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Tice et al.

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(54) **MULTI-SENSOR DETECTOR**

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(51) **Int. Cl.**[7] **G08B 29/00**

(52) **U.S. Cl.** **340/506**; 340/511; 340/517; 340/522; 340/541; 340/508; 340/521

(58) **Field of Search** 340/506, 507, 340/508, 517, 541, 521, 565, 522

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(57) **ABSTRACT**

A multi-function detector has at least two different sensors coupled to a control circuit. In a normal operating mode the control circuit, which could include a programmed processor, processes outputs from both sensors to evaluate if a predetermined condition is present in the environment adjacent to the detector. In this mode the detector exhibits a predetermined sensitivity. In response to a failure of one of the sensors, the control circuit processes the output of the remaining operational sensor or sensors so that the detector will continue to evaluate the condition of the environment with substantially the same sensitivity.

57 Claims, 3 Drawing Sheets

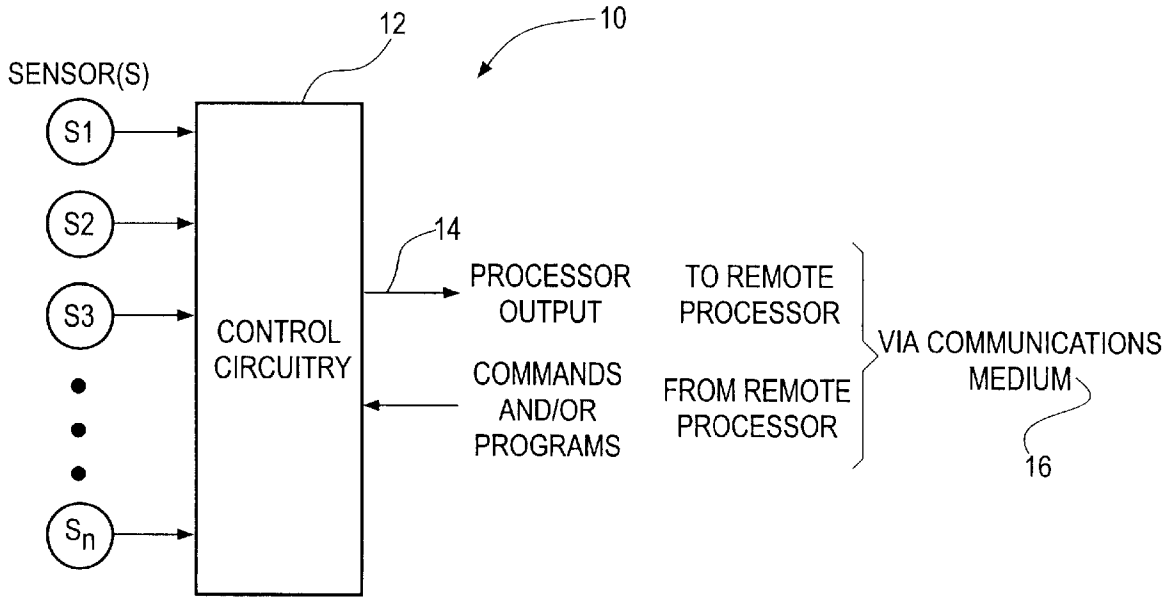


FIG. 1

