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Barnes

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[54] ELECTRONIC SMOKE DETECTOR

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[52] **U.S. Cl.**.....**340/237 S,** 250/218

[51] **Int. Cl.**.....**G08b 17/06,** G08b 17/10

[58] **Field of Search** .....340/237 S; 250/218

[56] **References Cited**

UNITED STATES PATENTS

3,555,532	10/1968	White et al.	340/237 S
3,474,435	10/1966	White et al.	340/237 S

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Assistant Examiner—Daniel Myer
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[57] **ABSTRACT**

Detection and warning of hazardous smoke and heat conditions are performed by a network wherein a photocell triggers a thyristor-controlled alarm in response to a particle-reflected illumination from a timing-circuit flasher within a light-tight detector chamber which admits smoke particles wafted by rising air currents, the detector chamber being finned, baffled and surfaced to promote the intended responses to smoke, and a thermal detector being connected to trigger the thyristor when effects of ambient heat predominate.

2 Claims, 6 Drawing Figures

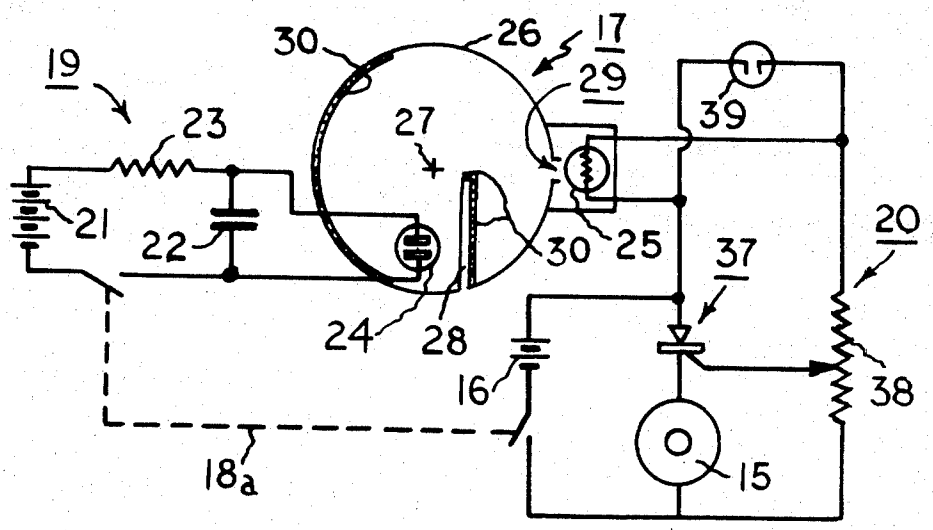


Fig. 1.

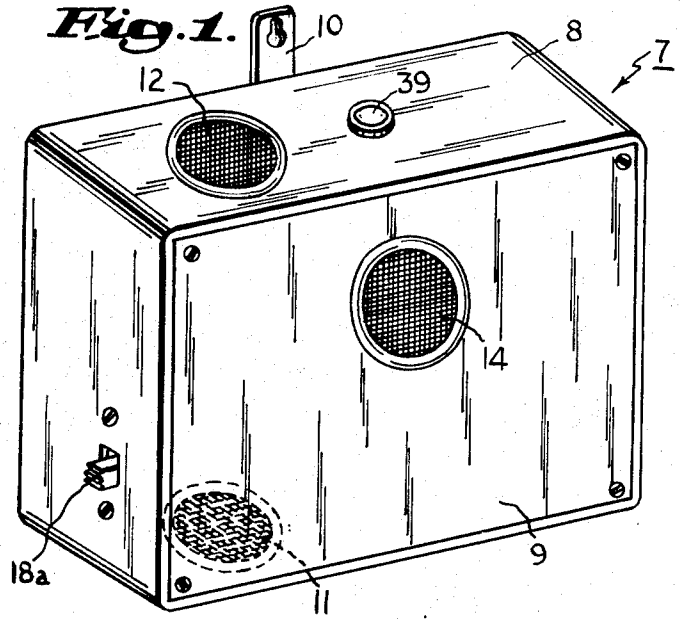


Fig. 4.

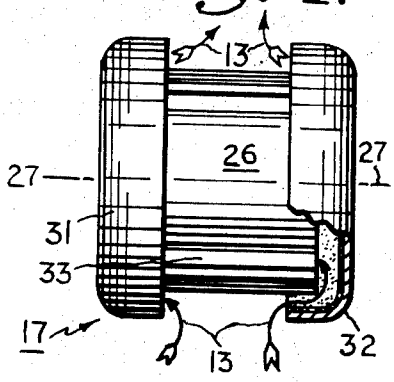


Fig. 5.

