

[54] SMOKE DETECTION UNIT WITH DUAL PURPOSE ALARM CIRCUIT

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[51] Int. Cl. G08b 17/10; G08b 19/00

[58] Field of Search 340/237 S, 249, 384 E, 340/251

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Primary Examiner—John W. Caldwell

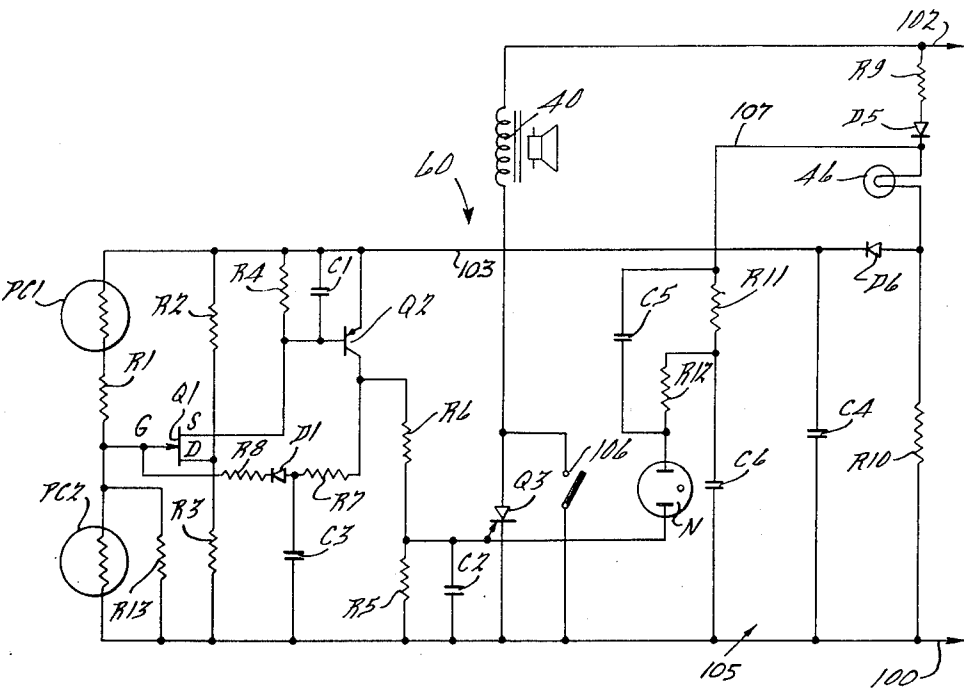
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[57] ABSTRACT

A unit for detecting the presence of smoke in the air utilizing a single sound emitting device for producing a plurality of distinguishable sounds for indicating different conditions such as the presence of smoke and burnout of the actuating light source. The sound emitting device operates continuously to indicate a selected smoke threshold point and operates intermittently to indicate burnout of the light source.

