

[54] **PRESSURE CHANGE RESPONSIVE ALARM APPARATUS**

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[51] **Int. Cl.²**..... **G08B 13/08; G01L 9/00**

[58] **Field of Search** **340/240, 274; 310/8.3, 310/8.8; 324/71 R, 71 SN; 73/205 R, 262, 269, 398 R, 407 R, 49.3; 328/146, 148, 149; 317/148.5 R; 307/235 R; 200/83 R, 83 A, 81 R**

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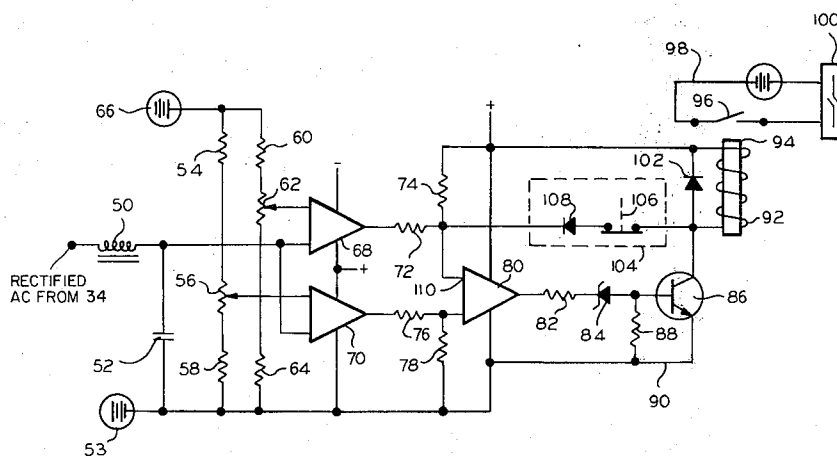
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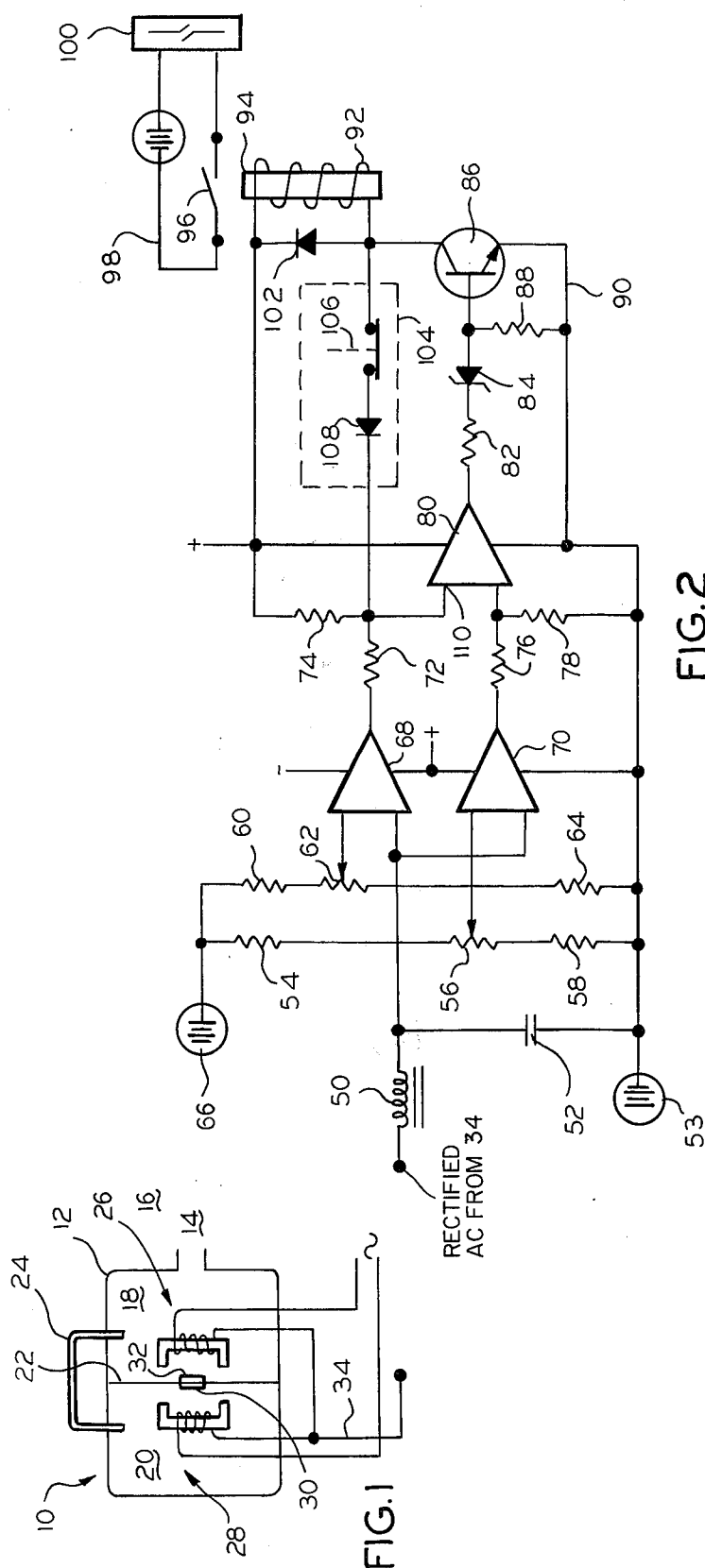
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ABSTRACT