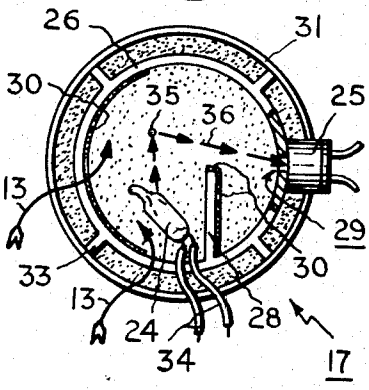


Fig. 2.

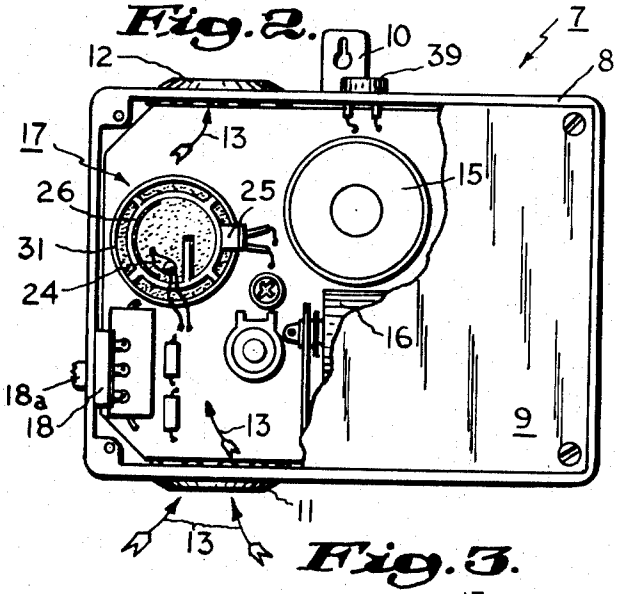


Fig. 6.

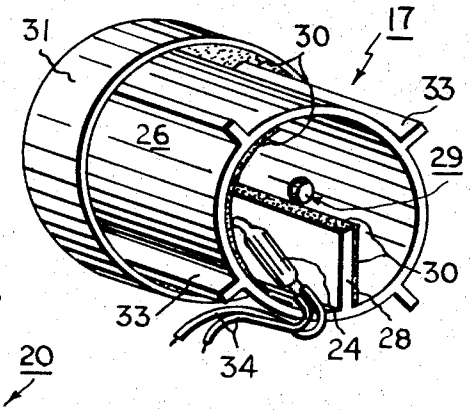
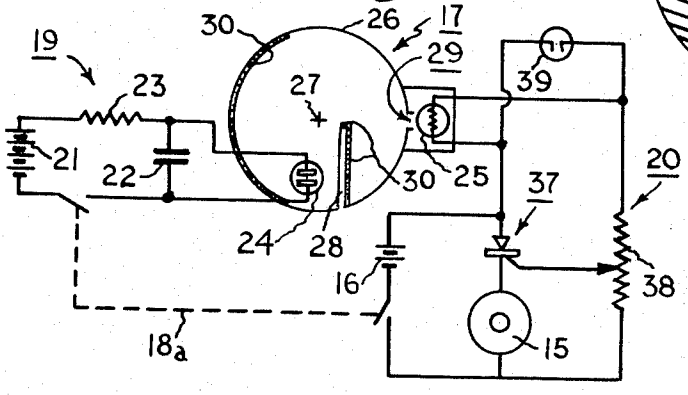


Fig. 3.



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ELECTRONIC SMOKE DETECTOR

BACKGROUND OF THE INVENTION

The present invention relates to improvements in the electronic detection and warning of hazardous conditions such as those of smoke and heat attending the initial stages of a fire, and, in one particular aspect, to novel and improved smoke detectors of uncomplicated reliable construction in which a single periodically-flashing gas tube cooperates with a photoresponsive cell in a unique reflecting chamber, the low-power flashing circuitry being in electronic triggering control of an electrical alarm circuit which is electrically in an essentially standby condition.

Proposals for the use of photocells and an associated light source as a means for sensing the presence of minute particles such as those of smoke have been known for some time, and in a variety of forms. Smoke obstruction of a light path through a forcibly-circulated air path was relied upon to detect fire conditions in U.S. Pat. No. 2,185,361, for example, and the fire itself provided a light source for photocell excitations in the ducting control arrangement of U.S. Pat. No. 2,355,664. Reflections, by smoke particles, of light from incandescent lamps, served to actuate photocells and their associated electrical alarm-operating relays, in U.S. Pat. Nos. 2,301,367 and 2,537,028. In efforts to offset certain inherent difficulties associated with the illuminations in such systems, an infrared source and multiple frequency-selective photocells have been proposed, as in U.S. Pat. No. 3,122,638.

