April 4, 1961 A. SCHOEPE ET AL 2,978,582

SMOKE DETECTOR

Filed Aug. 16, 1957 2 Sheets-Sheet 1

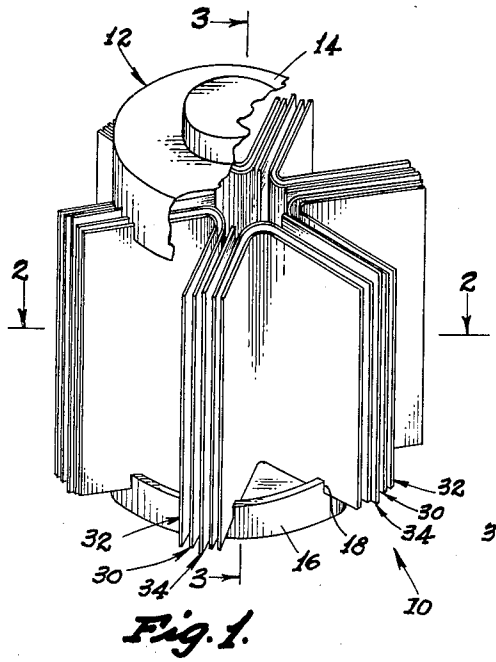

Fig. 1.

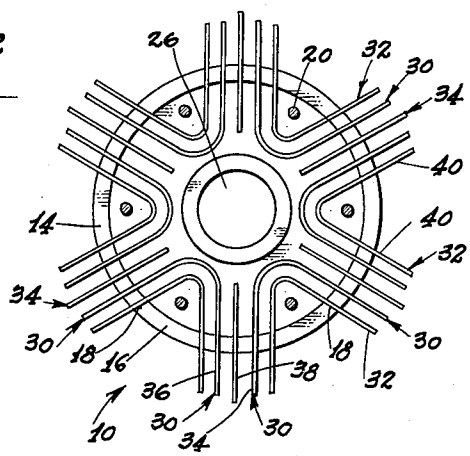

Fig. 2.

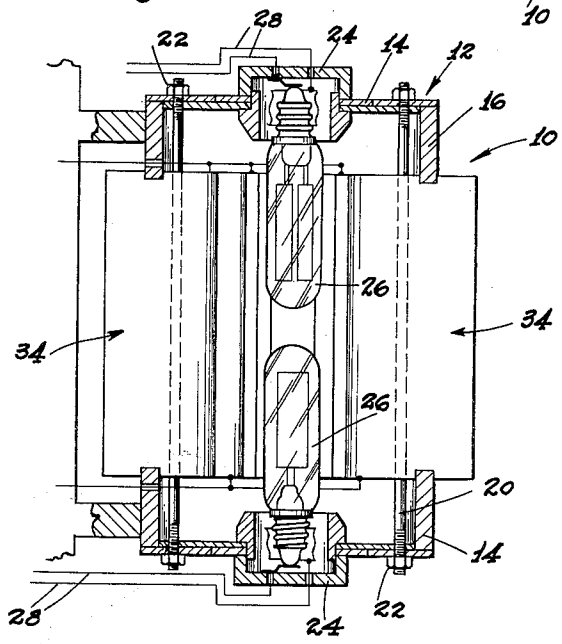

Fig. 3.

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SMOKE DETECTOR

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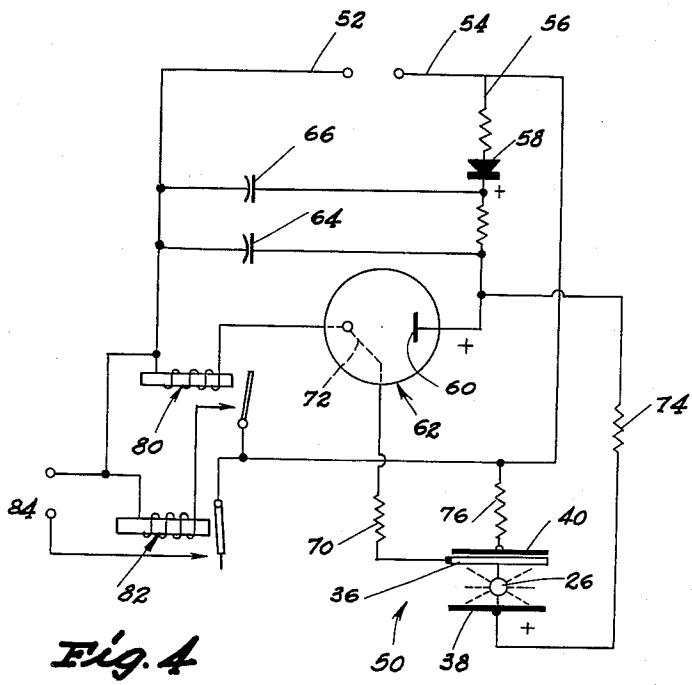

