents in the canister are expended by use. Thus, the removable signaling means can be used repeatedly with different canisters. Signaling means **25** may generate a signal of either audible sound or visible light such as lamp **27,** or both. The drop in resistance to trigger the audio/visual alarm is satisfied by melting of the wax in the aforementioned manner so that an electrically conductive bridge is formed between electrodes **22** and **23** by direct contact with charcoal granules **21.**

Suitable signaling means **25** to generate an audio and/or visual alarm in response to a dangerously high concentration of toxic gases is illustrated in FIG. **3.** Lines **28** and **29** are coupled to electrode **22** and **23** as discussed previously. When the electrical insulating barrier of one electrode is still intact electrical resistance produced between lines **28** and **29** is relatively high; for example, greater than 10^8 ohms. Thus, the current flow caused by the positive potential of the battrey **B1** through the series circuit of **R4, R5** and the high effective resistance between lines **28** and **29** is very low. The base input of transistor **Q3** is very close to the plus battery potential and is maintained in an off condition. The collector of **Q3** is connected to light emitting diode **D1** and is also coupled to an oscillator circuit which includes transistors **Q1** and **Q2,** the resistors **R1, R2, R3,** and the capacitor **C1.**

In operation when the insulating coating on one of the electrodes is melted due to the generation of heat caused by a dangerously high concentration of toxic gases the resistance between lines **28** and **29** is reduced. When this resistance reaches a certain point, for example 5000 ohms, transistor switch **Q3** is turned on which applies power to the visual alarm light emitting diode **D1** and at the same time activates the oscillator through resistor **R3** to the base of transistor **Q1.** The oscillator circuit oscillates at an audio frequency which is converted to an audio signal by means of a suitable electro-mechanical transducer or loud-speaker which is tapped off between **Q2** and line **29.** In accordance with the invention even if the user of the device does not see the visual signal he is notified by the audible sound.

In the embodiment illustrated in FIG. **2,** coatings are provided upon both electrodes. It should be understood that it is only necessary to coat one electrode as that will create the high resistance which prevents completion of the electrical circuit between the electrodes. Also, the wax coating only need be present in the area of the charcoal or other electrically conductive medium. Thus, where there are two compartments, as in FIG. **2,** only the portion of the electrodes below screen **20** need be coated.

Referring to FIG. **4,** another embodiment of the alarm system of the present invention is illustrated with the electrode means in different form. A canister **40** of the same general type as described with respect to FIG. **2** is provided. A single layer of sorbent material **41** is provided rather than the two layers illustrated in FIG. **2.** Electrode **42** extends into sorbent material **41.** The other electrode comprises the housing **43** of canister **40** which is formed of a conductive metal. Signaling means housing **44** is fitted with an electrically conductive finger **45** in electrical communication with canister wall **43.** Finger **45** is connected to the same portion of the circuit of the signaling means as one of the electrode probes **22** or **23** in FIG. **2.** An inert coating **46** of the type set forth above is deposited on the surface of electrode **42.**

In the embodiment of FIG. **4,** sorbent **41** serves two purposes. It is the chemical means which generates sufficient heat on contact with threshhold levels of the predetermined toxic gases to melt coating **46.** In addition, it is the electrically conductive medium between electrodes which enables the alarm system to be activated upon melting of the coating. Activated charcoal is capable of performing both of these functions. This

is to be contrasted with the embodiment of FIG. 2 wherein the chemical means for generating heat and the electrically conductive medium are in two separate compartments.

It is apparent that in the present system the chemical means must generate sufficient heat on contact with the threshhold level of toxic gases to melt the coating in order to activate the alarm system. Contact of certain gases with activated charcoal alone is sufficient to generate the requisite heat. Such gases include hydrogen sulfide and chlorinated solvents such as carbon tetrachloride or perchloroethylene.

Thus, the activated charcoal is capable of serving both as the chemical means to generate heat and the electrically conductive layer. The sizes of the granular activated charcoal or other layers of particulate material used in accordance with the invention are the same as conventionally used in the gas mask industry. The size is greater than that which would present any undue pressure drop to gas flow. A suitable size is 8–12 mesh.

