May 25, 1965 A. D. KOMPELIEN 3,185,975

PHOTOELECTRIC SMOKE DETECTOR

Filed June 18, 1962

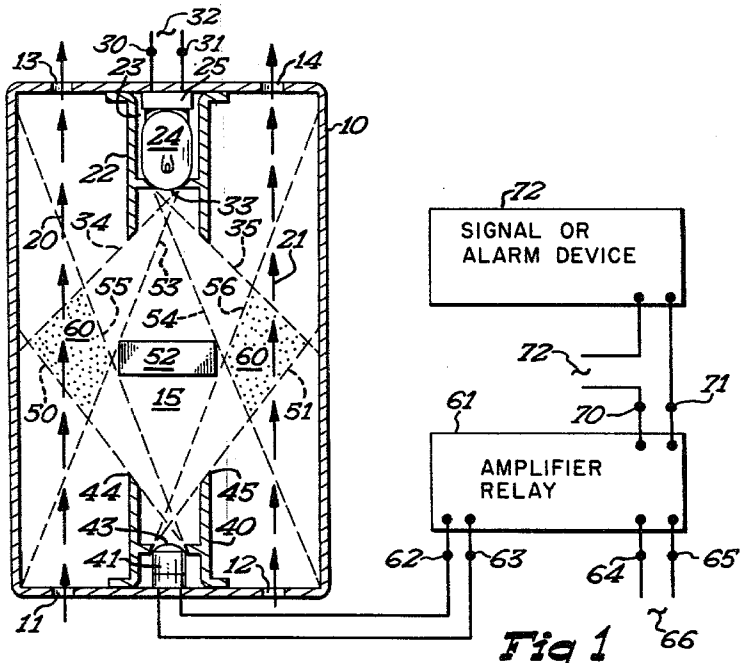


Fig 1

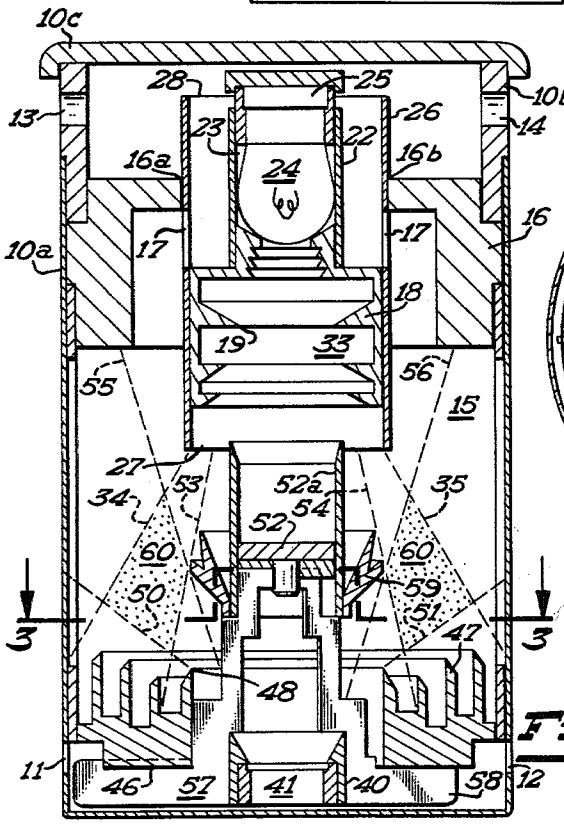


Fig 2

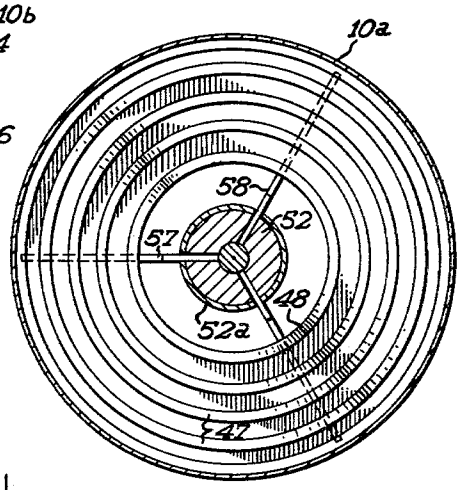


Fig 3

INVENTOR.
ARLON D. KOMPELIEN
BY Clyde C. Glenn
ATTORNEY

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PHOTOELECTRIC SMOKE DETECTOR

