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(19)



(54) METHOD OF OBTAINING FIRE ALARM SIGNAL AND-FIRE ALARM APPARATUS

(71) We, CERBERUS AG, a Swiss Company of CH-8708, Mannedorf, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to sensing and indicating the presence of a fire, and more particularly to apparatus arranged to indicate the presence of a fire reliably, while rejecting at least a majority of spurious responses, which might lead to false alarms. Specifically, the present invention relates to a method to reliably detect a fire, and to apparatus to carry out the method, in which electrical signals are processed.

Fire alarm systems in which an alarm signal is generated as soon as a characteristic of a fire exceeds a certain threshold value are known. Various types of fire sensors respond, specifically, to certain characteristics of fires. Difficulties arise when such fire sensors are used in rooms, or spaces in which the specific characteristic of the fire may occur for a short period of time, intermittently, or in pulses, without a fire actually being present. One such sensor uses smoke as the sensing characteristic. In offices, garages, automotive repair shops, and the like, smoke may arise, intermittently, without a fire actually being present. Fire sensors installed in such locations may provide false alarms. It has been attempted to avoid the undesirable influence of such pulsed smoke on the sensors by introducing a time delay, either mechanically, or electrically. A mechanical time delay can be introduced by partly masking, or interfering with the accessibility of a measuring chamber of the fire sensor to the ambient air, for example by means of covers, shrouds, or the like. Time delays can also be introduced electrically by electrically delaying a signal derived from the sensor. Delaying the response of the sensor has the result that the threshold value of the response circuit connected to the sensor

will be reached only after a predetermined time corresponding to the delay time.

Interfering with free air circulation as a way to introduce a time delay has a decided disadvantage. Slowly developing fires such as smouldering fires are sensed only with difficulty, or poorly. Usually, therefore, the second solution has been used, that is, a signal derived from the sensor is delayed in time. Disturbances due to single, short-time smoke pulses, which might have led to a false alarm, can be avoided by this solution. If, however, sequential smoke pulses follow each other in relatively short periods of time, the known fire sensors and systems will integrate the signal, and an average value will result which may well be above the alarm threshold of the response circuit so that a false alarm is triggered, although with delay. Sequential smoke pulses are frequent in actual practice, for example, due to heavy smoking by various people in a small space.

It is an object of the present invention to provide a fire alarm system and method, in which false alarms are essentially avoided although the sensors may be subjected to pulsed influences, characteristic of fires, and to which the sensors can respond.

According to the present invention there is provided a method for obtaining an alarm signal denotive of the presence of a fire which comprises generating an electric signal indicative of fire, providing a first signal representative of the amount by which the fire indicative signal exceeds a first threshold level, integrating may increase in the level of said first signal with a first integration time constant, and integrating any decrease in the level of the first signal with a second integration time constant which is smaller than said first integration time constant, detecting when the integrated signal reaches a second threshold value, and thereupon providing an alarm signal.

The invention also provides a fire alarm apparatus comprising fire sensing means arranged to provide an output signal indicative

of the occurrence of a fire to a first threshold detector arranged to provide a first signal representative of the excess of the fire-indicative signal above a first threshold, an asymmetrical integrator arranged to integrate any increase in the first threshold signal with the first integrating time constant (RC) and to any decrease in the first signal with a second integrating time constant which is smaller than said first time constant and a second threshold detector arranged to sense when the integrated signal has reached a second threshold level and thereupon to provide an alarm output.

In accordance with a feature of the invention, the system includes an integrator which has a diode in its integrating circuit so poled that it is blocked when a rising signal is applied thereto, so that the time constant of the integrator will be determined by circuit parameters other than the diode and, for decreasing input signals, the diode becomes conductive to provide a low resistance, short time constant discharge path for the integrating capacitor of the integrator.

The invention will be further described by way of example with reference to the accompanying drawings, wherein:

Figure 1 is a highly schematic diagram of one embodiment of fire alarm apparatus in accordance with the present invention; and

Figure 2 is a series of graphs illustrating the operation of the circuit of Figure 1, and the method in accordance with the present invention.

