Jan. 12, 1971 G. S. WHITE ET AL 3,555,532

VAPOR OR PARTICLE DETECTION DEVICE

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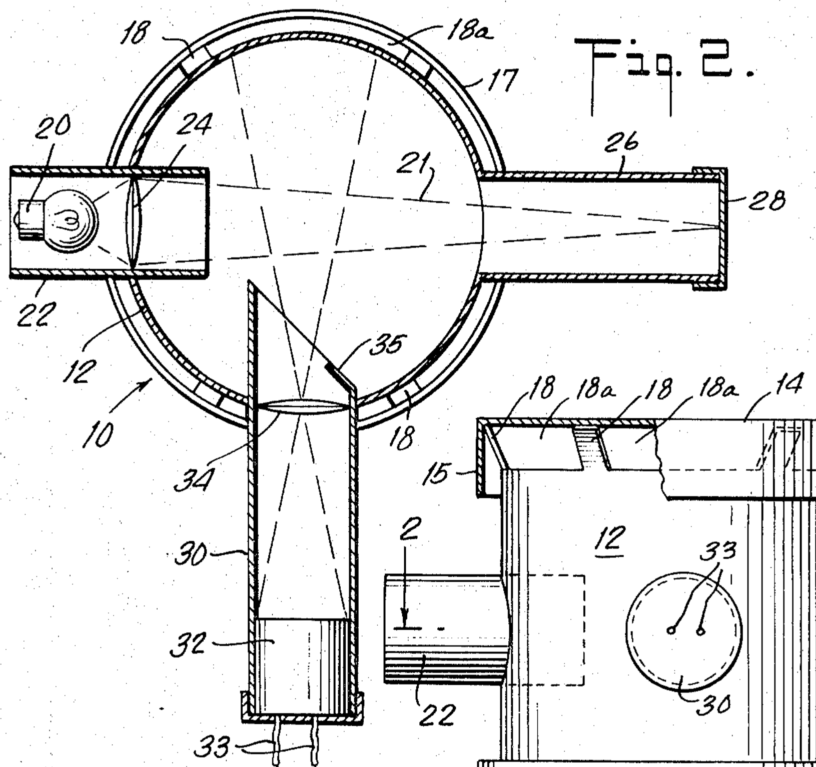

Fig. 2.

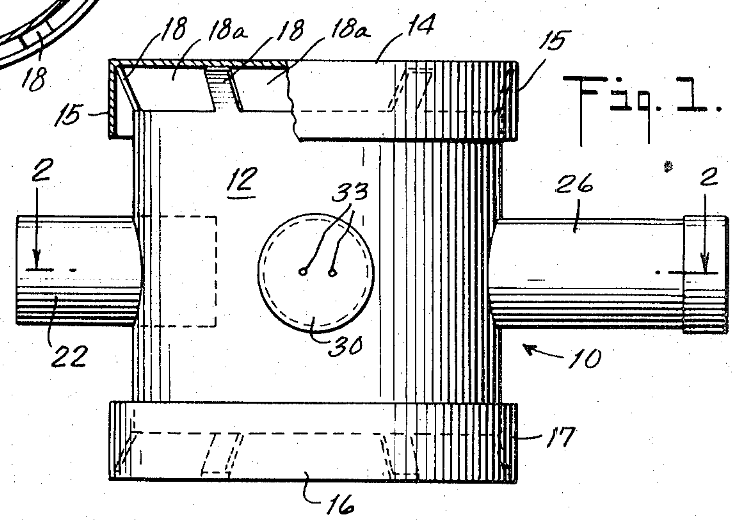

Fig. 1.

