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(54) HARDWIRED ALARM SYSTEM WITH POWER-ON SEQUENCE

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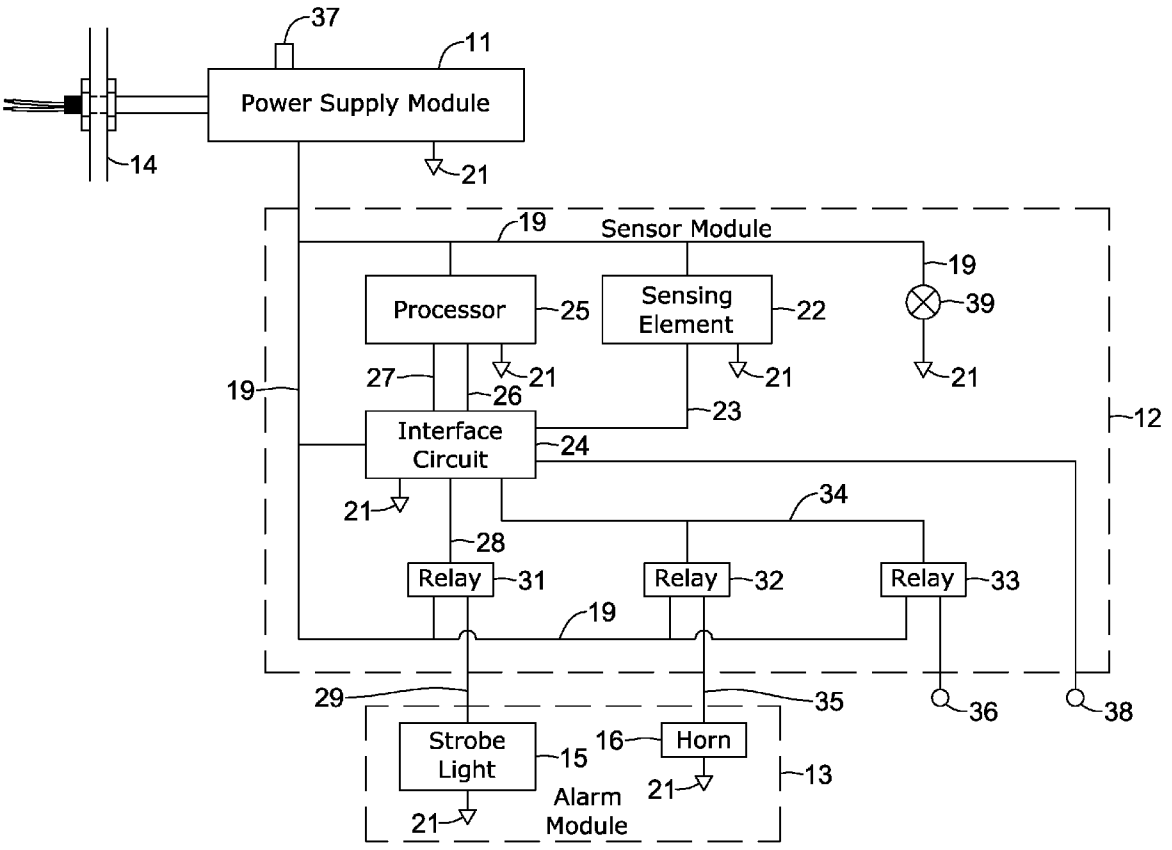
(57) **ABSTRACT**

A sensor and alarm system having a power-on sequence. The system has a power supply permanently-like connected to a power line of a facility. There may be a power interrupt to the power supply, which may initiate a power-on sequence of alarms. The sequence of alarms may indicate whether the system is wired properly and operating normally. If the sequence does not occur in a pattern as expected, then there may be a problem with the system. Also, the sensor portion of the system may set off an alarm pattern if a sensed gas has a concentration greater than a first magnitude. The system may set off another alarm pattern if a sensed gas has a concentration greater than a second magnitude. If a sensing element of the sensor portion goes out of calibration, then the system may set off still another alarm pattern.