The fire alarm sensor selected for the example is an ionization-type fire sensor. Referring to the circuit of Figure 1, an ionization chamber 1, acting as the fire sensor, is connected in series with a reference chamber 2. The ionization chamber 1 can be referred to as the sensing chamber, and is accessible to the external, ambient atmosphere. Chambers 1, 2 are series connected between conductors connected to supply terminals 3, 4. At the junction 5 between the chambers 1, 2 there will arise a voltage which changes continuously as the smoke or aerosol concentration in the sensing chamber 1 changes. This voltage is applied to a threshold detector 6. The threshold detector 6 will provide an output signal only if the input applied to it from junction 5, exceeds a certain threshold value. The output from threshold detector 6 is applied to an integrator 1, which includes a resistor 7, having a resistance value r . The voltage across resistor 7 is applied to capacitor 8 by way of a resistor 9, which has a resistance R . The capacitor 8 is thus charged with a time constant of RC , in which C is the capacitance of capacitor 8. When the voltage across capacitor 8 reaches the alarm threshold of a second threshold detector 10, to which it is connected, threshold detector 10 will generate an alarm signal. The time required after the first threshold detector 6 provided an output signal exceeding its first threshold value

before the second threshold detector provides an alarm is determined by the time constant of the R/C circuit determined by register 9 and capacitor 8. This is the alarm delay time.

A diode 11 is connected in parallel with resistor 9. The diode 11 is so poled that the voltage across capacitor 8 can discharge through the diode. As soon as the voltage from the first threshold detector 6 drops, and specifically when the signal from the sensor drops below the threshold level of the first threshold detector 6, capacitor 8 can discharge through diode 11. This discharge will occur with the time constant rC , in which the time constant of the discharge circuit is governed by the resistance value of resistor 7 and the capacitance of capacitor 8. Resistor 7 is selected to be substantially less than resistor 9. Thus the rate at which the capacitor discharges when the signal from the sensor disappears will be much faster than the rate of charge build-up on the capacitor 8 when the first threshold level is exceeded.

The operation of the circuit is best seen by reference to Figure 2, in which also curves showing the operation of known systems are illustrated. Curve S is indicative of separate smoke pulses which, for example, may arise in an office in the presence of heavy smokers. Similar pulses may arise in an automobile garage. Clearly, no fire is present, and the pulses are essentially disturbance pulses. In case of a fire, there would be a continuous increase in smoke concentration.

A simple fire alarm sensor, without time delay, will provide an alarm when the first smoke pulse exceeds the alarm threshold, as indicated at A_0 , and as shown on curve S. A known fire sensor with time delay would have different characteristics; in accordance with curve V, the voltage at the input to the threshold detector would, first, increase slowly; after termination of the pulse S, the voltage would drop slowly, with the same time constant. As can be seen by consideration of curve V, several sequential smoke pulses would, eventually, cause the level of the signal to rise until, finally, the alarm threshold is exceeded, providing a false alarm, as indicated at A_1 .

A fire sensor in accordance with the present invention, under conditions of smoke pulses, would provide signals as shown in curve B. Upon sensing of the first smoke pulse, the input voltage to the second threshold detector would follow curve B, and rise. After the smoke pulse stops, however, the curve drops rapidly, that is, with a short time constant. Thus, although sequential smoke pulses occur, following each other rapidly, the voltage at the input to the second threshold detector cannot build up, or accrete, and reach the alarm threshold. After each smoke pulse, the voltage of the integrator, that is, across capacitor 8, again drops practically to zero or null. Thus, false alarms due to sequential smoke pulses are avoided. A real fire which persists would, however, cause

continuous charge of the integrating capacitor, as seen in curve C. An alarm will be given when the threshold level of the first threshold detector has been exceeded by the duration of the desired delay time, that is, at A_2 .

Experience has shown that false alarms can be avoided if the second time constant, that is, the discharge time constant, is less than the time constant of the first, or charge circuit by a factor of 10, at least. A typical example would be:

RC : 30 seconds; rC : 1 second.

These time periods are not critical; the charge time, that is, the RC time constant may be in the range from 10 to 60 seconds; the discharge time constant, rC, may be in the range from 0.1 to 5 seconds, the two respective time constants having a relationship of 1 to 10, at least.

Various types of fire sensors may be used, and the present invention is not limited to ionization-type sensors, with which it has been described. The fire sensors may be responsive to other parameters than smoke, for example combustion gases, or other indicia of fire, and suitable sensors of known types may be used. Various changes and modifications may be made within the scope of the inventive concept.

WHAT WE CLAIM IS:-

1. A method for obtaining an alarm signal denotive of the presence of a fire which comprises generating an electric signal indicative of fire, providing a first signal representative of the amount by which the fire indicative signal exceeds a first threshold level, integrating any increase in the level of said first signal with a first integration time constant, and integrating any decrease in the level of the first signal with a second integration time constant which is smaller than said first integration time constant, detecting when the integrated signal reaches a second threshold value, and thereupon providing an alarm signal.