An alarm system for protecting an environment wherein the pressure changes when the integrity of the environment is violated. The alarm system senses the pressure change and creates a signal in response thereto. The signal is transmitted through a discriminator amplifier circuit which operates a relay for actuating a discernable alarm, such as a buzzer, light or the like.

5 Claims, 2 Drawing Figures





PRESSURE CHANGE RESPONSIVE ALARM APPARATUS

This invention relates to an alarm system for protecting an environment, and in particular to a device for sensing an intrusion into a guarded environment, and triggering an alarm to warn of such intrusion.

Alarm systems for protecting environments such as rooms, homes, offices, business and industrial facilities, and other interior structures are well known in the art. Heretofore, such alarm devices consisted of physical, electrical or magnetic triggering devices which, when upset by, for example, the opening of a door or the breaking of a window, created a signal which was transmitted to an audible, visual, or otherwise discernable display device such as a buzzer, light, bell or the like. In addition, there are systems wherein the alarm signal created by the disturbance is transmitted to a central station, such as a computer or receiving unit at a local police or fire station.

Presently available alarm systems for protecting an interior environment require that the triggering or sensing devices associated with the system be located at each point of access to the environment, i.e. doors and windows, to protect against all manner of unauthorized entry. These alarm systems also involve extensive wiring or conduit installation extending between each sensing unit and a central signal receiving unit, usually located in a box at one location within the environment. The alarm display unit is then connected by wires or the like to the signal receiving unit.

These alarm systems have several disadvantages. The extensive wiring required throughout the protected facility vastly increases the cost of the system. The installation of wires in a room also creates an undesirable aesthetic appearance, as contrasted with the desired decor of the environment. In addition, measures have been devised by professional burglars to compromise or neutralize mechanical, electronic, or magnetic sensing units. These sensing units are located adjacent the boundary of the protected facility i.e. in the door or window, and therefore are readily accessible in most cases to an intruder stationed just outside the facility.

For example, many magnetic sensors can be rendered impotent by passing a strong magnet adjacent the outside of the door in which such sensor is placed. When the door is broken open, the magnetic sensor remains untriggered by the intruder's magnetic device, and the alarm fails to go off. Electrical systems may be neutralized by disconnecting the source of energy, as by cutting the power line leading to a home. Likewise, mechanical sensors may be disarmed by devices such as crowbars, screwdrivers, coat hangers or the like.

Each of the foregoing disadvantages of presently available alarm systems may be overcome through the use of a device constructed in accordance with the present invention. This device sets off an alarm display within a response time of one second or less after the integrity of a protected environment has been violated. The alarm system is completely self-contained, requires no installation or wires or other sensing or transmitting devices, and is small enough to be housed in a decorator designed unit which may be located in a room or office, and blend with its surroundings. The alarm system of the present invention is extremely reliable, and operates from a small, self-contained power source. The system is compact in construction, inexpensive to man-

ufacture, and is greatly simplified in its design and operation.

An apparatus constructed in accordance with the present invention includes a device for sensing minute changes in air pressure in an environment, which changes are caused by the opening of a door or window leading into the environment. The change in pressure causes the sensing device to create a signal, such as an electrical impulse, which is transmitted to an amplifier and relay operating circuit. The relay activates an alarm circuit which controls a buzzer, bell, light or other suitable alarm display means. Since the device is responsive to a change of air pressure at any point in the protected environment, the alarm system of the present invention may be located anywhere in the environment. There is no need to install wires or other impulse transfer means in the guarded facility.