In an alarm system suitable for toxic gases which do not yield sufficient heat upon sorption by activated charcoal alone, suitable chemical means may be impregnated into the charcoal which generates the requisite amount of heat to melt the coating upon contact with the selected threshhold level of toxic gases. For example, activated charcoal impregnated with silver or copper chromate has been found to generate sufficient heat when contacted with alkyl (e.g., methyl, ethyl or butyl) mercaptans and disulfides, cyanogen, phosgene, hydrocyanic acid and chloropicrin. Also, impregnating activated charcoal with potassium iodide significantly increases the heat generated by contact with hydrogen sulfide. Other chemical means which generate sufficient heat on contact with selected toxic gases may also be impregnated into the charcoal.

Referring to FIG. 2, a system has been described in which the chemical means for generating heat, hopcalite, is independent from the electrically conductive medium. It should be understood that a heat generating substance other than hopcalite may be used in such systems so long as the substance generate the requisite amount of heat when contacted with the threshhold level of predetermined toxic gases. For example, the chemical means may comprise granules of a solid base such as sodium hydroxide or calcium hydroxide or a combination of the former with calcium oxide (known as soda lime), such materials are exothermically reactive with threshhold levels of acidic gases to generate sufficient heat to melt the wax coating. Such gases are generally strongly acidic and include hydrogen sulfide, hydrogen chloride, and sulfuric acid. Sulfur dioxide in a humid or moist atmosphere which converts to sulfurous acid will also trigger the alarm system.

As set forth above, the canisters may serve as the base for mounting the signaling means of the present invention by drilling a hole in the canister wall and mounting at least one electrode to project into the activated charcoal compartment. However, other electrically conductive media may be used in place of activated charcoal, such as untreated carbon granules or metal particles. These would suffer from the disadvantage that they would not perform the sorbent function described above. As set forth above, chemical means for generating heat other than activated charcoal also could be employed as the electrically conductive medium, if upon melting of the wax, a sufficiently low resistance is presented to the flow of electricity to activate the alarm system.

The foregoing alarm system is illustrated with the electrode projecting through the top of the canister. It should be understood that such electrodes could also project through other portions of the canister housing where a single layer of activated charcoal carries the chemical means for generating heat and serves as the electrically conductive medium. With separate layers, the electrodes must project into the electrically conductive medium and be in thermal communication with the chemical means for generating heat. Referring to FIG. 2, the electrodes could project through the side wall of the canister adjacent to the activated charcoal. The thermal communication between the heat generated by the upper sorbent layer is provided by both layers of granular materials as well as the metallic wall of the canister.

The foregoing description relates to a chemical filter breathing apparatus of the chin canister type. However, it should be understood that the invention is applicable to larger canisters of both front and back mounted type. An audio alarm system is particularly beneficial for the chin-type or back-mounted canister because of the difficulty for the wearer of the gas mask to detect the visual warning signal.

When the alarm system is used in conjunction with a chemical filter breathing apparatus, it serves to warn the wearer of dangerously high levels of toxic gases beyond the capacity of the breathing apparatus. The exact threshhold level of toxic gases which will trigger the present alarm system is dependent upon a number of factors including the level of exothermic heat generated by the chemical means. However, it can be generalized that in many systems including those of the type described herein, such threshhold level is on the order of 1–4 percent toxic gas. Even this minimum level is beyond the capacity of the foregoing type of breathing apparatus, especially of the small chin-type canister.

The foregoing electrically actuated safety alarm system is described in terms of signaling means attached to a canister of a chemical filter breathing apparatus. The invention in its broadest aspect includes the use of the alarm system independently of the chemical filter breathing apparatus. In this case, of course, no facemask or passageway to the same is required. Instead, a simple canister of the general type used in the breathing apparatus is either independently constructed or the facemask portion is removed from the breathing apparatus. Otherwise, the alarm system is essentially the same as the one described above.

An independent alarm system of the foregoing type may be installed in any environment of potential toxic gas presence where people might gather or be near. It can be used to warn of a sudden massive leak or production of toxic gases to warn people to leave the area. For example, it could be employed in a chemical plant, coal mine, or the like. An audio alarm system is particularly effective to provide a warning in this type of environment.

It should be understood that it may require either a longer time or a higher concentration of toxic gases to activate the independent alarm system than would be required to activate the alarm system utilized in conjunction with the chemical filter breathing apparatus. This is because in the latter case the air and toxic gases are rapidly drawn past the chemical means for generat-

ing heat during lung inflation. This is to be contrasted with the stationary independent canister, say, mounted upon a wall of a chemical plant, which relies upon permeation of toxic gases in relatively stagnant air into the canister which contact the chemical means. It is apparent that a given level of toxic gases in the atmosphere will generate heat at a rate dependent upon the rate of contact with the chemical means.