6 Claims, 3 Drawing Figures



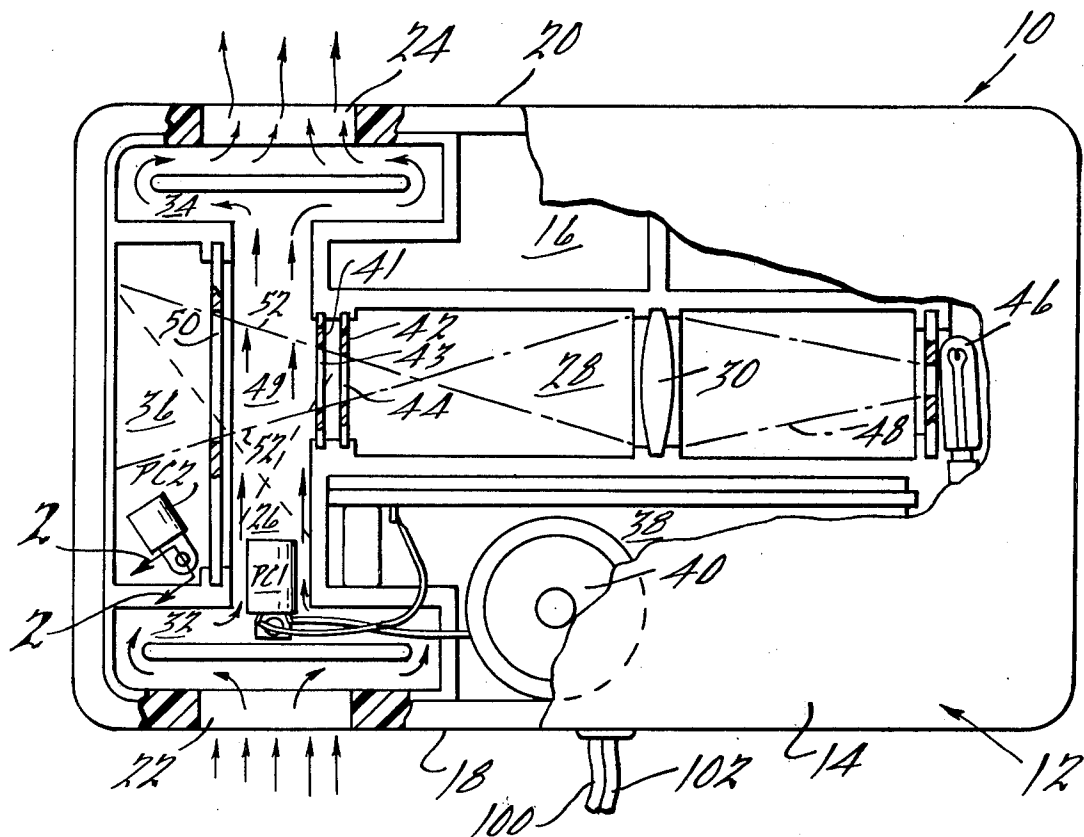


FIG. 1.

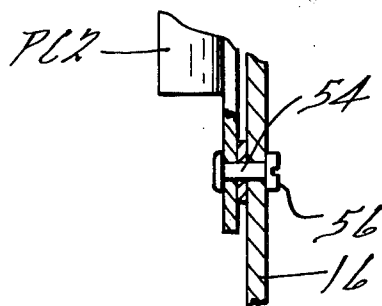
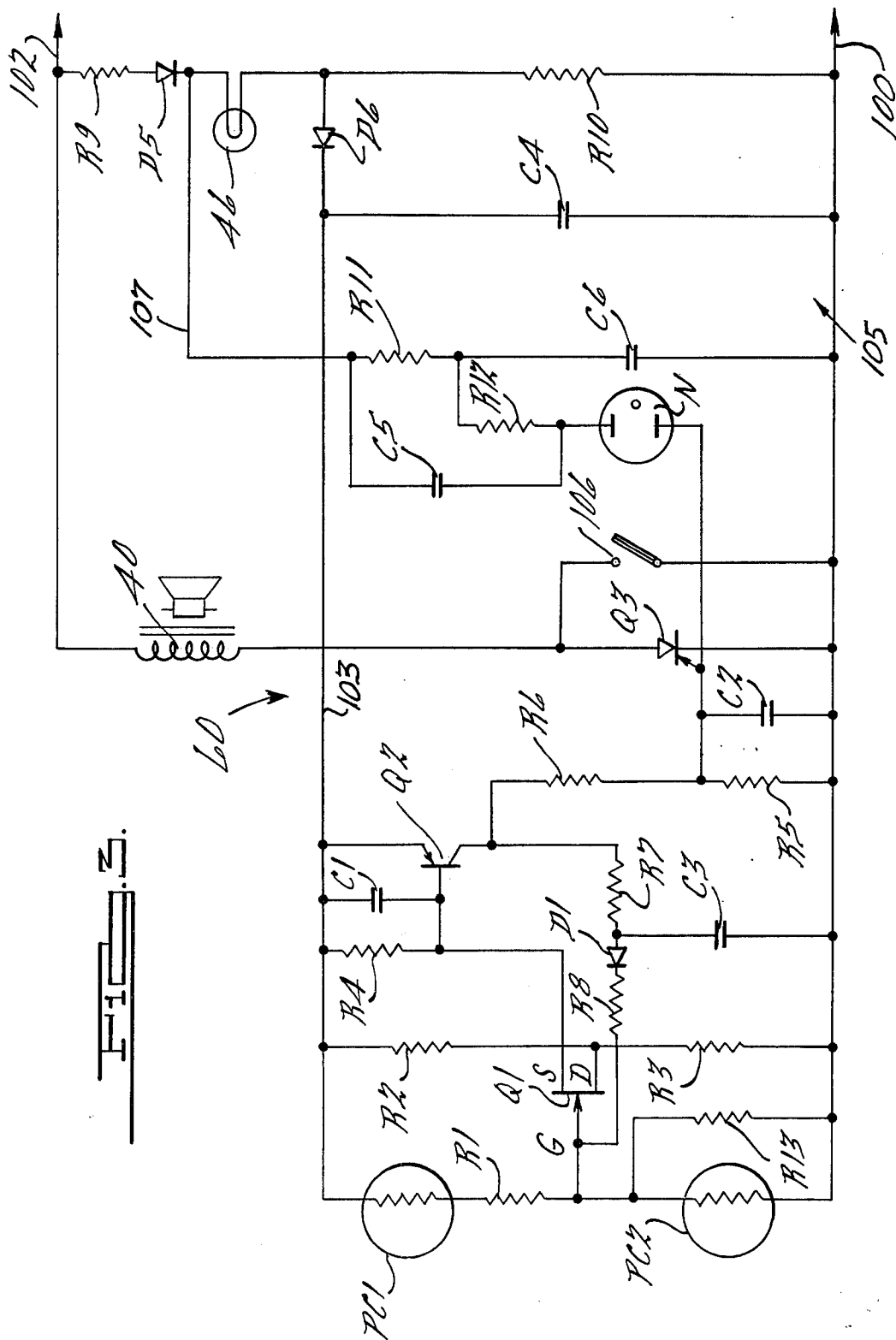