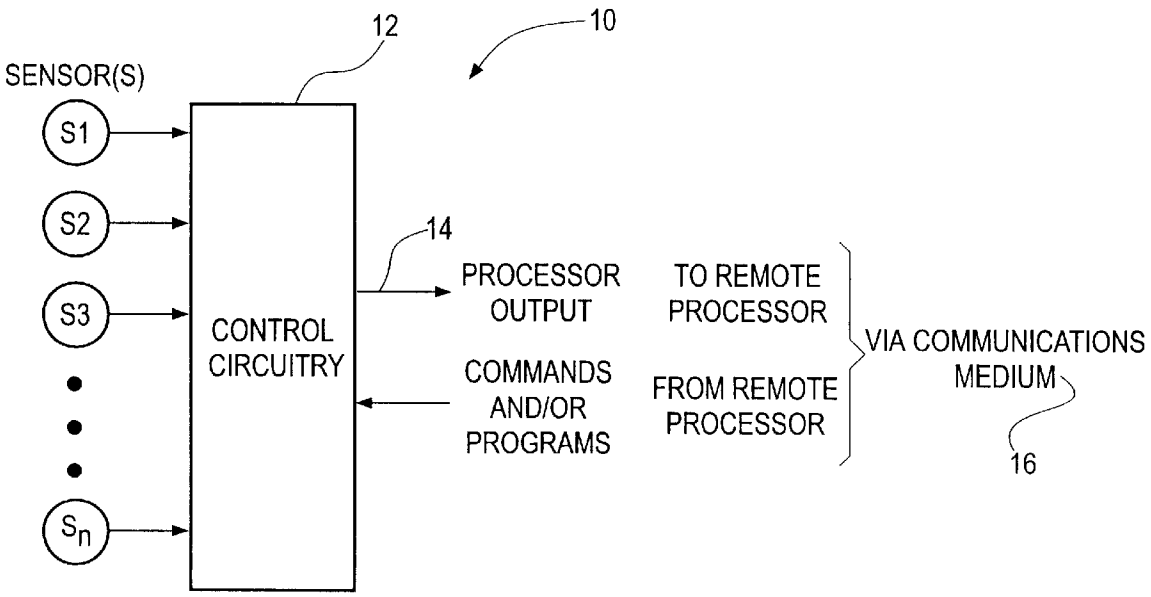


FIG. 2

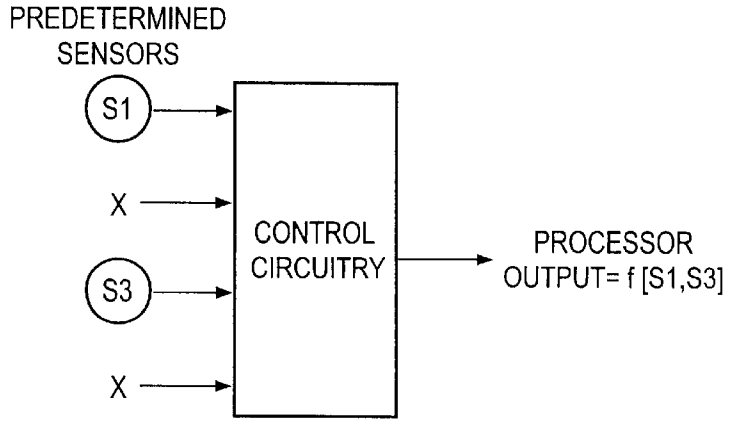


FIG. 3

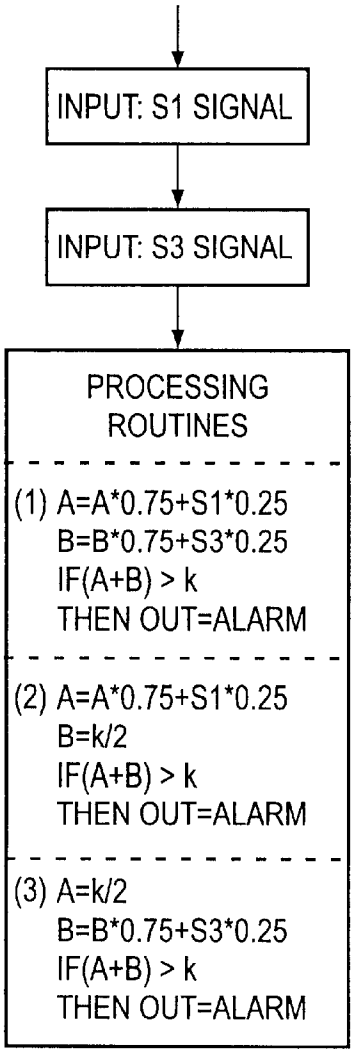


FIG. 4

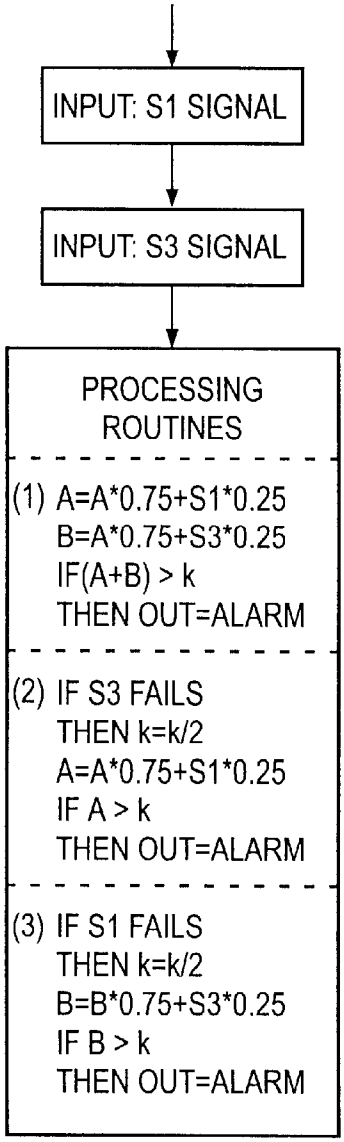


FIG. 5

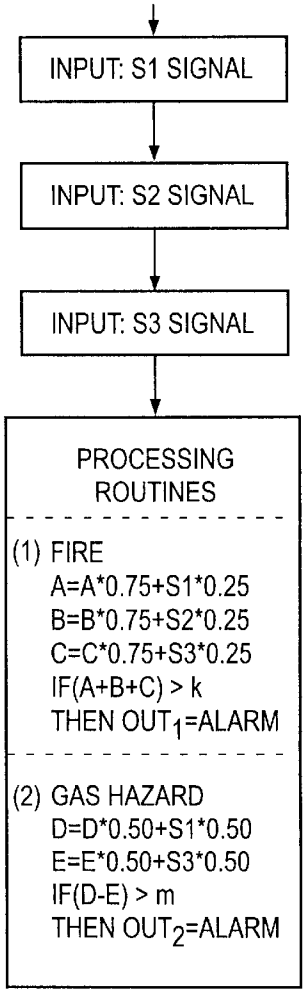
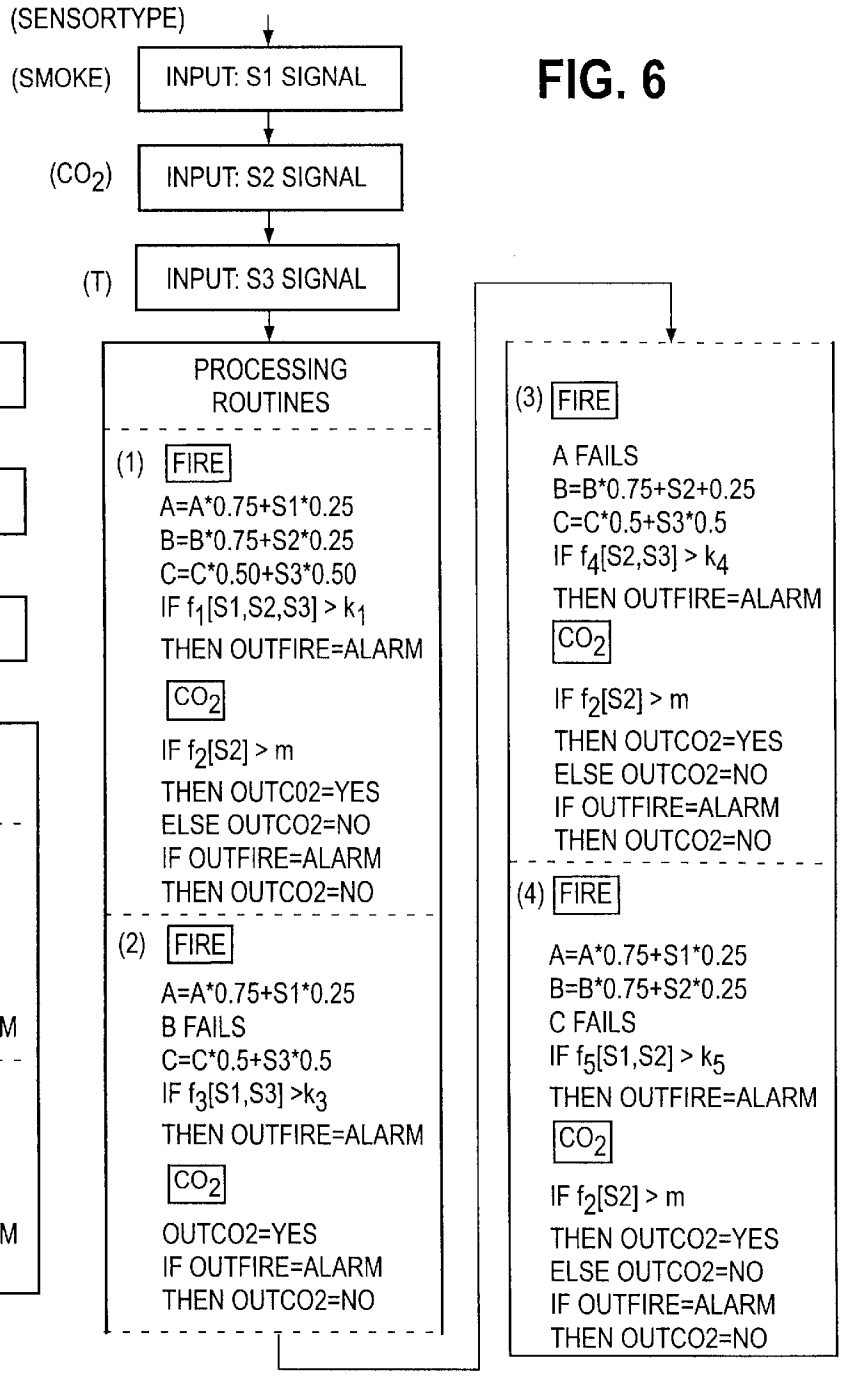


FIG. 6



MULTI-SENSOR DETECTOR

FIELD OF THE INVENTION

The invention pertains to ambient condition detectors. More particularly, the invention pertains to such detectors which incorporate multiple sensors and processing circuitry and which exhibit improved operational characteristics in the presence of sensor failure.