To decrease the response time of the above independent alarm system in a stagnant atmosphere, an aspirator bulb or a pump can be used to draw the surrounding air (which may contain toxic gas) into the canister. For example, a small four-cylinder electric pump is capable of drawing a 1 percent carbon monoxide in air mixture into the canister at a rate of 4 liters per minute.

Referring to FIG. **5**, another embodiment of the invention of the general type set forth in FIG. **4**, is illustrated in compact form particularly suitable for use in limited space such as a flue or gas conduit or the like. Instead of a canister, the device includes a perforate cylindrical container **50** formed of an electrically conductive material such as a copper mesh screen. Electrode **51** extends into activated charcoal layer **52** and is rigidly mounted to container **50** with a layer **53** of a suitable electrically insulating adhesive such as epoxy resin as set forth above. Container **50** forms the other electrode. Signaling means is provided of the type set forth above and includes a housing **54.** Electrical leads **56** and **57** connect and are attached to electrode **51** and container **54**, respectively, to provide communication with the appropriate portion of the circuit in housing **54.** A coating **58** of the type set forth above is deposited on the surface of electrode **51.**

The embodiment of FIG. **5** is well adapted to placement in a conduit of flowing gas. The signaling means is remote from the conduit as in a central control panel. Also, the open mesh of container **50** exposes the chemical component of the system to the flowing gas more rapidly than in the generally solid canister. Furthermore, the container sizing can be small enough, (e.g., 1 inch diameter by 6 inch length), to fit in a confined space.

An independent alarm system of the type set forth in FIG. **5** is well adapted for mounting in a flue or conduit at the exit from an internal combustion engine, an oil refinery, a coal combustion operation, blast or open hearth furnace and the like for actuation of the alarm system upon sensing of toxic gases in excess of the predetermined level. It is particularly useful in the above environments for monitoring the completeness of combustion of the carbonaceous fuel.

The alarm system of the present invention is particularly economical because it can be utilized in conjunction with a canister for a conventional gas mask as of the type manufactured by MSA. For example, in a dual electrode system, the electrodes are mounted to the canister wall to contact the signaling means. Alternatively, in a single electrode system, only one electrode probe is mounted in the canister wall since the other electrode is provided by the canister wall itself. Whether the alarm system is used alone or in conjunction with the chemical filter breathing apparatus, the signaling means is readily mounted to a conventional canister used in such apparatus. Similarly, after the alarm system is triggered, the signaling means can be removed from the used canister and is reusable with fresh canisters. Also, the embodiment of the invention in which the container is a wire mesh basket or the like is inexpensive to construct.

In order to more clearly disclose the nature of the present invention, specific examples of its practice are herein given. It should be understood, however, that this is done by way of example and is not intended to limit the scope of the appended claims.

EXAMPLE 1

A chin-type canister having separate compartments for chemical means and activated charcoal was utilized. Specifically, the gas mask was of a GMC type manufactured by MSA with a chemical means in an upper compartment of soda lime mixture and a lower compartment of activated charcoal. A single copper probe coated with paraffin wax (melting point 53°–54°C) was inserted projecting through the soda lime and into the charcoal granules. The distance between the copper probe electrode and the side of the canister serving as the other electrode was on the order of 0.5 inches. The signaling means had an audio/visual signal of the type described herein. The toxic gas in the atmosphere was poisonous phosgene at a level of 0.2 percent by volume. The breathing rate of the wearer was about 20 liters of air per minute at 25°C. The wax melted and the audio/visual alarm was activated by the time the canister reached a temperature of about 57°C.

EXAMPLE 2

A chin-type gas mask canister of the GMP type manufactured by MSA was employed with the general construction of FIG. **1.** The only difference was that the charcoal layer was impregnated with copper chromate. A breathing rate of 15 liters per minute and a toxic gas level of 200 ppm was utilized in two different runs. In one run the toxic gas was hydrocyanic acid and in the other run was chloropicrin. Both gases generated highly exothermic reactions in a short time and activated the alarm.

The above experiments were repeated using a chin type gas mask canister of the GMR type also manufactured by MSA with the same results.