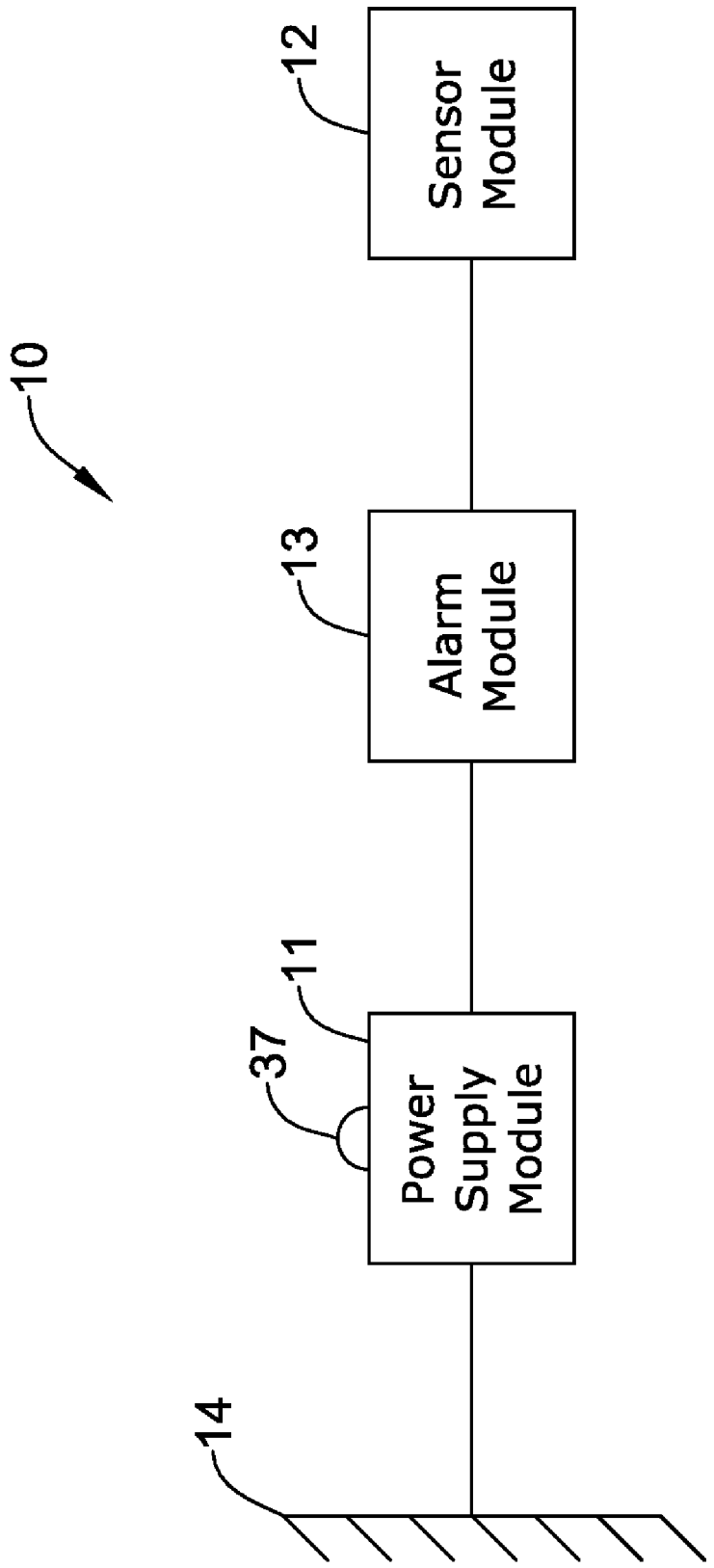

10
12
Sensor Module
13
Alarm Module
11
37
Power Supply Module
14

Figure 1

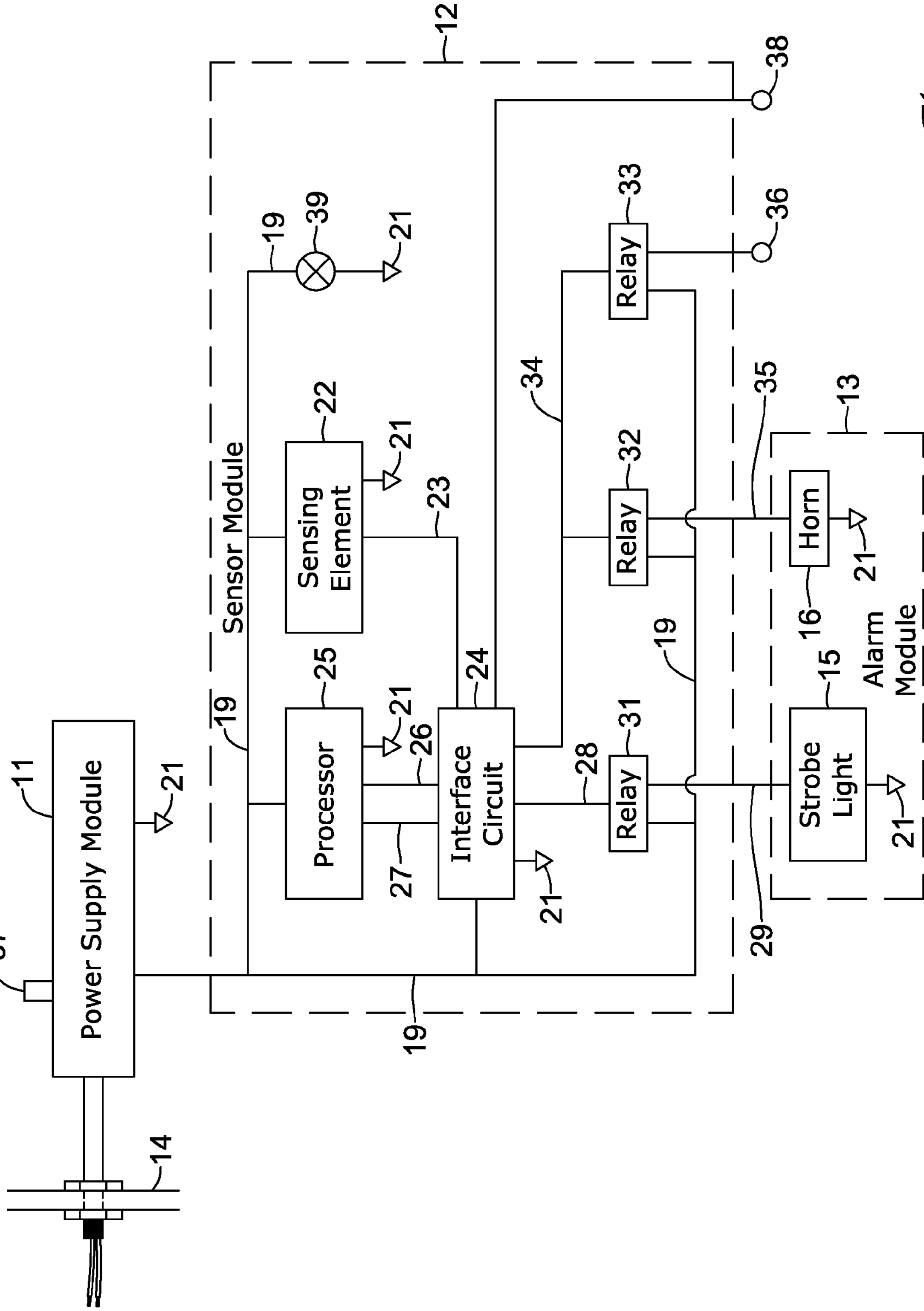

Power Supply Module
Sensor Module
Sensing Element
Processor
Interface Circuit
Relay
Relay
Relay
Horn
Strobe Light
Alarm Module
11
12
13
14
15
16
19
21
22
23
24
25
26
27
28
29
31
32
33
34
35
36
37
38
39