Arlon D. Kompelien, Richfield, Minn., assignor to Honeywell Inc., a corporation of Delaware

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This invention relates generally to apparatus used in conjunction with standard fire detection and alarm systems. More particularly it concerns a device which is designed to detect and announce the presence of smoke in an air stream flowing through said device. The components are arranged so that light reflected from the smoke is detected by a normally unilluminated photoelectric cell.

While this general idea is not new, its utilization in a device suitable for commercial use has given rise to several problems. One such problem has been to achieve a stable environment for the photocell under normal conditions. The problem is especially critical when, as here, photocell and light source are mounted in close proximity within the same casing. A certain amount of light has always been reflected from the interior surfaces of the casing in previous smoke detectors; this light affecting the photocell even when smoke is not present in the casing. Since the photocell must be sufficiently sensitive to detect the small increase in light when smoke is present, a similar increase in light caused by normal variations in intensity of the light source will also cause the device to initiate an alarm. One solution to this problem has been to design the electrical circuitry such that the variations in light intensity cancel out. This often requires the use of two photocells. Although this results in stable operation, it is essentially a compromise between sensitivity and stability since the sensitivity of a photocell to a given increase in light is reduced as the normal ambient light level increases. The signal to noise ratio of the output from the photocell will be the best when the increase in light sensed is large in relation to the normal level. Thus for a given increase in light, a much more usable signal will be obtained from a photocell which is normally unilluminated than from one which is normally exposed to light. A novel solution to the problem is disclosed in my invention. The photocell is completely shielded from stray light under normal conditions, thus precluding the need for complicated electrical stabilization circuitry. The shielding is accomplished by a block mounted between the light source and the photocell. The symmetrical arrangement of the light source, light block and photocell permits the use of new and more effective components designed to reduce reflected light without sacrificing the size of the area surveyed by the photocell.

It is an object of my present invention to provide a method for detecting the presence of smoke in the air passing through a device having a light source and a photocell mounted therein, the photocell being maintained in an unilluminated condition through the use of light directing and shielding means arranged in a new and unique relationship with respect to the light source and the photocell.

A further object of my invention is to provide a smoke detector having unusual stability and sensitivity due to the normally unilluminated condition of the photo-electric cell and to the suppression of unwanted light reflections within the detection compartment.

Further objects and advantages of my invention will be evident upon consideration of the specification and claims contained herein in conjunction with the appended drawings in which:

FIGURE 1 is a cross sectional side view of the proposed smoke detector in simplified form, showing the major components and their structural relationship.

FIGURE 2 is a cross sectional side view of the preferred embodiment of my invention.

FIGURE 3 is a sectional view on line 3—3 of FIGURE 2, as seen from the top.

Referring now to the drawings, there is illustrated in FIGURE 1 a cross-sectional side view of the proposed smoke detector. FIGURE 1 is intended to show the general location of components and convey their intended function rather than illustrate their detailed structure. The essential components are located within a cylindrical casing 10 having openings 11 and 12 in its lower portion and openings 13 and 14 in its upper portion. Openings 11, 12, 13 and 14 allow air to flow through a compartment 15 as indicated by the arrows 20 and 21. Mounted in the upper portion of compartment 15 is a second cylinder 22 having a chamber 23 therein. Located in chamber 23 is a source of light 24 and suitable mounting means 25. Conductors 30 and 31 connect light source 24 to a suitable source of power 32. When energized, light source 24 radiates heat which provides the energy necessary to induce convective air flow through the smoke detector. An aperture 33, provided in the lower portion of chamber 23, directs light downward into compartment 15 in a conical beam within the limits schematically defined by the dashed lines 34 and 35.