Fig. 4

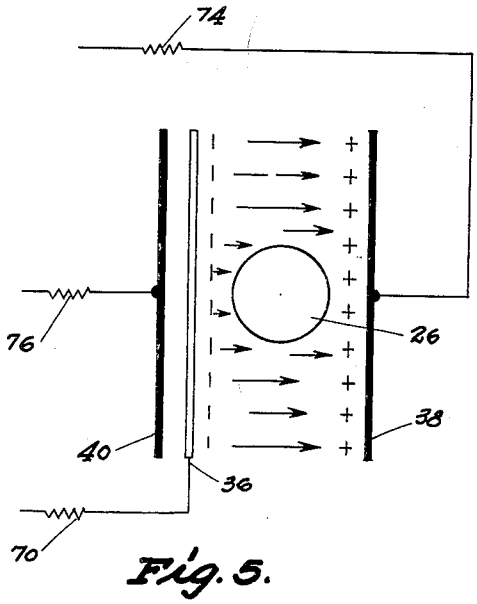

Fig. 5.

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2,978,582

SMOKE DETECTOR

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7 Claims. (Cl. 250—43.5)

This invention relates to a smoke detector and, more particularly, to a smoke detector adapted to be utilized in various types of buildings in detecting smoke prior to the commencement of a full-scale conflagration.

There are, at present, on the market various types of devices which are sensitive to the increase in temperature incidental to a full-scale conflagration in the vicinity and there are also devices which will function when a relatively large amount of smoke is present. The latter devices for detecting smoke are generally photo-electric in character and require a relatively large quantity of dense smoke to cause the energization of the same.

It is, therefore, an object of our invention to provide a smoke detector which is extremely sensitive and which is capable of response to relatively small quantities of smoke, thus permitting the energization of the smoke detector and the detection of smoldering fires prior to the initiation of a full-scale conflagration.

A further object of our invention is the provision of a smoke detector which includes first and second detecting means, one of which is more sensitive to ultraviolet radiation than its associated detecting means, said smoke detecting means being juxtaposed to a source of ultraviolet ray radiation and being incorporated in an electrical circuit having a signal emitting means therein whereby when the smoke detecting means are subjected to the passage of smoke through the field thereof, the circuit and the signal constituting a part thereof are energized to give a warning of smoke conditions in the vicinity of the smoke detector of our invention.

A further object of our invention is the provision of a smoke detecting device of the aforementioned character wherein the more sensitive of the smoke detecting means is constituted by a metal such as selenium, cesium-oxide, tantalum, zinc, or the like which, when exposed to ultraviolet radiation becomes electronegative and which normally retains said electronegative charge as long as its exposure to a source of ultraviolet radiation with which it is associated in the smoke detector of our invention is not interfered with.

However, we have discovered that when a smoke detecting means of the electronegative character described immediately hereinabove is associated with a nonsensitive detecting means or one of less sensitivity, the exposure of the more sensitive detecting means to smoke particles will lessen the electronegative character of the sensitive electronegative detecting means and cause the energization of a circuit associated therewith to create a signal or to actuate a warning device associated with the smoke detector of our invention.

Other objects and advantages of our invention will be apparent from the following specification and the accompanying drawings which are for the purpose of illustration only and in which:

Fig. 1 is a partially sectional view of a smoke detector fabricated in accordance with the teachings of our invention;

Fig. 2 is a transverse, sectional view taken on the broken line 2—2 of Fig. 1;

Fig. 3 is a vertical, sectional view taken on the broken line 3—3 of Fig. 2;

Fig. 4 is a schematic electrical circuit showing the various components thereof incorporated in the smoke detector of our invention; and

Fig. 5 is an enlarged schematic view showing the electrical relationship between the first and second detectors of our invention.

Referring to the drawings and particularly to Figs. 1–3 thereof, we show a smoke detector **10** constructed in accordance with the teachings of our invention and including a housing **12** which includes oppositely disposed, spaced end plates **14** of substantially cylindrical configuration.

The end plates **14**, as best shown in Fig. 3 of the drawings, include axially extending cylindrical mounting flanges **16** formed from insulating material and provided with a plurality of mounting slots **18**, for a purpose which will be described in greater detail below. The end plates **14** are retained in operative and spaced relationship with each other by tie bolts **20** having nuts **22** secured to the outer extremities thereof, as best shown in Fig. 3 of the drawings. Electrical receptors or sockets **24** are mounted centrally of the end plates **14** and are adapted to receive argon glow lamps **26** which are connected by leads **28** to a suitable source of electrical energy.