EXAMPLE 3

In this case, a type GMC-SS-1 gas mask canister manufactured by MSA was utilized. Middle and bottom layers of potassium iodide-impregnated charcoal were used with a top layer of soda lime. The apparatus was the same as that of Example 1.

A breathing rate of about 30 liters per minute was used for air including 1.5 percent of hydrogen sulfide at 25°C. After approximately 4 minutes, the canister heated to a temperature of about 68°C. By this time, the paraffin wax coating on the electrode melted and the electrical circuit was completed. The ohmic resistance dropped sharply from about 10^{10} ohms to about 10^{3} ohms. It was noted that the melted wax provided an adhesive for the bonding of a large number of carbon granules to the inserted metal probe. This phenomenon is believed to lower the resistance after wax is melted.

EXAMPLE 4

A canister of the type generally set forth in Example 1 used where there is a danger of carbon monoxide is used. The canister is type N manufactured by MSA which includes hopcalite as an upper layer serving as a catalyst to convert carbon monoxide to carbon dioxide

in the presence of air. The highly exothermic reaction with carbon monoxide rapidly raised the temperature of the canister to as high as 94°C in the presence of a gas mixture at the above breathing rate including 0.4 percent by volume carbon monoxide. Prior to reaching this temperature, the paraffin wax coating on the electrode has melted activating the audio/visual alarm.

EXAMPLE 5

A canister with a single layer of activated charcoal as illustrated in FIG. 1 was employed. The particular canister was a type GMA produced by MSA filled with activated charcoal granules (8–12 mesh). Carbon tetrachloride in air at a level of 2 percent by volume were inhaled at a breathing rate of about 25 liters per minute. After 8 minutes, the canister attained a temperature of about 75°C and the coating of paraffin wax melted to set off the alarm. The ohmic resistance dropped sharply from 10^9 ohms to approximately 10^3 ohms.

The above experiment was repeated except that the carbon tetrachloride was in an air stream of 85 percent relative humidity. The only difference in results was that the alarm was actuated at a slightly longer time, about 11 minutes.

EXAMPLE 6

Breathing tests were performed with a type N gas mask canister manufactured by MSA. In this case a dual copper electrode probe was utilized with the signaling means, both of which were coated with polyethylene wax. The electrodes were spaced about 0.5 inches apart. They projected through the hopcalite layer into the activated charcoal layer.

The warning system was utilized for the detection of about 0.6 percent by volume of carbon monoxide in an air mixture at a breathing rate of about 30 liters at room temperature. After about 20 minutes, the temperature of the canister reached about 90°C at which time the wax had melted. The ohmic resistance decreased from about 10^{10} ohms to about 10^3 ohms. This reduction was sufficient to activate the warning system.

EXAMPLE 7

The preceding experiment was repeated with the exception that the warning system was of a single electrode with the canister serving as the ground electrode. After about 20 minutes of inhalation, the metal canister reached the same temperature and the wax coating melted. The final ohmic resistance after melting was about 500 ohms.

EXAMPLE 8

A single inserted wax coated copper probe was utilized with a chin type GMP gas mask cartridge manufactured by MSA. A single layer of charcoal granules impregnated with copper chromate salts is employed. Gases such as methyl, ethyl or butyl or mercaptans and disulfides undergo exothermic oxidation-reduction reactions in the presence of the salts as they are sorbed by the activated charcoal. The temperature of this reaction is sufficient to melt the wax coating and thereby activates the warning system at a concentration of 0.3 percent by volume in air of the foregoing toxic gases.

EXAMPLE 9

An alarm system was employed including a single copper probe coated with wax (melting point 65°C) inserted into a lower layer of granular activated charcoal and an upper layer of hopcalite catalyst both layers being surrounded by a cylindrical copper ground screen. An audio alarm of the type described herein was employed. This alarm was used to detect a hazardous concentration of 1 percent by volume of carbon monoxide in stagnant air of 50 percent relative humidity. On exposure of the hopcalite to this carbon monoxide containing atmosphere for 14 minutes the canister reaches a temperature of 68°C and the wax melted. Thereafter, the activated charcoal granules (8–12 mesh size) made good electrical contact with the bare copper probe to activate the audio alarm.

To decrease this response time for the alarm, a small electric pump was attached to the canister. This pump forced the passage of the same gas through the hopcalite layer wherein a rapid exothermic reaction occurred. The response time to activate the audio signal was reduced to about 6 minutes.