Figure 2

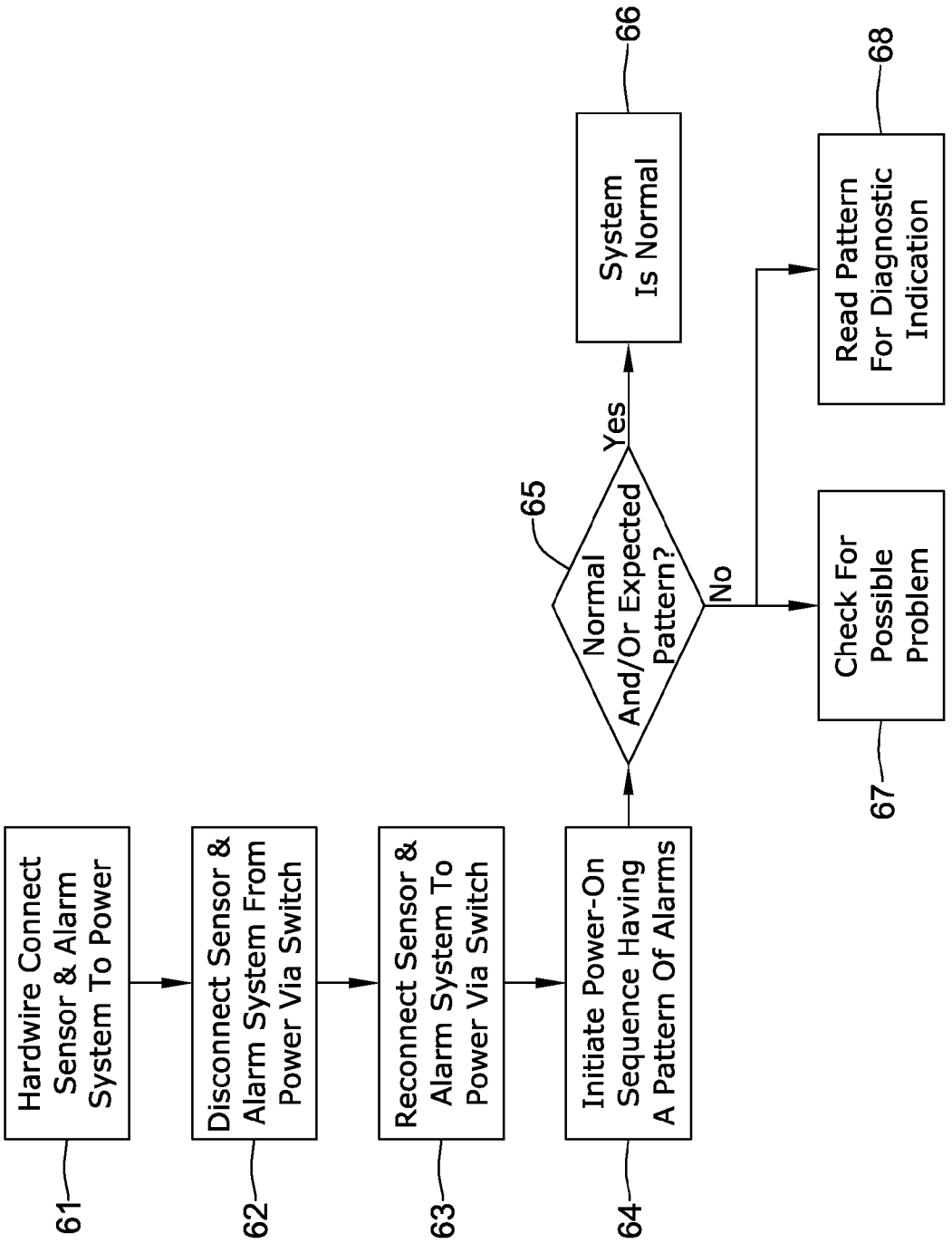

Hardwire Connect Sensor & Alarm System To Power
61
Disconnect Sensor & Alarm System From Power Via Switch
62
Reconnect Sensor & Alarm System To Power Via Switch
63
Initiate Power-On Sequence Having A Pattern Of Alarms
64
Normal And/Or Expected Pattern?
65
Yes
System Is Normal
66
No
Check For Possible Problem
67