BACKGROUND OF THE INVENTION

Known ambient condition detectors include one or more condition sensors. Representative sensors include smoke, heat and gas sensors.

In some detectors outputs from the respective sensors are processed substantially independently for purposes of determining if a predetermined condition, to which a respective sensor is responding, meets a selected alarm criteria. In other detectors, outputs from multiple sensors are taken into account in alarm determination processing.

In those detectors where alarm determinations are made in response to single sensor processing, a failure of one sensor will not necessarily affect processing of output signals from the other sensor. On the other hand, while multi-sensor processing can potentially provide the benefit of more complex, multi-input processing, loss of the output from one of the sensors, in known detectors, may result in a loss of sensitivity.

Known prior art detectors that process sensor outputs in parallel and independently may have several software routines operating in parallel, one of which is a safety or bypass routine if a sensor fails. The first routine to determine an alarm condition generates an alarm indicating output. These routines are fixed and operate without change. They do not adjust themselves to compensate for the loss of a sensor. More specifically, these routines do not make automatic adjustments to maintain sensitivity when a sensor fails but rather have failure mode sensitivities less sensitive than the normal mode sensitivities. A trouble indication is given by these detectors whenever a sensor fails so the less sensitive operating mode during trouble is tolerated. However, in many cases, this trouble mode may not be serviced in a timely manner and the fire protection is not optimum during the time frame between failure and servicing.

There are also prior art detectors that have more than one sensor and provide different audible sounds as a local warning. For example, some devices combine a smoke detector and a CO detector and give separate sounds locally at the device indicative of the type of detector responding. However, these devices do not transmit that information into a system and use this information for controlling other processes or functions such as ventilation, lighting, heating, security, etc.

It would be desirable if the advantages of multi-sensor processing could be provided with minimal sensitivity losses due to sensor failure. Preferably, substantially constant sensitivity could be provided even where a sensor fails. It would be most desirable if such functionality could be provided without significantly increasing detector complexity or cost.

SUMMARY OF THE INVENTION

An ambient condition detector includes two or more sensors. Each sensor is coupled to a control circuit. The control circuit could, in one embodiment, be implement, at least in part, using integrated circuits including a programmed processor.

In one aspect of the invention, the sensors could respond to indicia of fire such as smoke, heat or gas, such as carbon monoxide. The control circuit processes the sensors' outputs to evaluate if a fire condition exists. Depending on the type of sensors used, other conditions can be sensed and evaluated. The selected sensors in combination with the processing result in a detector that has a characteristic sensitivity.

In yet another aspect of the invention, the characteristic sensitivity can be substantially maintained even if one of the sensors ceases functioning properly. In this embodiment, in response to a sensor failure the control circuitry processes the outputs from the remaining sensors so as to continue to maintain the same sensitivity.

Numerous other advantages and features of the present invention will become readily apparent from the following detailed description of the invention and the embodiments thereof, from the claims and from the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** illustrates a block diagram of a multiple sensor detector in accordance with the present invention;

FIG. **2** illustrates the detector of FIG. **1** configured with selected sensors;

FIG. **3** is a flow diagram of several different processing routines executable by the detector of FIG. **2**;

FIG. **4** illustrates a flow diagram of alternate processing that takes into account a failure of a sensor;

FIG. **5** illustrates processing routines executable by the detector of FIG. **1**; and

FIG. **6** illustrates alternate processing routines executable by the detector of FIG. **1**.

DETAILED DESCRIPTION

While this invention is susceptible of embodiment in many different forms, there are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

FIG. **1** illustrates an ambient condition detector **10** that incorporates multiple sensors **S1**, **S2**, **S3**, through SN. Outputs from one or more of these sensors can be processed by control circuitry **12** to produce one or more processed outputs indicative of the one or more ambient conditions to be detected. These outputs **14** can be transmitted to a remote processor via a communications medium **16**. Medium **16** can be hardwired or wireless.

The control circuitry may incorporate a plurality of processing routines and may be constructed with discrete circuitry, custom integrated circuits, processors, or the like. As illustrated in FIG. **2**, one or more of the sensors **S1**, **S2** . . . Sn can be selected depending on each different ambient condition desired to be detected. When different sensors are selected, then such as **S1**, **S3**, respective processing routines are also selected and executed.

Sensor selection can be implemented locally at the detector **10** at installation or when convenient. Selection can be by hardwired circuitry at the detector **10** or via software preloaded into the control circuitry **12**. Alternately, commands and/or selection programs can be downloaded from a remote processor via the medium **16**.

The sensors can include without limitation smoke, particle, gas, temperature, light, sound, security, or other

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