Accordingly, one of the principal objectives of the present invention is to provide an alarm system for protecting an environment which system senses the change in pressure resulting from a violation of the integrity of the environment, and transmits this signal to activate a discernable alarm display device.

An additional object of the present invention is to provide an alarm system for an environment which is entirely self-contained and does not require installation of additional equipment on the protected premises.

Still another object of the present invention is the provision of an alarm system wherein a change in air pressure in the protected environment causes movement of a sensing device which, in turn, creates an electrical signal for actuating a discernable alarm display device.

A further object of the present invention is to provide an apparatus for amplifying an electrical signal generated by a pressure change responsive device, and applying that amplified signal to a means for activating a discernable alarm display device.

An additional object of the present invention is to provide an alarm system for protecting an environment which system eliminates the need to install sensor devices at the accessible boundaries of the environment, such as doors and windows.

Yet another object of the present invention is the provision of an alarm system for an environment which eliminates the need for the installation of any physical devices between the alarm system and the accessible boundaries of the environment.

Another object of the present invention is to provide an alarm device which cannot be comprised or neutralized by actions outside the protected environment.

An additional object of the present invention is the provision of a self-contained, low cost alarm system which is inexpensive to manufacture, highly reliable, easy to operate, and requires only a minimum of power to operate.

Yet another object of the present invention is to provide a device for detecting an increased pressure in a protected environment caused by a fire within or adjacent the environment, and activating an alarm in response to the increase in pressure.

Various other advantages, objects, and features of the present invention will be apparent as the description proceeds in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view of the pressure-change responsive device of the present invention; and

FIG. 2 is a schematic view of the electronic amplification and alarm display activator circuit used in conjunction with the pressure-change responsive means of FIG. 1.

Referring to the drawings, and in particular FIG. 1, the numeral 10 generally denotes the detector apparatus used in conjunction with the present invention. The apparatus 10, which is generally disclosed and described in U.S. Pat. No. 3,451,265 to Ball, dated June 24, 1969, relating to a rate of climb indicator for aircraft, consists of a pressure-change detecting means 12 which has a port or aperture 14 extending between a region 16 and a chamber 18 within the detecting means. Region 16, for purposes of presenting the preferred embodiment of the invention, is an environment such as a room, office, or other facility having doors, windows, or the like at the boundary between the environment and its adjacent surroundings. The adjacent surroundings may be another room of office, or a hallway, or outdoors. It is to be understood that the region 16 is normally maintained at a specified, preferably substantially constant, air pressure, while the adjacent environment or surroundings are maintained at a different pressure.

Pressure change detector 12 also includes a second chamber 20 which is separated from chamber 18 by a pressure responsive elastic diaphragm member 22. One side of diaphragm member 22 is exposed to the pressure within second chamber 20, and the other side thereof is exposed to the pressure in region 16 by means of aperture 14 exposing chamber 18 to the pressure in region 16. Fluid passage means 24 interconnects chambers 18 and 20, and effects a flow between the chambers substantially proportional to the difference at any given point in time between the pressure in chamber 20 and the pressure of region 16.

The detector 12 also includes a pair of variable inductive means 26, 28 for sensing movement of the diaphragm 22 and generating an electrical impulse or signal in response thereto. Each inductive means 26, 28 is located on an opposite adjacent side of diaphragm 22, and includes a strip 30, 32 of magnetically permeable material secured to opposite sides of the diaphragm. Conductive means 34 is connected to inductive means 26, 28 and transmits the signal or impulse created in the inductive circuit, as will be described.

The operation of the detector apparatus of FIG. 1 will next be explained.

When the pressure within chamber 20 is equal to the pressure within region 16, the diaphragm member 22 is centered between inductive means 26 and 28. Under these conditions, the inductance of these inductive means 26 and 28 is identical, and the signals from each cancel the other out and, thus, no signal is transmitted to conductive means 34. Upon a change in pressure within region 16, as would be occasioned by the opening of a door or window leading to region 16 which would decrease the pressure in the region, air flows from chamber 20 to the region 16 through passage 24 for effecting flow substantially directly proportional to the pressure differences between chamber 20 and region 16.