Read Pattern For Diagnostic Indication
68

Figure 3

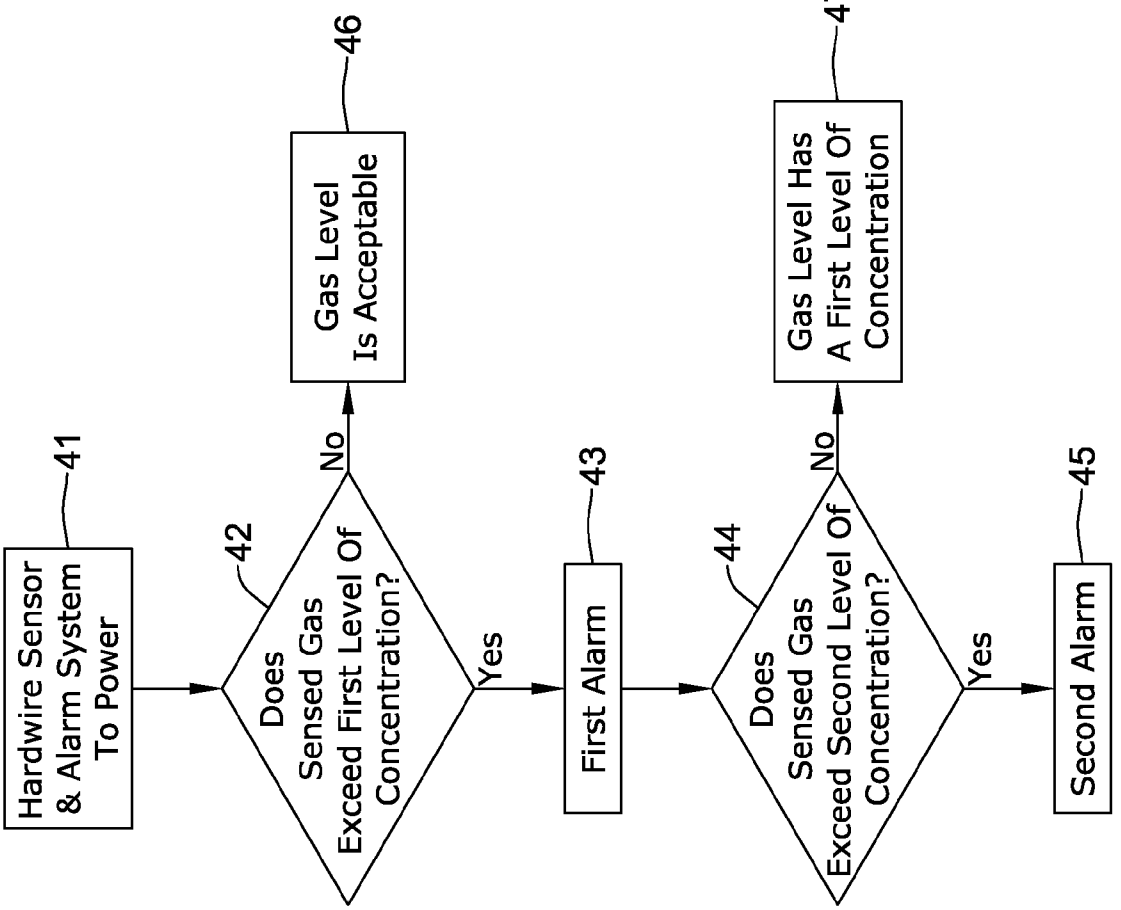

Hardwire Sensor & Alarm System To Power
41
Does Sensed Gas Exceed First Level Of Concentration?
42
No
Yes
Gas Level Is Acceptable
46
First Alarm
43
Does Sensed Gas Exceed Second Level Of Concentration?
44
No
Yes
Gas Level Has A First Level Of Concentration
47
Second Alarm
45