Mounted between the end plates **14** and supported in the slots **18** provided in the cylindrical flanges **16** thereof are individual smoke detectors constituted, respectively, by internested, substantially V-shaped plates **30** and **32** and individual rectangular plates **34** mounted between opposed legs of the V-shaped plates **30**. The oppositely disposed legs of the V-shaped plates **30** provide first detector elements **36** while the second detector elements **38** are constituted by the rectangular plates **34**. The oppositely disposed legs of the V-shaped plates **32** constitute third detector elements **40**.

In the present embodiment of our invention the first detector plates are formed from zinc, selenium, cesium-oxide, tantalum, or other metal or metal oxide which, when exposed to ultraviolet radiation, acquires an electronegative charge. Since the flanges **16** on the end plates **14** are formed from insulating material, the first detector elements constituted by oppositely disposed legs of the V-shaped plates **30** are insulated to isolate said first detector elements **36** from ground.

The rectangular plates **34** constituting the second detector elements are preferably formed from a material which is completely insensitive to ultraviolet radiation or which is less sensitive to such ultraviolet radiation than the first detector elements **36** so that when the first and second detector elements **36** and **38** are associated in an electronic circuit, to be described hereinbelow, an ionization effect can be created by the passage of smoke into the field thereof to cause the energization of said circuit and the operation of an alarm signal or other device.

The second detector element **38** constituted by the rectangular plate **34** can be fabricated from copper, carbon, or similar materials which are quite insensitive to the operation of the ultraviolet ray radiation emanating from the argon lamps **26** and which are electropositive in contradistinction to the electronegative first detector elements **36** constituted by the oppositely disposed legs of the V-shaped plates **30**.

The V-shaped plates **32** are also formed from the same material as the V-shaped plates **30** and thus, when the plates **30** are formed from copper, the plates **32** will be formed from the same material.

While we have disclosed the various mechanical and electro-mechanical elements of the smoke detector **10** of our invention as formed in predetermined shapes and arranged in predetermined operative and mechanical combinations, as illustrated in Figs. 1–3 of the drawings, it is, of course, conceivable that variations in the operative relationship between the component parts such as the argon lamps **26** and the first, second, and third detector elements may be made. However, by the provision of a mechanical construction of the character previously disclosed, the infiltration of smoke between the first, second, and third detector elements **36**, **38**, and **40**, respectively, is facilitated so that the operation of the smoke detector **10** of our invention is both extremely precise and sensitive.

There is shown in Fig. 4 of the drawings an electrical circuit **50**, the input leads **52** and **54** of which are connected to a simple source of 60 cycle, 115 volt, alternating current. A lead **56** is connected between the input lead **54** and a rectifier **58** whose output of pulsating D.C. voltage is applied to the anode **60** of a thyratron tube **62**. Connected across the anode **60** of the thyratron tube **62** is a capacitor **64** which is connected to the output of the rectifier **58**. A limiting capacitor **66** is disposed in parallel relationship with the capacitor **64**.

The first detector element **36** is connected through a resistance **70** to the grid **72** of the thyratron tube **62** and is exposed to the ultraviolet ray radiation from the argon gas glow lamp **26**. Incidentally, the glow lamp **26** utilized is an AR3 glow lamp manufactured by General Electric and operating in the approximate range of 2800 to 2900 Angstrom units.

Since the first detector element is fabricated from a metal which is rendered electronegative by the action of the ultraviolet ray radiation, the grid **72** of the thyratron tube **62** and the first detector element **36** are floating from a potential standpoint.

The second detector element **38** is connected through a resistance **74** to the pulsating D.C. voltage from the rectifier **58** and is thus maintained at the same potential as the anode **60** of the thyratron tube **62**. The third detector element **40** is connected through a resistance **76** to the lead **54** and is thus supplied with A.C. potential.

A relay **80** is connected to the output of the thyratron tube **62** and when energized by the thyratron tube **62** causes simultaneous energization of a holding relay **82** whose output **84** is connected to a suitable alarm or other device intended to give notice of the existence of smoke conditions and the possible existence of a conflagration constituting the source of the same.

The maintenance of the grid **72** of the thyratron tube at floating potential to maintain the thyratron tube **62** at cut-off depends on several factors, among them being the distance between the ultraviolet radiation source **26** and the total energy of its saturation constant; the distance between the first and second detector elements **36** and **38**; the resistance in ohms of the resistor **70**; the capacitance on the capacitor **64** and the condition of the air between the detector elements **36**, **38**, and **40**.

When the proper relationship between these elements is accomplished by the methods well-known to those skilled in the art, the grid **72** will be maintained in floating bias and the thyratron tube **62** maintained at cut-off to prevent energization of the relays **80** and **82** and the alarm **84** associated therewith.