A small time period is required for a sufficient quantity of pressurized air within chamber 20 to flow to the region 16 and the flexible pressure responsive diaphragm member 22 will flex or move toward the right, as viewed in FIG. 1. Movement of diaphragm member

22 in this manner results in the magnetically permeable strips 30 and 32 being positioned closer with respect to inductive means 26 than with respect to inductive means 28, thereby changing the inductance of inductive means 26 relative to inductive means 28. The signal generated in inductive means 26 is no longer equal to the signal being generated in inductive means 28, and the signals no longer cancel each other out. Therefore, a resulting signal or impulse is transmitted through conductive means 34.

It is understood that when the pressure within region 16 increases, diaphragm member 22 will move to the left, as viewed in FIG. 2, and a corresponding signal will again be generated in conductive means 34.

The electrical signal generated by pressure change detector 12 is transmitted through conductive means 34 and is applied to the amplifier and relay driver circuit of FIG. 2. This circuit operates a switch in circuit 98 for actuating discernable alarm display device 100, which, as shown in FIG. 2, is an audible buzzer. However, it is to be understood that buzzer 100 may be replaced with a light, bell, or any other discernable device for displaying the alarm signal generated in detector 12. Also, any combination of such alarm display devices may be actuated by circuit 98.

Referring to FIG. 2, conductive means 34 is connected to choke coil 50. A smoothing capacitor 52 is disposed between ground 53 and choke coil 50. The choke coil is necessary because the pressure differential detector may contain an AC audio component signal superimposed on the DC voltage which must be filtered.

A voltage divider consisting of resistors 54, 56, 58, 60, 62 and 64 is connected between battery 66 and ground 53 to establish a bias potential for discriminator amplifier circuits 68, 70. Resistors 56 and 62 are variable potentiometers, which are connected respectively to balance the operation of amplifiers 70 and 68. The DC input signal from pressure differential detector 12 is also applied to each amplifier circuit 68, 70. The output of discriminator amplifier 68 is connected to current coupling or limiting resistors 72, 74. Similarly, the output of discriminator amplifier 70 is connected to current coupling or limiting resistors 76, 78.

Resistors 72, 74, 76, and 78 act as voltage dividers to set the potential at the upper and lower inputs to discriminator amplifier 80. The output from amplifier 80 passes through current limiting resistor 82 to zener diode 84 which functions as a snap switch when the zener voltage is exceeded. Zener diode 84 is connected to the base of NPN transistor 86, with resistor 88 acting to provide a bias potential to the transistor. A line current input is provided through line 90 to the input of transistor 86, and the output of the transistor is connected to a circuit for energizing relay coil 92.

Relay 94, in turn, activates switch 96. When switch 96 is closed, circuit 98 activates buzzer 100, or any other suitable discernible signal device such as a light, dial, trigger, etc. Diode 102 is provided in the relay circuitry to prevent reverse EMF in the coil from affecting the detect circuit.

An optional latched output circuit 104 is provided between one input to amplifier 80 and relay coil 92. The latched output circuit consists of a normally closed reset button 106 and diode 108.

The operation of the amplifier circuit of FIG. 2 will next be explained.

When the integrity of a protected environment is violated, such as by the opening of a door to a room, the pressure will change in the room where the detector apparatus 10 is located. This change is reflected in pressure change detector 12, which produces an electrical current in conductive means 34 by means of diaphragm 22 moving adjacent inductive means 26 and 28. This current is fed to the input of the level detect circuitry shown in FIG. 2. The filtered DC voltage from choke coil 50 is applied to the inputs of discriminator amplifiers 68, 70 which function as level detectors. The reference signal inputs to amplifiers 68, 70 are adjustable above or below the DC input signal by means of variable resistors 56, 62. The inverting input of amplifier 68 is set to the low trip limit. This set point input vs. signal input condition on the inputs of amplifiers 68 and 70 causes the output of amplifier 68 to be normally low and the output of amplifier 70 to be normally high. These outputs are subsequently voltage divided such that the output of amplifier 80 is normally high (+12). This in turn causes the transistor relay driver 86 to be normally on, in which state relay coil 92 is energized and switch 96 is in an open condition.

Should either amplifier 68 or 70 change state because of an alarm input, amplifier 80 will change state, causing the relay 94 to drop and switch 96 to close. If the optional latched output circuit 104 is installed when relay 94 drops out, the voltage on pin 110 of amplifier 80 will rise to a value higher than the other input. This will in effect latch the circuit during the time that the reset button 106 is operated. Reset button 106 is normally closed, and opens when operated, thereby removing the latch signal.