Figure 4

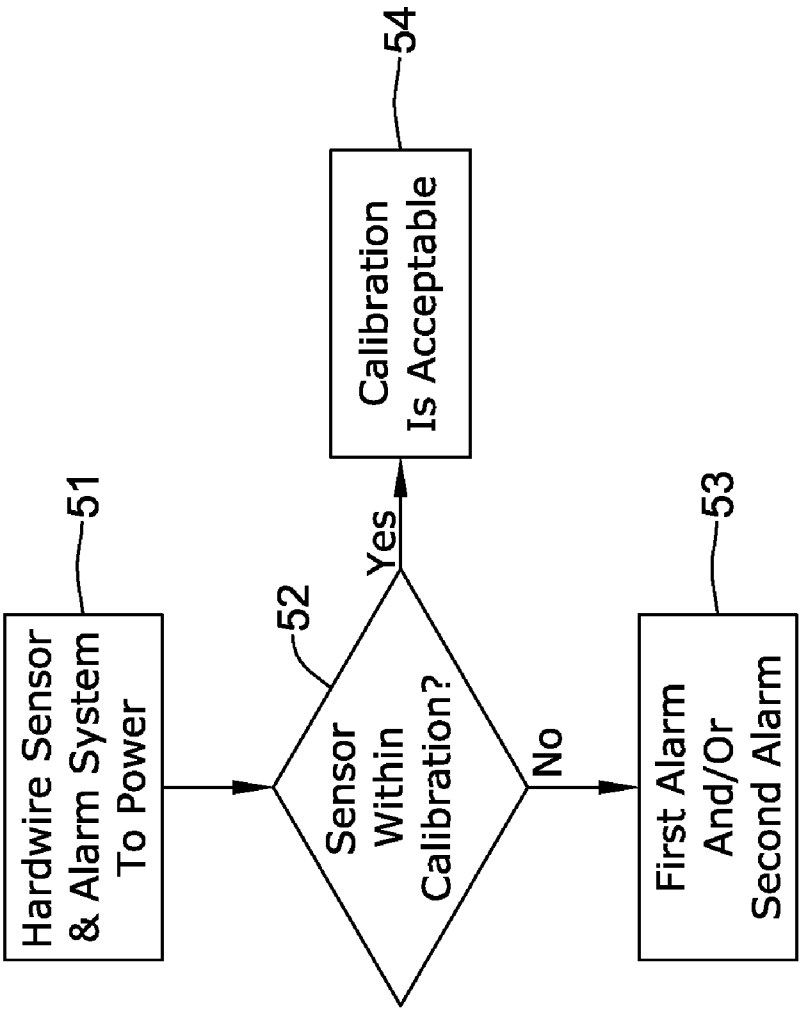

Hardwire Sensor & Alarm System To Power
51
Sensor Within Calibration?
52
Yes
No
Calibration Is Acceptable
54
First Alarm And/Or Second Alarm
53

Figure 5

HARDWIRED ALARM SYSTEM WITH POWER-ON SEQUENCE

BACKGROUND

[0001] The present invention pertains to alarms and particularly to alarms connected to room air sensors. More particularly, the invention pertains to alarms with an operational test sequence.

SUMMARY

[0002] The invention is an air sensor alarm system having a power interrupt and a power-on sequence for verifying satisfactory operation.

BRIEF DESCRIPTION OF THE DRAWING

[0003] FIG. **1** is a block diagram of an alarm equipped gas sensor;

[0004] FIG. **2** is a diagram of an illustrative example of the alarm system shown in FIG. **1**;

[0005] FIG. **3** is a diagram of a power-on sequence approach of the system;

[0006] FIG. **4** shows a level of gas concentration approach of the system; and

[0007] FIG. **5** reveals a sensing element calibration warning aspect of the system.

DESCRIPTION

[0008] FIG. **1** shows a block diagram of a sensor system **10**. A power supply **11** may be connected permanently to power of a structure (e.g., building) **14** where the system is situated. A permanent power connection for system **10** may require installation of an appropriate junction box. System **10** may be designed to be non-pluggable in an outlet and have no non-permanent electrical power connection easy to disconnect. Power may be provided from supply **11** to a sensor **12** and an alarm **13**. The wire connections may be made at or in the alarm or alarm module **13**. System **10** may have a combination of more than one sensor **12** and/or more than one alarm **13**.