FIG. 2.



SMOKE DETECTION UNIT WITH DUAL PURPOSE ALARM CIRCUIT

CROSS REFERENCE TO RELATED APPLICATION

This application is a division of my copending application Ser. No. 72,627 filed Sept. 16, 1970, and now abandoned.

SUMMARY OF THE INVENTION

This invention relates generally to units for detecting and signaling the existence of smoke or heat in room air above a predetermined level of the type disclosed in my earlier U.S. Pat. No. 3,383,670. The unit of this invention is an improvement on the unit shown in the aforementioned patent. The unit of this invention includes the same general arrangement of a light source, a lens containing light transmission conduit, a light interaction region, a light receptacle, a photosensitive cell for receiving light deflected by smoke in the light interaction region and a photocell actuated horn disclosed in the aforementioned patent. In addition, the unit of this invention includes a second photosensitive cell adjustably mounted in the light receptacle and connected in an alarm circuit to the first cell for adjusting the sensitivity of the circuit. The cells receive comparable light intensity at the selected smoke threshold point, namely, the smoke concentration point which it is desired to sense, and by virtue of this arrangement the cells have similar resistive temperature coefficients and time constants. This cooperative arrangement of the two cells compensates for variable conditions such as line voltage affecting the intensity of the light source and heat conditions affecting the resistivity of the cells which would otherwise adversely affect the sensitivity of the unit. In addition, the unit of this invention includes a control circuit for the signaling noise source which provides for the emission of three readily distinguishable sounds from the noise source to indicate the three conditions which it is desired to sense in the unit. The noise source, a conventional horn, emits intermittent bursts of noise when the light source burns out to indicate to the user of the unit that the light source lamp must be replaced. A second continuous sound at substantial sound level is emitted from the horn when the unit senses a high heat condition. A third continuous sound which is readily distinguishable because of its raspy character is emitted from the horn when the unit senses a threshold smoke condition. Thus, the smoke and heat detector unit of this invention is capable of continuous operation over a prolonged service life to continuously monitor heat and smoke conditions within desired sensitivity limits for fire detection purposes.

Further objects, features and advantages of this invention will become apparent from a consideration of the following description, the appended claims, and the accompanying drawing in which:

FIG. 1 is a front view of the unit of this invention with the front face of the enclosing casing broken away and other parts shown in section for the purpose of clarity;

FIG. 2 is an enlarged fragmentary sectional view of a portion of the unit of this invention as seen from substantially the line 2—2 in FIG. 1; and

FIG. 3 is a diagrammatic illustration of the alarm circuit which forms a part of the detector unit of this invention.