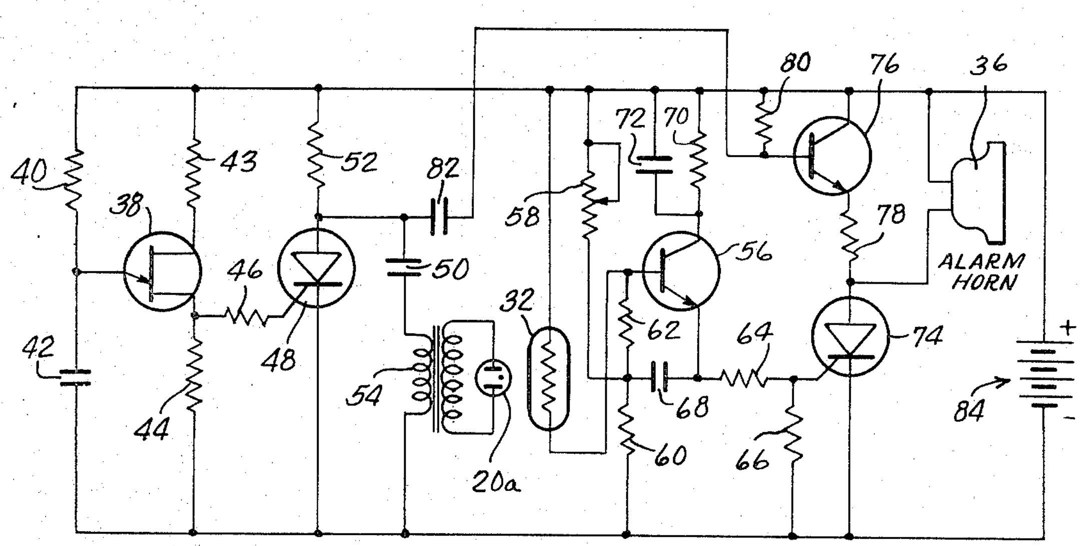

Fig. 3.

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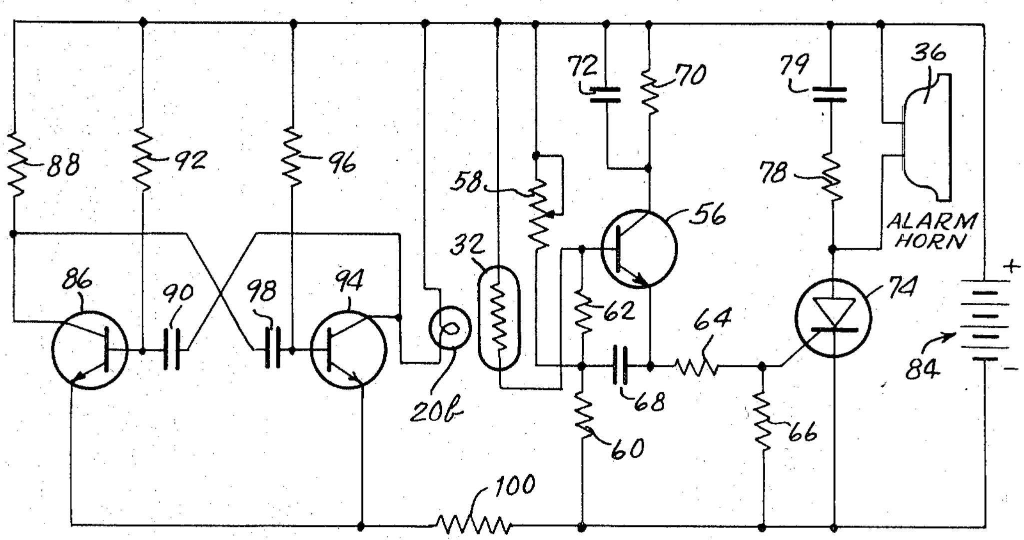
Fig. 4.


88
92
96
58
72
70
79
36
78
ALARM
HORN
56
32
86
90
98
94
62
64
74
84
20b
68
66
60
100
+
-

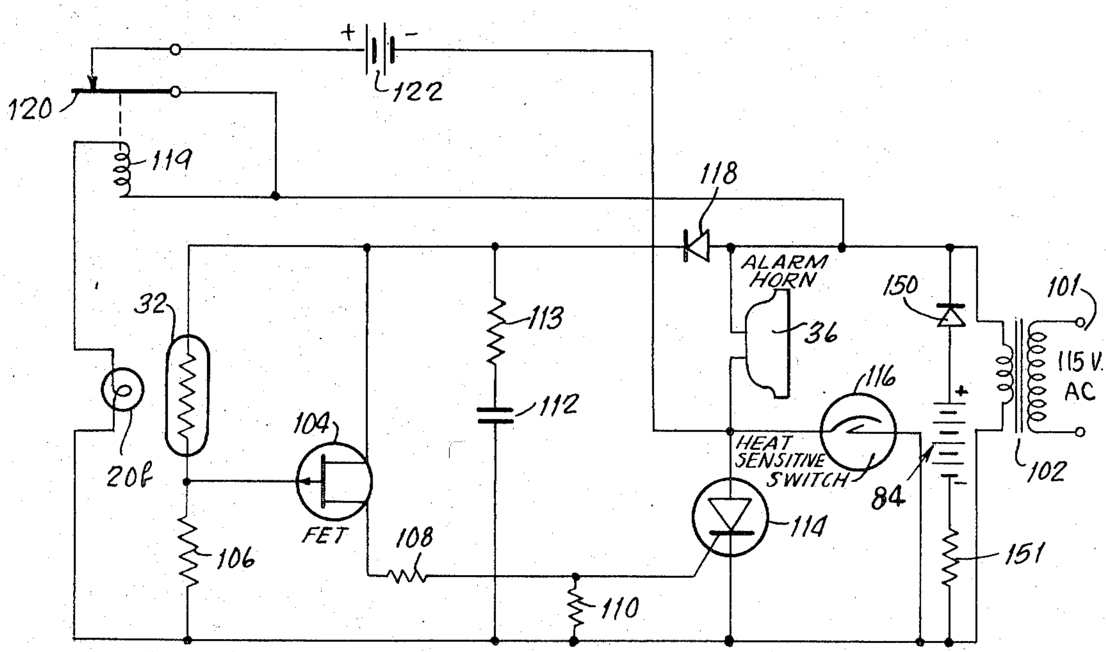

+
-
122
120
119
118
ALARM
HORN
36
150
101
32
113
115 V.
AC
112
116
104
HEAT
SENSITIVE
SWITCH
84
102
20b
FET
108
114
106
151
110