[0009] FIG. **2** shows an illustrative example of the gas alarm system **10** having the power supply **11**, the sensor **12**, and a strobe light **15** and a horn **16** for the alarm **13**. The strobe light **15** may provide about 30 or more flashes of white light per minute. The brightness and strobe rate of light alarm **15** may be adjusted. The alarm **16** may emit a sound of about 75 dB. The loudness or intensity and type of sound from alarm **16** may be adjusted. The sound may be electronically synthesized. The visual and audio alarms may be other kinds of indications besides those illustratively shown as examples.

[0010] For security against tampering, the power supply or power supply module **11** may be permanently and/or hardwired to live power of the building or structure **14**. The sensor or sensor module **12** may be for sensing CO_2 or another gas. Alarms may include other kinds of devices such as annunciators, telephone calls, alert communications, and the like. System **10** may be used as a stand-alone system or be tied in with a building automation system.

[0011] An illustrative example of the invention may be described herein to show the elements of the system **10**. The example system **10** described herein uses certain kinds of components for illustrative purposes; however, some of these components may be replaced with other kinds but equivalent types of components. The present example system **10** may be a CO_2 alarm system in a space that alerts occupants of high levels of CO_2 or another gas which may be hazardous to their health. Places where the alarm system **10** may be used include carbonated beverage dispensing areas, manufacturing plants, chemical laboratories, supermarkets, and so on.

[0012] The power supply module **11** may have a combination of a transformer, switch, rectifier, regulator, filter, controller and/or other components. For instance, a current mode controller model ICE2B265 along with associated circuitry may be implemented as part of the power supply module **11**. Such device may be available from Infineon Technologies AG. An input of module **11** may 240/120 VAC. An output of module **11** may be about 12 VDC across line **19** and ground **21**. The input and output may be another voltage according to the power supply design of module **11**.

[0013] The sensor module **12** may have a sensing element **22** for detecting various levels of a gas such as CO_2. Element **22** may be a non-dispersive infrared (NDIR) sensing device. An output line **23** of sensing **22** may have an analog signal indicating a magnitude of a sensed gas, such as the CO_2. Line **23** may be connected to an interface circuit **24**. Circuit **24** may convert the analog signal on line **24** to a digital signal which is sent to a digital processor **25** on line **26** for processing and evaluation. Signals resulting from the processing may be sent to circuit **24** on line **27**. Circuit **24** may convert the signal from processor **25** to an analog signal. Processor **25** may have software to provide an appropriate signal or signals for alarms, indicators and/or the like. The analog signal in circuit **24** may be processed, amplified and/or converted, as needed, and sent via line **28** for actuating relays **31** and/or relays **32** and **33**. The relays may instead be some other kind of actuated switch, such a solid state device. One may note that the voltage on line **19** may be provided to power sensing element **22**, interface circuit **24** and processor **25**. Module **13** may have additional alarms of the same or other kinds, having various durations, for exhibiting a particular pattern or patterns. Such alarms may be simultaneous and/or separate and exhibit patterns that do not necessarily exhibit a satisfactory indication about the system but indicate particular problems and/or have diagnostic meanings. Module **12** may be expanded to accommodate an expanded alarm module **13**.

[0014] A power indicator light **39**, such as a green LED, may indicate whether there is electrical power to at least the sensor module **12**. An off state of indicator light **39** may indicate not only a lack of power to the sensor module **12** but also a lack of power available for the alarms **15** and **16**. Also, it may very likely mean a lack of power to the power supply module **11**. Under normal circumstances, an interruption of power for test purposes may be indicated by an off state of the indicator light **39**. During a power-on sequence, whether due to initial or interrupted power, the light **39** should be in an on state. Light **39** may be utilized for other system **10** indications, such as a blinking light to indicate other potential problems with the system **10** such as poor sensing element calibration.

[0015] At a first level of CO_2 concentration in the ambient environment of the sensor system **10**, the sensor module **12** with a signal from circuit **24** along line **28** may cause a first relay **31** to close or connect power from line **19** to line **29** resulting in a voltage across the input terminal and ground **21** of a strobe light **15** to cause it to flash. At a higher level

of CO_2 concentration, the sensor module **12** with a signal from circuit **24** along a line **34** may cause a second relay **32** to close or connect power from line **19** to line **35** resulting in a voltage across the input terminal and ground **21** of horn **16** to cause it to sound while the strobe continues to flash. The first and second levels of CO_2 concentration may be, for instance, 15,000 ppm and 30,000 ppm, respectively. 15,000 may be regarded as a warning and 30,000 ppm as a significant threat relative to the health of persons in the vicinity of the sensor module **12**. Other levels of alarm thresholds may be selected and defined. If the magnitude of the CO_2 or other gas decreases below the second and first levels, the second and first alarms may cease, respectively.

[0016] There may be one or more annunciators or other indicators noting that one or both levels of CO_2 concentration were previously achieved after the alarms are inactivated. An output line **38** from interface circuit **24** may provide a DC voltage between 0 and 5 volts proportionally or linearly representing a magnitude of CO_2 detected by sensing element **22**. For instance, 0 volts may represent 0 ppm, 2.5 volts may represent 15,000 ppm and 5 volts may represent 30,000 ppm. The voltage representation of ppm values may be different than those indicated herein.