With reference to the drawing, the detector unit of this invention, indicated generally at 10, is illustrated in

FIG. 1 as consisting of a casing 12 having a front wall 14, a back wall 16, a bottom wall 18 and a top wall 20. An inlet opening 22 for room air is formed in the bottom wall 18 and an outlet opening 24 for this air is formed in the top wall 20. Partitions in the casing 12 define a smoke detection chamber or compartment 26 disposed between the openings 22 and 24, a light transmission conduit 28 containing a lens 30, a lower light trap 32 and an upper light trap 34. The casing partitions also cooperate to form a light receiving compartment 36 and a compartment 38 in which a signal horn 40 is located. For a purpose to appear presently, orifice plates 41 and 42, provided with orifices 43 and 44, respectively, are mounted in the light transmission conduit 28 to one side of the smoke detection chamber 26. A light source 46 is positioned in the casing 12 at one end of the light transmission conduit 28. When the light source 46 is energized, it projects a light beam 48 onto the lens 30 and the lens 30 in turn projects this beam of light toward the orifice plate 42 so that an image of the light source 46 is formed at the orifice 44 and a diverging beam of light is projected through the orifice 43 and across the detection chamber 26. This diverging light beam forms a light interaction region 49 in the chamber 26 between the orifice 43 and an inlet opening 50 for the light receiving compartment 36 and between the upper and lower boundaries 52 of the light beam.

A first photosensitive cell PC1 is mounted in the casing 12 at one end of the chamber 26 so that some of the light impinging on particles in the interaction region 49 will be reflected onto the cell PC1. A second photosensitive cell PC2 is disposed in the light chamber 36 and is mounted on a pivot 54 which extends through the back wall 16 of the casing 12 as shown in FIG. 2. The pivot 54 terminates in a readily accessible screw head 56 which can be rotated to adjust the position of the cell PC2 in the chamber 36 to in turn adjust the intensity of the light received by the cell PC2 for a purpose to appear presently. The horn 40, the light source 46, and the cells PC1 and PC2 are connected in a control circuit 60 shown in detail in FIG. 3 and the components of which are housed principally in the compartment 38.

In the signal circuit 60, the detector cell PC1 is connected in series with a resistor R1 and the cell PC2, as shown in FIG. 3. The cells PC1 and PC2 are such that the resistance of each will vary generally proportionately to the intensity of the light impinging on the cells. Direct current is supplied to the cells through conductors 100 and 103 which are connected to a DC power source 105 which in turn is connected to a conventional 110 volt AC source via conductors 100 and 102. The horn 40, which is a conventional 110 volt AC horn is operative at 60 cps and is actuated via the AC lines 100 and 102 in a manner to be hereinafter described.

The circuit 60 includes a four leg bridge defined by the cell PC1 and resistor R1, cell PC2, resistor R2 and resistor R3. Cell PC1 and resistor R1 and cell PC2 are serially connected with the combination being connected in parallel with serially connected resistors R2 and R3. A resistor R13 is connected in parallel with cell PC2 for a purpose to appear presently. Bridge unbalance is sensed by a field effect transistor amplifier Q1 which has its gate connected to the juncture between R1 and PC2 and has its drain connected between resistors R2 and R3. In this manner, when a selected threshold of unbalance occurs in the bridge circuit caused

by a predetermined drop in the resistance of PC1 relative to the resistance of PC2, the amplifier Q1 will be rendered conductive. The output circuit of Q1 is connected to a transistor amplifier Q2 such that the source of Q1 is connected to the base of Q2. The amplifier Q2 is a p-n-p type transistor with its emitter connected to the DC voltage source 105 via line 103 and its base connected to the same line via resistor R4 which acts as a biasing resistor for the base of Q2 and load resistance for the source of Q1. Thus, when Q1 is rendered conductive, Q2 will also be turned on. The transistor Q2 provides a trigger pulse to the gate circuit of a SCR amplifier Q3 so as to render amplifier Q3 conductive. This is accomplished by a circuit which includes a resistor R8 which is connected to the gate of amplifier Q3 and also to the conductor 100 via biasing resistor R5.