It has been observed that pressure change detector 12 will generate an alarm signal in an environment regardless of whether the pressure in the adjacent environment is the same or not. Assuming a door is opened in a room, the action of the door in swinging into the room creates a pumping action which forces an immediate, slight increase in the room's air pressure. This is due to the fact that the action of the door compresses the air in the room faster than it can escape from the opening at the door. Eventually there is pressure equalization, but not before the alarm system of the present invention can detect the initial pressure change and generate a signal in response thereto.

The apparatus of the present invention also functions as aforescribed where the integrity of a room, office or the like is violated by sliding a door or window to an open position. The design of pressure change detector 12 enables the sensing of even minute changes in air pressure, which are caused when one environment is exposed to another. There is always at least a slight difference in pressure between these two environments, and the apparatus of the present invention is sensitive enough to respond to these slight changes.

In view of the foregoing, it will be readily appreciated that an apparatus for detecting a slight pressure change in an environment has been described for use as an alarm device when the integrity of a protected environment is violated. The device is inexpensive to manufacture, simple in operation, and compact in construction. It is completely self contained with its own power source and can be installed in any room, office, or the like without the addition of cumbersome and time-consuming wiring problems. The invention operates with a fast response and thereby creates an alarm signal

the instant a door or window is opened in the protected environment.

It has further been observed that the present invention functions to provide an alarm when a fire occurs in the protected environment. The heat created by the fire raises the pressure in the environment, which is a constant volume. This pressure increase is detected by the present invention which creates an impulse in response thereto and actuates the alarm.

It is to be understood that this invention is not limited to the exact embodiments of the apparatus shown, which is merely by way of illustration and not limitation, as various other forms and modifications will be apparent to those skilled in the art.

I claim:

1. An alarm system for determining through pressure differentials that a door leading to an enclosed environment has been opened or closed,

said environment normally maintained at a predetermined pressure,

said alarm system comprising a rate of pressure change detecting means located in said enclosed environment and adapted to sense said pressure change,

said rate of change pressure detecting means comprising a dynamic chamber coupled to said enclosed environment,

a static chamber isolated from said enclosed environment,

fluid passage means connecting said dynamic chamber to said static chamber,

said fluid passage means controlling the rate of flow between the chambers as a function of the pressure differential between said chambers,

elastic diaphragm means separating said static and dynamic chambers,

variable inductive means for sensing movement of said diaphragm and varying a frequency in response to said movement,

discriminator means connected to said rate of pressure change detecting means to provide an output signal responsive to said pressure changes, and

alarm means responsive to said output signal to activate a discernible alarm display device responsive to the movement of said door.

2. The alarm system of claim 1 wherein said discernible alarm display device is an audible buzzer.

3. The alarm system of claim 1 wherein said discernible alarm display device is a visible light.

4. An alarm system for determining through pressure differentials that the integrity of an environment has been violated,

said environment normally maintained at a predetermined pressure,

access means in said environment,

said access means including closure means movable from an open position to a closed position, and sensing the pressure of said environment when said closure means moves from its closed position to its open position,

said alarm system comprising rate of pressure change detecting means located in said environment adapted to sense said pressure change,

alarm means associated with said rate of pressure change detecting means for creating a signal responsive to said pressure sensed,

said rate of pressure change detecting means comprising a region maintained at the pressure of said environment,
a static chamber,
diaphragm means separating said region and said static chamber, 5
fluid passage means interconnecting said static chamber and said region,
said fluid passage means affecting a flow between said chamber and said region that is substantially proportional to the pressure difference between the pressure in the static chamber and the pressure in the region, 10
a pair of inductive means located on opposite adjacent sides of the diaphragm with one inductive means in the region and the other inductive means in the chamber, 15
mechanically permeable material secured to the opposite side of the diaphragm for varying the inductance of said pair of inductance means as the diaphragm moves, 20
the variation in the inductance for varying the fre-

quency at the output of said inductances,
said means associated with said rate of pressure change detecting means comprising discriminator means to transform the change of frequency to a change in amplitude, and
means responsive to the change of amplitude for operating said alarm means.

5. The method of actuating a discernible alarm display device to indicate a violation of the integrity of an environment comprising the steps of:

detecting a rate of change of pressure within said environment caused by said violation;
comparing the rate of change of pressure within said environment with the rate of change that is a function of the pressure differential between the new pressure and the original pressure;
creating a signal responsive to said change of pressure; and
applying said signal to actuate a discernible alarm display device.

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