EXAMPLE 10

An alarm system of the type set forth in Example 3 was placed within a four-inch internal diameter pipe or conduit through which a 0.3 percent by volume hydrogen sulfide in dry air was flowing at a rate of 20 liters per minute at 20°C. The paraffin wax used had a melting point of 65°C.

In order to simulate an emergency condition, the concentration of hydrogen sulfide in this flowing gas mixture was suddenly increased to a level of about 2 percent by volume. The reaction of this high level of hydrogen sulfide with the catalyst in the canister rapidly increased the canister temperature to 71°C in about 4 minutes. This melted the wax and activated the audio/visual alarm.

I claim:

1. In an electrically actuated safety alarm system for detecting and signaling the presence of a selected threshhold level of predetermined toxic gases, a container; electrode means in the form of spaced apart electrodes; an electrically conductive medium disposed in said container between said spaced apart electrodes; chemical means for generating substantial heat on contact with threshhold levels of the said predetermined toxic gases and disposed in said container in gaseous communication with the outside of the container and in thermal communication with at least one of said electrodes; an inert coating on at least said last named one electrode disposed in the region of said electrically conductive medium serving to provide an electrically insulating barrier against contact between said one electrode and said medium, said coating being characterized by high electrical resistance and a melting point no greater than the temperature of heat generated in said container by contact of said chemical means with a threshhold level of a predetermined toxic gas; signaling means connected in series with the electrodes and including means for generating a signal responsive to the melting of said coating whereby said resistance is substantially reduced.

2. An alarm system as in claim **1** in which said coating is a wax.

3. An alarm system as in claim **1** in which said signaling means includes audible sound generating means.

4. An alarm system as in claim **1** in which said signaling means includes a lamp.

5. An alarm system as in claim 1 in which said electrically conductive medium comprises a layer of granular material in the container.

6. An alarm system as in claim 5 in which said medium comprises carbon granules.

7. An alarm system as in claim 5 in which said electrically conductive layer and chemical means comprise activated charcoal.

8. An alarm system as in claim 5 in which said chemical means is deposited onto the granules of said electrical conductive layer.

9. An alarm system as in claim 5 together with a partition and wherein said chemical means comprises a layer of heat generating material separated by said partition from said electrically conductive layer.

10. An alarm system as in claim 5 in which said electrode means is in the form of one electrode extending into the electrically conductive layer and the other electrode in the form of a body with the electrically conductive layer disposed in the body.

11. An alarm system as in claim 5 in which said electrodes comprise two spaced apart probes extending into the electrically conductive layer.

12. An alarm system as in claim 1 in which said signaling means is detachable from said container.

13. In a chemical filter breathing apparatus with electrically actuated safety alarm system for detecting and signaling the presence of a selected threshhold level of predetermined toxic gases, a facemask; a container with a gas passageway between the surroundings and the facemask; electrode means in the form of spaced apart electrodes; electrically conductive medium disposed in said container between said spaced apart electrodes, chemical means for sorbing the predetermined toxic gases and for generating heat on contact with threshhold levels of said predetermined toxic gases, said chemical means being disposed in said container passageway and in thermal communication with at least one of said electrodes; an inert coating on at least said last named one electrode disposed in the region of said electrically conductive medium serving to provide a barrier against contact between said one electrode and the electrically conductive medium, said coating being characterized by high electrical resistance and a melting point less than the temperature of heat generated in said container by contact of said chemical means with a threshhold level of the predetermined toxic gas in the container passageway; signaling means connected in series with the electrodes and including means for generating a signal responsive to the melting of said coating whereby the resistance between electrodes is substantially reduced.

14. A chemical filter breathing apparatus as in claim 13 in which said coating is a wax.

15. A chemical filter breathing apparatus as in claim 13 in which said signaling means includes audible sound generating means.

16. A chemical filter breathing apparatus as in claim 13 in which said electrically conductive medium comprises a layer of carbon granular material in the canister.

17. A chemical filter breathing apparatus as in claim 16 in which said carbon granules and chemical means comprise activated charcoal.

18. A chemical filter breathing apparatus as in claim 16 in which said chemical means is deposited onto the carbon granules.

19. A chemical filter breathing apparatus as in claim 16 together with a partition and wherein said chemical means comprises a layer of heat generating material separated by said partition from said carbon granules.

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