[0017] Connected in parallel with the second relay **32** may be a third relay **33** which is a dedicated two-wire dry contact device. Relay **33** need not be connected in the system **10**. Relay **33** may be connected, for example, to an auxiliary device. Relay **33** may instead be a normally closed relay. It may be connected to a fire alarm panel of a facility, at the discretion of the installer or user, for instance, in indicating a 30,000 ppm concentration of CO_2. A signal on line **34** may close relay **33** to provide a voltage or power from line **19** on an output line **36** of relay **33**.

[0018] A characteristic of the present alarm system **10** is that it may be hardwired (i.e., the power input is wired directly to 120/240 VAC or other available electrical power, but not plugged into an electrical outlet. The hard-wired system **10** may provide constant protection of sustained power to the alarm system, and prevent the risks of the easy pulling or disconnecting of a plug/outlet of power supply connection. A problem may include verifying that the sensor **10** is properly wired to the power and operating correctly once its hardwired connection is made.

[0019] The sensor alarm system **10** may provide a momentary power interrupt with a push-button normally-closed switch **37** in the power supply module **11**. The interrupt may be effected in other ways such as a processor initiated interrupt. The interrupting mechanism may be solid state device other kind of device. When the power interrupt button switch **37** is pressed at the power supply module **11**, the sensor module **12** may have the processor **25** with respective software to initiate a pre-determined sequence for relays **31** and **32**. The sequence may be designed to start about 15 seconds after power turn-on or interrupt. When the sequence begins, for example, the first relay **31** and the second relay **32** may close simultaneously. The first relay may be closed for a duration of ten seconds and the second relay may be closed for a duration of two seconds. These durations are just examples, as the durations may be for other periods of time. Testing the sensor system **10** may then verify that the strobe **15** and horn **16** outputs correspond to the relay closings. In other words, the strobe **15** and the horn **16** may be energized simultaneously, with the horn **16** ceasing after the two seconds, and the strobe **15** ceasing after ten seconds. Other patterns of alarms may be programmed in module **12** for indicating a correct connection and normal operation of the system. Other types of alarms may be used.

[0020] A delay of, or a different sequence of, alarms **15** and **16**, other than expected, or no sequence, may indicate incorrect wiring of the power to the system or between the modules **11**, **12** and/or **13**, a defective component such as the processor **25**, a circuit **24** element, sensing element **22**, relay **31** or **32**, strobe **15** or horn **16**, or poor or broken inter- or intra-module **11**, **12** or **13** connections, due to incorrect installation, tampering or hardware or software failure. There may be other causes of an incorrect or no sequence other than noted herein. The built-in power interrupt and the power-on sequence at the sensor may be one characteristic of the sensor system **10**. The power-on sequence may be of various forms or patterns as long as the form or pattern is defined, expected and known to the tester. The interrupt push button **37** may be replaced with a programmed interrupt and/or reset mechanism, for example, with software in processor **25**, for system **10** testing.

[0021] The sensor module **12** may have an automatic background calibration relative to sensing element **22**. If the background calibration drifts from the factory calibration by 3000 ppm, the strobe alarm **15** may intermittently flash or flash for about 10 seconds each minute. This may mean that the sensing element **22** should be replaced. Other components of system **10** may also be checked. The system **10** may be tested regularly by depressing the push button **37** to reasonably ensure that the system has not been tampered with and is operating normally.

[0022] FIG. **3** is a flow diagram of an illustrative example of a power-on sequence as a system check. The sensor and alarm system may be permanently connected or hardwired to power according to block **61**. The system may be disconnected (for instance, temporarily with a push button) with a switch from power according to block **62**. The system may be promptly reconnected with the switch to power as in block **63**. Upon reconnection, a power-on sequence of alarms in a pattern may be initiated by the system, according to block **64**. In diamond **65** is a question as to whether the alarms are exhibited in a normal and/or expected pattern. If the answer is "Yes", then the system is fine or normal as in block **66**. If the answer is "No", then as in block **67** one may check for a problem in the system. However, the alarms may be simultaneous and/or separate and exhibit a pattern that does not exhibit a satisfactory condition about the system but indicates a particular problem and/or diagnostic meaning, as in block **68**. The alarms may be a combination of numerous visual, audio and/or other kinds of alarms, having various durations.

[0023] FIG. **4** is a flow diagram of an illustrative example of indicating gas concentrations by the present system. Block **41** shows a permanent or hardwire connecting of the sensor and alarm system to power. Diamond **42** is a question of whether the sensed gas exceeds a first level of concentration. If the answer is "Yes", then a first alarm may be energized according to block **43**. If not, then the gas level may be fine or acceptable as in block **46**. Diamond **44** asks the question of whether the sensed gas exceeds a second level of concentration. If the answer is "Yes", then a second alarm may be energized according to block **45**. The alarms may be simultaneous and/or separate, and exhibit a pattern having a diagnostic meaning. If not, then the concentration may be still at the first level as indicated by block **47**. The

alarms or their pattern may be further or instead a combination of two or more visual, audio and/or other kinds of alarms, having various durations.