2. A method in accordance with claim 1, wherein the first and second time constants differ at least by a factor of 10.

3. A method in accordance with claim 1, wherein the first time constant is in the range 10-60 seconds and the second time constant in the range 0.1-5 seconds.

4. A fire alarm apparatus comprising fire sensing means arranged to provide an output signal indicative of the occurrence of a fire to a first threshold detector arranged to provide a first signal representative of the excess of the fire-indicative signal above a first threshold, an asymmetrical integrator arranged to integrate any increase in the first threshold signal with a first integrating time constant (RC) and to any decrease in the first signal with a second integrating time constant which is smaller than said first time constant and a second threshold detector arranged to sense when the integrated signal has reached a second threshold level and thereupon to provide an alarm output.

5. Apparatus in accordance with claim 4, wherein the fire sensing means comprises an ionization chamber, in which the ion current changes in response to the presence of smoke or fire aerosols therein.

6. Apparatus in accordance with claim 5 and further comprising a resistance means connected in series with the ionization chamber, the voltage drop across the ionization chamber forming the fire-indicative output signal.

7. Apparatus in accordance with claim 4, wherein the integrator comprises a capacitor and a resistor connected to charge the capacitor, said first signal being connected through the resistor to charge the capacitor.

8. Apparatus in accordance with claim 7 and further comprising a diode connected in parallel to the resistor to charge the capacitor, and poled oppositely to the polarity of said first signal applied to charge the capacitor, so as to permit rapid discharge of the capacitor upon cessation of said signal.

9. Apparatus in accordance with claim 4, wherein the integrator comprises a capacitor, a first resistor connected between the output of the first threshold detector and one terminal of the capacitor, and a second resistor connected between the output of the first threshold detector and the other terminal of the capacitor, and a diode connected in parallel to the first resistor and poled to prevent signals from the first threshold detector from charging the capacitor so that said signals flow through the first resistor, but to pass discharge current from the capacitor and permit discharge of the capacitor through the second resistor, the resistance value of said second resistor being small with respect to the resistance value of said first resistor, the second threshold detector being connected across the capacitor and providing an alarm signal when the charge across the capacitor reaches the second threshold level.

10. Apparatus in accordance with claim 9, wherein the relative values of resistance of said first resistor and said second resistor are selected to provide a charge time constant of the first resistor - capacitor R/C circuit which is at least ten times the discharge time constant of the R/C circuit formed of the second resistor and the capacitor.

11. Apparatus in accordance with claim 4, wherein the integrator comprises a first timing circuit having a time constant in the order of 10-60 seconds, a second timing circuit having a time constant in the order of 0.1-5 seconds, and a diode connected and poled in the integrator to render the timing circuit with the shorter time constant effective upon decrease of the signal applied to the integrator, thereby to provide asymmetrical integration of increasing and decreasing signals exceeding the first threshold level.

12. Fire alarm apparatus substantially as described with reference to the drawings.



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continuous charge of the integrating capacitor, as seen in curve C. An alarm will be given when the threshold level of the first threshold detector has been exceeded by the duration of the desired delay time, that is, at A_2 .

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2. A method in accordance with claim 1, wherein the first and second time constants differ at least by a factor of 10.

3. A method in accordance with claim 1, wherein the first time constant is in the range 10-60 seconds and the second time constant in the range 0.1-5 seconds.

4. A fire alarm apparatus comprising fire sensing means arranged to provide an output signal indicative of the occurrence of a fire to a first threshold detector arranged to provide a first signal representative of the excess of the fire-indicative signal above a first threshold, an asymmetrical integrator arranged to integrate any increase in the first threshold signal with a first integrating time constant (RC) and to any decrease in the first signal with a second integrating time constant which is smaller than said first time constant and a second threshold detector arranged to sense when the integrated signal has reached a second threshold level and thereupon to provide an alarm output.

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10. Apparatus in accordance with claim 9, wherein the relative values of resistance of said first resistor and said second resistor are selected to provide a charge time constant of the first resistor - capacitor R/C circuit which is at least ten times the discharge time constant of the R/C circuit formed of the second resistor and the capacitor.

11. Apparatus in accordance with claim 4, wherein the integrator comprises a first timing circuit having a time constant in the order of 10-60 seconds, a second timing circuit having a time constant in the order of 0.1-5 seconds, and a diode connected and poled in the integrator to render the timing circuit with the shorter time constant effective upon decrease of the signal applied to the integrator, thereby to provide asymmetrical integration of increasing and decreasing signals exceeding the first threshold level.

12. Fire alarm apparatus substantially as described with reference to the drawings.

13. A method for obtaining an alarm signal denotive of the presence of a fire substantially as described with reference to the drawings.

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