Power drain in fire detection systems is a significant problem, inasmuch as the hazard itself may have its origins in electrical faults which could disable a detector operated from conventional power lines, and because battery-operated units capable of energizing conventional lamps and relays cannot be expected to function over long periods without replacements. In this same connection, the need for auxiliary fans to force circulation of smoke-laden air to a detection site only compounds the difficulty. Further, such systems should be of relatively inexpensive, compact and uncomplicated construction, and should readily lend themselves to simple installations in almost any location, if they are to promote their intended purposes; moreover, their important warning functions dictate that they be highly reliable without involving critical adjustments.

SUMMARY

By way of a summary statement as to practice of this invention in one of its aspects, an improved smoke detector is packaged within a small enclosure having provisions for wall mounting, the enclosure having a lower inlet which will admit smoke wafted on rising air currents and further having upper outlets from which the intake of smoke may be discharged after it has been exposed to a light-tight smoke-detector cartridge disposed in the path of rising smoke currents within the enclosure. The hollow cartridge, which is generally cylindrical and oriented with its longitudinal axis substantially horizontal, is provided with external smoke-directing fins, end-caps fitted to exclude light but admit smoke, and an internal partition screening a photoresponsive cell from a gas-discharge tube within it; the finned and baffled body portion of the cartridge is conveniently fabricated as a section of an appropriately-shaped extrusion. All internal surfaces to which the cell is directly exposed are rendered non-reflective, while remaining internal surfaces are reflective of illumination from the gas-discharge tube and of secondary reflections from smoke particles. Periodic low-frequency firings of the gas-discharge tube are developed by a battery-powered relaxation circuit, and resulting responses, if any, of the cooperating light-detecting cell trigger a thyristor-controlled alarm horn which is also energized by a battery; normal power drain is exceedingly low in both the relaxation and alarm circuits. A thermal detector element cooperates with the thyristor to trigger the same alarm when ambient temperatures exceed a predetermined level.

It is one of the objects of the present invention to provide novel and improved fire-detection apparatus of inexpensive compact construction which operates reliably without attention over long periods of time, and in which both optical and alarm networks occasion only exceedingly low power drain.

A further object is to provide unique fire-detection apparatus wherein smoke levels are sensed within a light-shielded detector in which periodic flashes of light from a miniature gas discharge tube are efficiently reflected from smoke to a photoresponsive tube which, together with a thermal detector, is in triggering control of a thyristor alarm circuit.

Another object is to provide a fire detector unit in which smoke particles reflect to a photoresponsive cell the light developed periodically by a neon-tube in a low-power relaxation circuit, the unit being light-tight and having internal baffling and reflective surfaces to improve responses to low levels of light, and further having smoke-directing fins which promote flow of smoke through the light-tight unit.

Although the features of this invention which are considered to be novel are expressed in the appended claims, further details as to preferred practices, as well as to further objects and advantages, may be most readily comprehended through reference to the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective pictorial view of an improved fire detection apparatus designed for wall mounting;

FIG. 2 provides a front view of the same apparatus, with a portion of the front cover broken away to expose internal assembly details;

FIG. 3 is a schematic representation of gas-discharge tube relaxation circuitry in cooperation with a thyristor-controlled alarm circuit by way of an intermediate optical detector unit;

FIG. 4 portrays a light-tight smoke-circulating optical smoke-detector unit, from the side;

FIG. 5 views the smoke-detector unit of FIG. 4 from one end, with an end cover removed, and with a portion of the body broken away to expose an aperture admitting reflected light pulses to a photoresponsive cell; and

FIG. 6 depicts the unit of FIG. 5 in perspective.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As is illustrated in FIGS. 1 and 2, the improved fire-detection apparatus 7 is compactly packaged within a hollow enclosure 8 of generally rectangular outline having a removable front panel 9 and a rear bracket 10 by which the apparatus may be hung in the attitude shown. Grilles 11 and 12, at the bottom and top, respectively, and substantially in vertical alignment with one another, include metal or like mesh which will screen out dust particles but will admit and discharge smoke carried by ambient rising heated air currents, as designated by arrows 13 (FIG. 2). A like grille, 14, is located in front panel 9, and further serves to release audible warning signals emitted from an electrically-operated horn 15 within the enclosure. Electrical excitations are provided by batteries housed within the enclosure, one of which, 16, is visible in FIG. 2; these batteries, and horn 15, are mounted to one side of the vertical smoke-flow path between grilles 11 and 12, such that smoke traversing that substantially open path will mainly be intercepted by the smoke-detector unit 17, which is seen on end and with one end cover removed in FIG. 2.