The resistor R4 and a parallel capacitor C1 associated with the amplifier Q2 and the resistor R5 and a parallel capacitor C2 associated with the SCR Q3 function as filter subcircuits to minimize the possibility of undesirable actuation of the circuit 60 due to the presence of transient power sources such as start-up power, lightning, and the like.

In order to provide for continuous operation of the horn 40 in response to a sensing by PC1 of a smoke concentration above a selected threshold level, a latch-up subcircuit is provided consisting of resistors R6 and R7, diode D1, and capacitor C3. The latch-up circuit is connected between the emitter of Q1 and the gate of Q2 and operates in response to a voltage rise on capacitor C3 to hold Q1 in a turned on condition.

In the operation of the unit 10, the horn 40 is operated in response to a preset differential in resistance between PC1 and PC2. This differential will remain substantially constant irrespective of line voltage changes which affect the intensity of light source 46 and temperature conditions which affect the resistivity of PC1. Consequently, PC1 is capable of sensing a threshold condition of smoke concentration in interaction region 46 irrespective of variable conditions such as line voltage and temperature because of the compensating or offsetting influence of PC2. The threshold condition to be set is readily adjustable to any desired level by rotating the pivot 54 to adjust the position of cell PC2 to receive more or less light from compartment 36.

When the intensity of light impinging on PC1 relative to the intensity of light impinging on PC2 reaches the threshold condition, sufficient current can flow through Q1 to trigger Q2 and in turn provide for triggering of Q3. In response to triggering of Q3 approximately half wave drive to the horn 40 is achieved since horn 40 is connected in series with SCR Q3. This results in the emission of a distinguishable raspy noise of high output sound level from the horn 40 and a low temperature rise of the horn. The resistor R1, which is of small magnitude compared to the resistance of PC1 when exposed to light at the threshold level, provides current limiting protection for Q1 in case PC1 shorts out. The resistor R13 in parallel with PC2 functions to insure against an unbalance of the bridge toward turn-on of Q1 after the cell PC2 has been dark for a period of time, such as after prolonged storage of unit 10, when the circuit 60 is first connected to a power source. The value of resistor R13 is relatively high compared to the resistance of PC2 when exposed to normal light in the unit 10.

In response to the turning on of Q1 and Q2 the electrical potential at the R7, R6 node is approximately the same potential as that on a capacitor C4. After a short time, as set by the RC time constant of the circuit of C3, the voltage on C3 rises sufficiently to hold Q1 on, thus causing latch-up. The values of R8 and R7 are low enough to maintain the bridge unbalance in the alarm direction even when the resistance of PC1 is infinite, i.e. open circuit. Once latchup is achieved, the horn 40 will continue to operate to indicate a dangerous smoke condition until line power to conductors 100 and 102 is removed.

When there is no line power, C4 has a zero change. For a voltage on C4 less than at the gate of Q1, diode D1 is reverse biased and the latchup subcircuit is isolated from the bridge and Q1. Also, during a "no alarm" condition, Q2 is off and its collector potential is at or near line 102 potential so that diode D1 is maintained in a reversed biased state. The time constant for the filter subcircuits is chosen so that transients related to connecting power to the circuit 60, lightning, and other typical causes will not turn on Q2.

The circuit 60 also includes a heat responsive circuit which includes a heat responsive switch 106 connected in parallel with the SCR Q3 and hence in series with the horn 40. When the switch 106 is closed by the presence of excessive heat, the horn 40 receives full wave excitation through the switch 106. This produces a sound which is clearly distinguishable from the half wave excitation previously described indicating a threshold smoke condition.

One of the important advantages of the circuit 60 is its ability to detect burnout of lamp 46. This is achieved by sensing a substantial voltage rise compared with normal operation and producing short bursts of sound from horn 40 in response to this voltage rise. The lamp 46 is connected in series with a resistor R9, a diode D5 and a resistor R10 across the lines 100 and 102. The peak voltage across lamp 46 and resistor R10 is substantially less than peak AC line voltage which is the input to the series circuit when lamp 46 is not burned out. A diode D6 rectifies the voltage across R10 and cooperates with capacitor C4 to provide a steady DC voltage across the amplifier and bridge circuits thereby defining the DC power source 105. The peak voltage of lamp 46 and resistor R10 is selected so that it is less than the threshold of the lamp outage detection subcircuit hereinafter described.