[0024] FIG. **5** is a flow diagram of an illustrative example of the system's calibration indication. The system may be permanently hardwired or connected to power according to block **51**. Diamond **52** asks the question of whether the sensor or sensing element of the system is within calibration. If the answer is "Yes", then the sensor calibration may be fine or acceptable as in block **54**. If the answer is "No", then a first and/or second alarm (e.g., visual and/or audio alarm) may be energized according to block **53**. The alarms may exhibit a diagnostic indicating pattern. The alarm pattern may further or instead include a combination of two or more visual, audio and/or other kinds of alarms, having various durations.

[0025] In the present specification, some of the matter may be of a hypothetical or prophetic nature although stated in another manner or tense.

[0026] Although the invention has been described with respect to at least one illustrative example, many variations and modifications will become apparent to those skilled in the art upon reading the present specification. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.

What is claimed is:

1. An alarm system comprising:
a power supply module;
a sensor module connected to the power supply module; and
a alarm module connected to the sensor module; and
wherein the sensor module comprises a power-on sequence pattern for the alarm module.

2. The system of claim **1**, wherein:
the power-on sequence pattern indicates a normal condition of the alarm system; and
an absence of the power-on sequence pattern turning on power to the alarm system indicates an abnormal condition of the alarm system.

3. The system of claim **1**, further comprising:
a power-break mechanism connected to the power supply module; and
wherein the power break mechanism is for initiating the power-on sequence pattern.

4. The system of claim **3**, wherein:
upon initiating the power-on sequence pattern, an occurrence of a normal power-on sequence pattern indicates the alarm system to be in satisfactory condition; and
upon initiating the power-on sequence, an occurrence of a non-normal power-on sequence pattern indicates the alarm system to be not in satisfactory condition.

5. The system of claim **4**, wherein the non-normal power-on sequence pattern comprises an absence of a power-on sequence.

6. The system of claim **1**, wherein the power supply module has a permanent-like connection to a power source.

7. The system of claim **4**, wherein the normal power-on sequence pattern comprises:
providing a visual signal for a first period of time; and
providing an audio signal for a second period of time.

8. The system of claim **7**, wherein neither providing a visual signal for a first period of time nor providing an audio signal for a second period of time is a non-normal power-on sequence pattern.

9. The system of claim **8**, wherein the non-normal power-on sequence pattern indicates an abnormal situation with the alarm system.

10. An alarm system comprising:
a power supply mechanism;
a sensor connected to the power supply;
a alarm connected to the sensor; and
a power interrupt and power-up mechanism.

11. The system of claim **10**, wherein:
activating the power interrupt and power-up mechanism starts a power-up sequence; and
the power-up sequence comprises at least one pattern of alarms being energized and de-energized for various durations of time.

12. The system of claim **11**, wherein:
the power sequence comprises a plurality patterns of alarms; and
each of certain patterns reveals a particular condition of the alarm system.

13. The system of claim **12**, wherein one pattern of the plurality of patterns of alarms indicates the alarm system to be in a normal operating condition.

14. The system of claim **10**, wherein the power supply comprises a permanent-like connection to a power source.

15. A method for testing a sensor and an alarm system, comprising:
permanently connecting a sensor and an alarm system to a power source;
temporarily disconnecting the sensor and alarm system from the power source;
reconnecting the sensor and alarm system to the power source; and
initiating a power-on sequence having at least one alarm pattern.

16. The method of claim **15**, wherein an alarm pattern indicates a condition of the sensor and alarm system.

17. The method of claim **17**, further comprising initiating an alarm pattern when the sensor varies a certain magnitude from its calibrated magnitude.

18. The method of claim **17**, wherein an alarm pattern comprises:
a first type of an alarm for a first duration; and
a second type of an alarm for a second duration.

19. The system of claim **1**, wherein:
the power supply module is permanently connected to a power source;
the sensor module comprises:
a sensing element;
an interface circuit connected to the sensing element;
a processor connected to the interface circuit;
a first electrically actuated switch connected to the interface circuit;
a second electrically actuated switch connected to the interface circuit; and
the alarm module comprises:
a first type of alarm connected to the first electrically actuated switch; and
a second type of alarm connected to the second electrically actuated switch.

20. The method of claim **19**, wherein an power-on sequence pattern comprises:

the first type of alarm for a first duration; and

the second type of alarm for a second duration.

21. The system of claim **20**, wherein:

when the sensing element senses a gas exceeding a first concentration, a first pattern of alarms occurs; and

when the sensing element senses a gas exceeding a second concentration, a second pattern of alarms occurs.

22. The system of claim **1**, wherein the power-on sequence pattern indicates a normal or a diagnostic condition of the alarm system.

* * * * *