A single-throw double-pole switch 18, mounted with its actuating button 18*a* accesible from the exterior of enclosure 8, controls the battery excitations for two electronic circuits, 19 and 20 (FIG. 3), which are in cooperative relation by way of the detector unit 17. Circuit 19, which is powered through switch 18 by a relatively high-voltage battery source 21, comprises a simple R-C charging-and-discharging relaxation arrangement in which capacitor 22 is repeatedly charged through resistance 23, the inexpensive miniature neon gas-discharge tube 24 being periodically flashed each time its breakdown voltage is reached by the capacitor. The flashing rate, governed by the R-C circuit time constant, is preferably very slow, such as a 2-second or longer rate, and the resulting power drain is exceedingly low, permitting the battery to maintain the slow periodic flashing for a very long continuous period of time.

Illumination from each of the flashes of neon tube 24 is only at a very low level, and the associated photoresponsive cell, 25, such as one which efficiently changes resistance when irradiated with light of the spectral values developed by tube 24, must reliably respond only to the yet lower levels of such light reflected from certain of the smoke particles within unit 17. Therefore, it is highly important that unit 17 be light-tight in relation to ambient illumination which might falsely trigger cell 25 or which might seriously reduce its wanted sensitivity to flashes of smoke-reflected light from neon tube 24. At the same time, however, the detector unit must efficiently ingest smoke rising through the enclosure. To these ends, unit 17 is formed with a hollow-cylindrical body portion, 26, the longitudinal axis 27—27 (FIG. 4) of which is disposed substantially horizontally when the enclosure 8 is in a normal installed position. And, body portion 26 is provided with an internal partition 28 extending partly along a chord thereof, to screen from direct illumination, by the neon tube 24, the light-opening 29 which is intended to allow only smoke-reflected light to reach the cell 25 through a wall of the body portion. In addition, all interior surfaces of the body portion are specular except those which would directly reflect light from the neon tube to the cell; the latter surfaces are provided with a non-reflective dull black coating, designated by reference character 30. Further, the light-tight but smoke-admitting characteristics of the unit are promoted by cup-shaped end caps 31 and 32 (FIGS. 4 – 6) which are also internally coated to be non-reflective, and which are both axially spaced from the ends of the body portion and are radially spaced from the body portion by the latter's external longitudinally-extending fins 33 which extend part way into the end caps.

As is shown in FIGS. 4 and 5, rising smoke, designated by arrows 13, may enter the detector unit 17 between the end caps and body portion, being slowed and directed by the fins 33; egress of smoke is from the upper part of the unit, also between these end caps and the body portion with which they are partly mated. The miniature neon tube 24 may be allowed to rest in the unit as shown in FIGS. 5 and 6, with its flexible leads 34 threaded through end space under one of the caps. A typical light-ray track from tube 24 to a smoke particle 35, and thence by reflection to cell 25, is designated by reference character 36 in FIG. 5.

The second cooperating circuit, 20 (FIG. 3), includes the aforementioned warning horn 15 and battery 16 in a thyristor-controlled arrangement involving the bistable silicon controlled rectifier (SCR) 37. Horn 15, battery 16 and one switch section of switch 18 are in series through the anode-cathode electrodes of SCR 37, and the photoresponsive cell 25 and a series potentiometer resistance 38 are in parallel with the battery and switch section, the potentiometer tap providing a normal gate bias for SCR 37 which is just below the triggering level for that SCR. Under normal smokeless conditions, the standby power drain of circuit 20 is exceedingly small, and long operating life without battery changes is assured. Once the cell 25 responds to presence of a predetermined amount of smoke, and the flashed reflection therefrom, the gating bias changes and causes the SCR to switch to the ON state, with resulting excitation of the alarm horn to signal the detection of hazardous smoke conditions. Potentiometer 38 may be set to permit smoke detection and triggering of the alarm for levels of smoke which are as low as 2–4 percent of the ingested air. In the same circuit, a thermal detector 39 is also provided, in parallel with cell 25, and will cause like gating and triggering of the alarm when ambient temperatures exceed safe levels. Thermal detector 39 may be of the illustrated bimetal type, or of a variable-resistance type, and is preferably exposed outside of the enclosure 8 FIGS. 1 and 2). Following the sounding of an alarm, the apparatus may be turned off and reset by turning the switch 18 off and on.