The lamp outage detection subcircuit consists of resistor R11 and R12, capacitor C5 and C6 and voltage breakdown device which in the illustrated embodiment of the invention is a neon bulb N connected to the gate for Q3. This subcircuit constitutes a neon bulb relaxation oscillator. The bulb N is characterized by the fact that a minimum voltage is required to cause neon breakdown and a resulting flow of current through the bulb N. In the event bulb 46 burns out, nearly full peak line voltage is available through conductor 107 at the bulb N. Diode D5 provides a DC current to charge C6. Each time the voltage on C6 reaches the breakdown voltage of bulb N, C6 is discharged through bulb N and a pulse is coupled to Q3 causing a half wave pulse to the horn 40. This pulse is repeated after a plurality of line frequency passes to achieve the desired intermittent emission of noise from horn 40. The capacitor C5 and the resistor R12 assist in controlling the phase angle of the trigger pulse to Q3.

From the above description it is seen that this invention provides a smoke and heat detector 10 in which the single signal horn 40 is employed to provide different distinguishable alarm signals. As a result, alarm conditions such as a dangerous smoke threshold condition and a dangerous heat condition can be sensed, and a trouble condition, namely, burnout of the lamp 46 can also be sensed. As a consequent of this use of the single horn 40, an operable detector unit 10 can be produced at low cost. In addition, by virtue of the employment of the compensating cell PC2 in cooperation with the detector cell PC1, a smoke threshold condition which it is desired to detect can be set by adjustment of the position of the cell PC2. This cooperative relationship of the cells also compensates for variable light levels and temperature conditions which would otherwise adversely affect the sensitivity of the detector cell PC1. The latch-up subcircuit assures continuous operation of the horn 40 when an alarm condition is sensed which is advantageous for safety purposes because it requires the building occupant in which the unit 10 is placed to unplug the unit 10 in order to shut off horn 40.

What is claimed is:

1. In a unit for detecting and signaling the existence of smoke in room air above a predetermined level, a casing having a smoke detection chamber therein, a light source in said casing operable to provide for light in said chamber, an alarm circuit utilizing a single sound emitting device for producing distinguishable sounds for indicating different conditions which it is desired to detect, namely, an alarm condition indicating the existence of room air smoke above a certain level and a trouble condition indicating burnout of said light source, said circuit including first circuit means operable to actuate said device to produce a first continuous sound indicating said alarm condition, and second circuit means operable to actuate said device to produce an intermittent sound distinguishable from said first sound and indicating said trouble condition.

2. An alarm circuit according to claim 1 wherein said

sound emitting device is an electrically driven horn and wherein said second circuit means includes oscillator means connected to said horn and operable in response to energizing of said oscillator means to provide for intermittent operation of said horn.

3. An alarm circuit according to claim 2 wherein said oscillator means includes a neon bulb and capacitor means, and circuit means connecting said bulb and said capacitor means and providing for flow of current pulses through said bulb when the voltage at said capacitor means exceeds the breakdown voltage of said bulb.

4. In a unit for detecting and signaling the existence of smoke in room air above a predetermined level, a casing having a smoke detection chamber therein, a light source in said casing operable to provide for light in said chamber, an alarm circuit including means for detecting burnout of said light source, said means comprising electrically energizable signal means, and circuit means connecting said light source and said signal means and operable in response to a voltage increase therein caused by light source burnout to provide for intermittent actuation of said signal means.

5. A circuit according to claim 4 wherein said circuit means includes voltage breakdown means normally providing high impedance path and operable to provide low impedance path in response to a selected threshold potential connected thereacross, circuit means providing a current path through said voltage breakdown means to said signal means, capacitor means connected to said light source and to said voltage breakdown means and operable to intermittently provide for a voltage therethrough exceeding the breakdown voltage thereof in response to a voltage rise across said capacitor caused by burnout of said light source, said voltage breakdown means being operable when the breakdown voltage thereof is exceeded to pass an actuating pulse to said signal means.

6. A circuit according to claim 5 wherein said voltage breakdown means is a neon bulb.

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