A third cylinder 40 is mounted in the lower portion of compartment 15 directly below light source 24. A photoelectric cell 41 is mounted within cylinder 40. An aperture 43 in the top of cylinder 40 and the edges 44 and 45 of cylinder 40, limit the field of view of photocell 41 as illustrated by the dashed lines 50 and 51. Located in the center of compartment 15 directly between light source 24 and photocell 41 is a block 52 which is impervious to light. Light block 52 defines the inner limits 53 and 54 of the light beam and the inner limits 55 and 56 of the field of view of photocell 41. The cone of light from light source 24 and the field of view of photocell 41 thus intersect in an annular area 60 surrounding light block 52.

Because of light block 52, photocell 41 is normally shaded. If, however, smoke is being carried by the air through annular area 60, photocell 41 will detect light being reflected therefrom.

An amplifier relay combination 61 substantially equivalent to that disclosed in the Pinckaers Patent 3,024,390, is connected to photocell 41 by conductors 62 and 63. Conductors 64 and 65 connect amplifier relay 61 to a suitable source of power 66. Photocell 41, in response to light reflected from smoke suspended within annular area 60, passes a small magnitude electrical current to amplifier relay 61 through conductors 62 and 63. When the signal reaches a predetermined amplitude, amplifier relay 61 closes the circuit between conductors 70 and 71. A source of power 73 provides current through the circuit thus established to energize the signal or alarm device 72.

Referring now to FIGURE 2, a more detailed cross-sectional view of the preferred embodiment of my invention is shown. Surrounding the device is a casing

having three sections (10*a*, 10*b* and 10*c*) which are joined together to form a closed cylinder. Sections 10*b* and 10*c* can be separately detached from section 10*a* to allow access to the interior of the device. Attached to the entire interior circumference of section 10*a* near its junction with section 10*b* is a supporting member 16. Supporting member 16 reduces the circular opening in the top of cylindrical section 10*a* to the diameter 16*a*–16*b*. Attached directly to the inner surface of the opening thus formed by supporting member 16 is a second cylinder 26 having an opening 27 at the base and an opening 28 at the top. Cylinder 26 has also a series of openings 17 surrounding its outer circumference below the point of attachment to supporting member 16. Mounted within the lower portion of cylinder 26 below openings 17 is an aperture forming device 18. The aperture 33 thus formed is defined by a series of irregular protrusions 19 arranged in circular fashion around the interior of aperture forming device 18. Attached directly above aperture forming device 18 is a third and still smaller cylinder 22 having a chamber 23 therein. A light source 24 together with suitable mounting means 25 is mounted within chamber 23. Light source 24, when energized, provides a beam of light which is projected downward through aperture 33 into a lower compartment 15. The beam of light thus formed is conical in shape, having its apex at light source 24. The protrusions 19 within aperture 33 are designed to minimize the amount of light scattered outside the conical beam, the limits of which are shown by dashed lines 34 and 35.

A photoelectric cell 41 is mounted in a casing 40 which is attached to the base of the smoke detector directly below and coaxial with light source 24. Surrounding photocell 41 is a light absorbing device 46 having a series of concentric ridged rings 47 mounted on the upper surface thereof. The rings 47 are designed to prevent light from being reflected back into compartment 15, thus keeping in darkness the inner surface of section 10*a* which is surveyed by photocell 41. The inner-most ring 48 of light absorbing means 46 limits the field of view of photocell 41 within an arc described by dashed lines 50 and 51.

A light block 52 is located directly between light source 24 and photocell 41 to prevent light from impinging directly upon photocell 41. Light block 52 is secured firmly in place by support members 57 and 58. A cylindrical casing 52*a* surrounds light block 52 and extends upward into opening 27 of cylinder 26. Because of this feature, the light reflected from the upper surface of light block 52 is captured within casing 52*a* and thus is prevented from being reflected into compartment 15. Further surrounding light block 52 is a winged structure 59, again designed to minimize the reflection of light within chamber 15. The winged structure 59 also delineates the inner boundaries 53 and 54 of the light beam and the inner boundaries 55 and 56 of the field of view of photocell 41. The light beam and the field of view of photocell 41 thus intersect in an annular area 60 surrounding light block 52.