Cell 25 may also be of a type other than photoresistive, and the illustrated horn alarm may be aided or replaced by other signalling or automatic control devices. The body portion of smoke detector unit 17 is conveniently formed as an extrusion, but its shape may be other than cylindrical, and the internal partition or baffle and the external fins may be made as separate elements and in configurations other than those specifically illustrated. The reentrant configuration of the light-blocking but smoke-passing passageways between

the end caps and body portion of the detector unit may also be expressed in other designs. Accordingly, it should be understood that the preferred embodiments of the invention have been described and depicted for purposes of disclosure tather than limitation and that those skilled in the art may introduce various modifications, combinations and substitutions without departure from the spirit and scope of this invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Fire detection apparatus comprising a gas-discharge tube, a relaxation circuit consisting essentially of said gas-discharge tube and a resistance and a capacitance and which periodically fires said tube to develop periodic flashes of light therefrom, a photoresponsive cell exhibiting different resistances when illuminated and not illuminated by light from said tube, a substantially light-tight detector unit having a body portion with an opening therethrough defining a hollow chamber, said body portion of said detector unit being substantially cylindrical and having a plurality of external axially-extending radial fins for guiding rising smoke into said opening, a pair of spaced caps extending across the opposite ends of said opening and having ends of said body portion nested therein in spaced relation thereto, means for supporting said detector unit with said end caps spaced along a substantially horizontal axis, whereby ambient light is excluded from and smoke is permitted to pass into and out of said chamber, said caps with which said ends of said body portion are nested being cup-shaped, said gas-discharge tube being disposed within said chamber to illuminate smoke therein periodically and said photoresponsive cell being optically in communication with the interior of said chamber to respond to light flashes from said tube reflected by smoke in said chamber, said detector unit including means blocking passage of light from said tube directly to said cell, said means blocking passage of light comprising an internal partition extending substantially along part of a chord of said opening through said cylindrical body portion, said tube and said cell being disposed on opposite sides of said partition, non-reflective coatings on internal surfaces of said caps and on the internal surfaces of said chamber which are disposed to reflect light from said tube to said cell without reflection from smoke, other internal surfaces of said chamber being reflective of light reflected by smoke in said chamber, an enclosure, said enclosure having lower and upper openings for respectively admitting and discharging smoke carried by rising air currents, means including said supporting means mounting said detector unit within said enclosure with said horizontal axis transverse to and in the path of travel of smoke therethrough between said openings, a normally-OFF bistable circuit including signalling means responsive to an ON condition of said circuit, and means for gating said bistable circuit to said ON condition responsive to resistances of said cell which represent at least a predetermined level of illumination of said cell by reflected flashing of light from smoke in said chamber, said bistable circuit including a thyristor, and said gating means comprising means applying bias to the gate electrode of said thyristor responsive to resistances of said cell.

2. Fire detection apparatus comprising a gas-discharge tube, means for periodically firing said tube to develop periodic flashes of light therefrom, a photoresponsive cell exhibiting different resistances when illuminated and not illuminated by light from said tube, said gas-discharge tube comprising a neon tube, a substantially light-tight detector unit having a hollow chamber therein with openings communicating smoke from the exterior thereof into and out of said chamber and shielding the interior of said chamber from ambient light, said neon tube being disposed within said chamber to illuminate smoke therein periodically and said cell being optically in communication with the interior of said chamber to respond to light flashes from said tube reflected by smoke in said chamber, said detector unit including means blocking passage of light from said tube directly to said cell, means guiding rising smoke into said chamber through said openings, a normally-OFF bistable circuit including an electrically-operated sonic alarm responsive to an ON condition of said circuit, means for gating said bistable circuit to said ON condition responsive to resistances of said cell which represent at least a predetermined level of illumination of said cell by reflected flashing of light from smoke in said chamber, said bistable circuit comprising a silicon controlled rectifier, said gating means comprising means applying bias to the gate electrode of said silicon controlled rectifier responsive to resistances of said cell, said firing means comprising a relaxation circuit consisting essentially of a resistance and capacitance and said neon tube, the time constant of said relaxation circuit being of the order of a few seconds, battery means energizing said relaxation circuit, bistable circuit and gating means, a temperature detector, said gating means being further responsive to electrical characteristics of said temperature detector which represent at least a predetermined hazardous ambient temperature sensed by said temperature detector, and electrical switch means for disabling said silicon controlled rectifier after it has been gated to said ON condition.

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