However, should smoke infiltrate into the field of the detector elements **36**, **38**, and **40**, the smoke particles will be acted upon by the electrons and positive ions between the detector elements to accomplish ionization of the same. The positive ions are attracted to the previously electronegative first detector element **36** and the electrons are attracted to the second detector element **38**. The positive ions attracted to the first detector element **36** alter the electronegative characteristic of said first detector element and raise the potential of the grid

72 of the thyratron tube **62** sufficiently to cause the thyratron tube **62** to fire so that the relays **80** and **82** are simultaneously energized to introduce a signal to the output **84** of the relay **82**.

The thyratron **62**, when energized, discharges the capacitor **64** and the thyratron **62** is thus returned to cut-off and will remain at the cut-off until smoke once again enters the field of the first, second, and third detector elements **36**, **38**, and **40**. The capacitor **66** acts as a limiting capacitor to prevent recurrent energization of the thyratron **62** once the relay **84** has been energized in the above described manner.

The manner in which the electronegative plate **36** functions when exposed to ultraviolet radiation is graphically illustrated in Fig. 5 of the drawings. When exposed to ultraviolet radiation, the plate **36** becomes electronegative and the positive ions are attracted to the plate **38**. When smoke enters the field between the plates **36** and **38**, the plate **36** becomes less electronegative and the grid **72** of the thyratron **62** discharges said thyratron to discharge the capacitor **64**.

We thus provide by our invention a smoke detector which is characterized by its extreme sensitivity attributable, in large part, to the utilization of detecting elements having different levels of sensitivity to an ultraviolet radiation source rendering at least one of the elements more electronegative than an associated element, the electronegative element being associated with the grid of a thyratron tube to control the energization of the same and the energization of a warning signal circuit.

We claim:

1. In a smoke detecting device, the combination of: a source of ultraviolet rays; a first detector element exposed to said source and sensitive thereto; a second detector element exposed to said source and insensitive thereto; a normally inoperative circuit connecting said first and second detector elements in operative relationship with each other; and signal emitting means operable by said circuit upon the exposure of said detector elements to smoke.

2. In a smoke detecting device, the combination of: a source of ultraviolet rays; a first detector element exposed to said source and sensitive thereto, said first detector element incorporating selenium as the ultraviolet ray sensitive medium; a second detector element exposed to said source and insensitive thereto, said second detector element incorporating carbon as the ultraviolet ray insensitive medium; a normally inoperative circuit connecting said first and second detector elements in operative relationship with each other; and signal emitting means operable by said circuit upon the exposure of said detector elements to smoke.

3. In a smoke detecting device, the combination of: a source of ultraviolet rays; a first detector element exposed to said source and sensitive thereto, said first detector element incorporating zinc as the ultraviolet ray sensitive medium; a second detector element exposed to said source and insensitive thereto, said second detector element incorporating copper as the ultraviolet ray insensitive medium; a normally inoperative circuit connecting said first and second detector elements in operative relationship with each other; and signal emitting means operable by said circuit upon the exposure of said detector elements to smoke.

4. In a smoke detecting device, the combination of: a source of ultraviolet radiation; a first ultraviolet ray sensitive detector exposed to said radiation; a second ultraviolet ray insensitive detector juxtaposed to said first detector; a normally inoperative circuit operatively connecting said first and second detectors; and signal emitting means connected in said circuit and energizable thereby when smoke in the field between said detectors causes the energization of said circuit.

5. In a smoke detecting device, the combination of: a source of ultraviolet radiation; first and second detectors

having different levels of sensitivity to said radiation; a normally inoperative circuit connecting said first and second detectors in operative relationship with each other; and signal emitting means operatively connected in said circuit and energizable thereby when smoke in the field between said detectors causes the energization of said circuit.

6. In a smoke detector, the combination of: a source of ultraviolet radiation; first and second detectors juxtaposed to said source, one of said detectors being normally rendered electronegative by said radiation; a circuit incorporating said detectors and being maintained inoperative by said electronegative detector; and a signal operatively connected in said circuit and energizable thereby when said electronegative detector is rendered less negative by the passage of smoke into the field of said detectors to cause the energization of said circuit.

7. In a smoke detector, the combination of: a source of ultraviolet radiation; first and second detectors juxtaposed to said source, one of said detectors being normally rendered electronegative by said radiation and said detectors being constituted by spaced plates contiguous to said source; a circuit incorporating said detectors and being maintained inoperative by said electronegative detector; and a signal operatively connected in said circuit and energizable thereby when said electronegative detector is rendered less negative by the passage of smoke into the field of said detectors to cause the energization of said circuit.

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