Air enters compartment 15 through a series of openings 11 and 12 in the lower portion of section 10*a*. The air is induced to move upward through compartment 15 by convection; the convection being caused by the heat generated by light source 24. The air passes through annular area 60 in compartment 15, thence upward through openings 17, opening 28 and finally exits through openings 13 and 14 in the upper portion of section 10*b*. If no smoke is present in the air, the surface of photocell 41 remains unilluminated. If, however, smoke is present, light will be reflected from the smoke particles unto the surface of photocell 41 as the smoke passes through annular area 60.

From the foregoing, it will be apparent that I have invented a smoke detection device having new and unique means for reducing unwanted light reflection within the detection compartment and for maintaining the photoelectric cell in darkness under normal smoke-free conditions.

While I have shown and described a particular embodiment of my invention, it will be understood that changes and modifications may be made within the spirit of the invention limited only by the scope of the appended claims.

What I claim is:

1. A smoke detection device comprising a casing, air intake means in lower portion of said casing, air outlet means in upper portion of said casing, conduit means to direct the flow of said air through said casing, first compartment located in upper portion of said casing, electric light means in said first compartment, a source of power, conductor means connecting said light means to said source of power to energize said light means; said light means being adapted to heat said first compartment, thereby heating the air surrounding said first compartment and thus causing convection currents to flow upward through said casing; light directing means, said light directing means being mounted below said light means in said first compartment such that a cone-shaped light beam is directed downward through said casing, said light directing means being constructed with multiple interior reflecting surfaces arranged to prevent light from being reflected outside said cone of light; light blocking means, said blocking means being mounted directly below said first compartment within said cone of light, said blocking means providing a darkened core within said cone of light; a photoelectric cell, said photoelectric cell being mounted in the lower portion of said casing within said core provided by said blocking means thereby shading said cell, said photoelectric cell having a field of view encompassing the central portion of said casing, a portion of said field of view intersecting an annular section of said cone of light surrounding said light blocking means, said photoelectric cell being responsive to light reflected from smoke particles suspended in the air passing through said annular section of light; light absorbing means, said absorbing means being within said cone of light surrounding said photoelectric cell, said absorbing means preventing light from reflecting unto the interior walls of said casing surveyed by said photoelectric cell; amplifier relay means, second conductor means, said conductor means connecting said amplifier relay means to said photoelectric cell; alarm means; and means connecting said alarm means to said amplifier relay means, said alarm means being activated by said amplifier relay means in response to a signal initiated by said photoelectric cell upon detecting the presence of smoke within said annular section.

2. A smoke detection device comprising, a casing having openings to permit the flow of air therethrough, light source means mounted in said casing and adapted to maintain said air flow, light directing means associated with said source means, said directing means having an aperture through which a beam of light is projected into said casing, a plurality of light deflecting means, said deflecting means being in the form of a ridge-like protrusion encircling the interior circumference of said aperture, each of said deflecting means being mounted within said aperture at a predetermined distance from and at a desired angle with respect to said light source whereby said deflecting means inhibit the reflection of extraneous light outside the limits of the required light beam; a photoelectric cell, said cell being mounted to have a field of view in the direction of said light source, light blocking means, said blocking means being mounted directly between said light source means and said cell to prevent light from falling directly on said cell, said cell responding to light reflected from smoke particles suspended in the air passing through an area common to both said light beam and said field of view of said photoelectric cell; and light absorbing means, said absorbing means being cylindrical in form and mounted in con-

centric ridged rings around said photoelectric cell in the path of said light beam, said light beam being reflected from said absorbing means in such a direction that it does not impinge on an inner surface of said casing within said field of view of said photoelectric cell.

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NEIL C. READ, *Primary Examiner.*