Fig. 5.

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VAPOR OR PARTICLE DETECTION DEVICE

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Fig. 6.

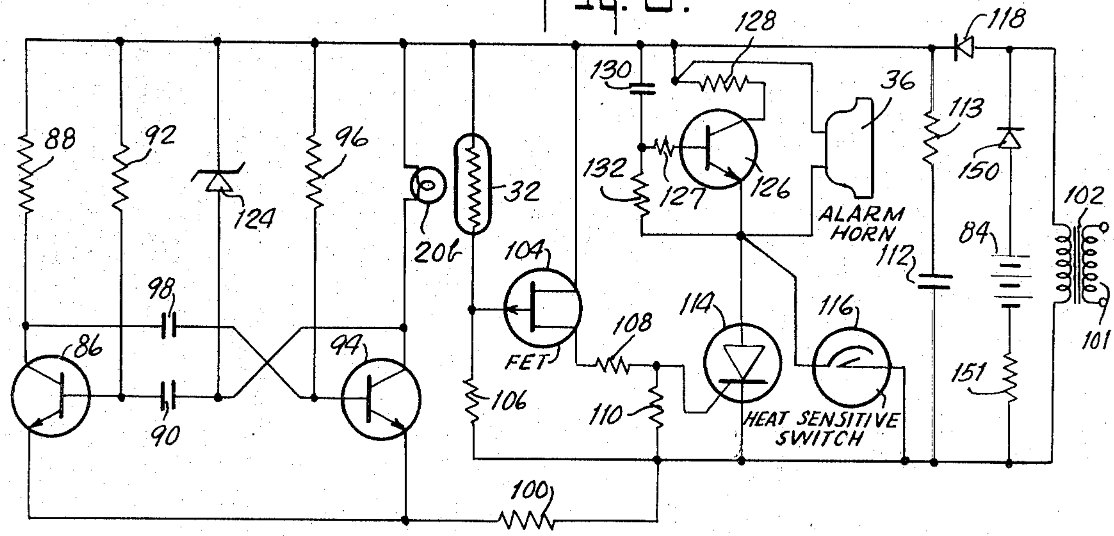


Fig. 7.

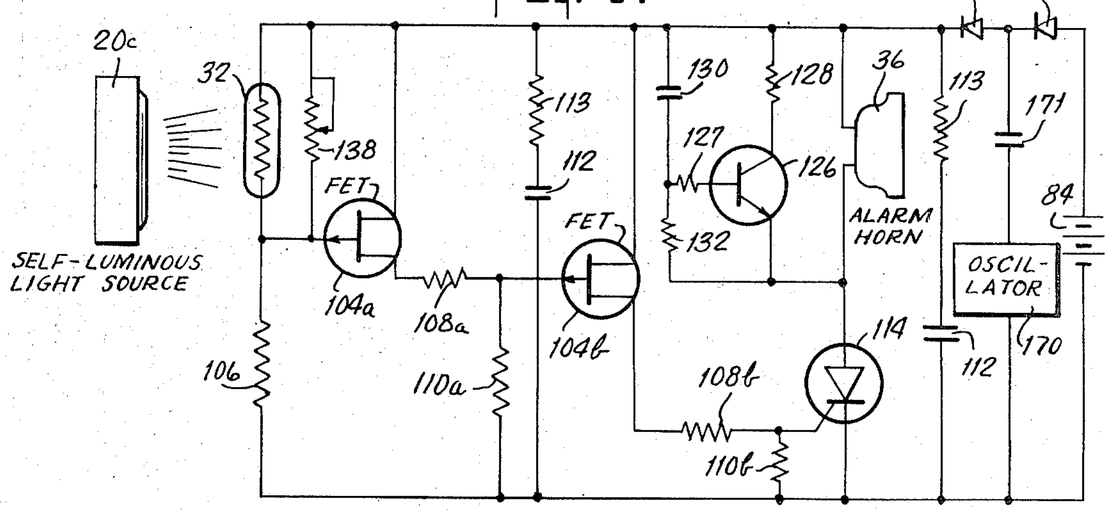
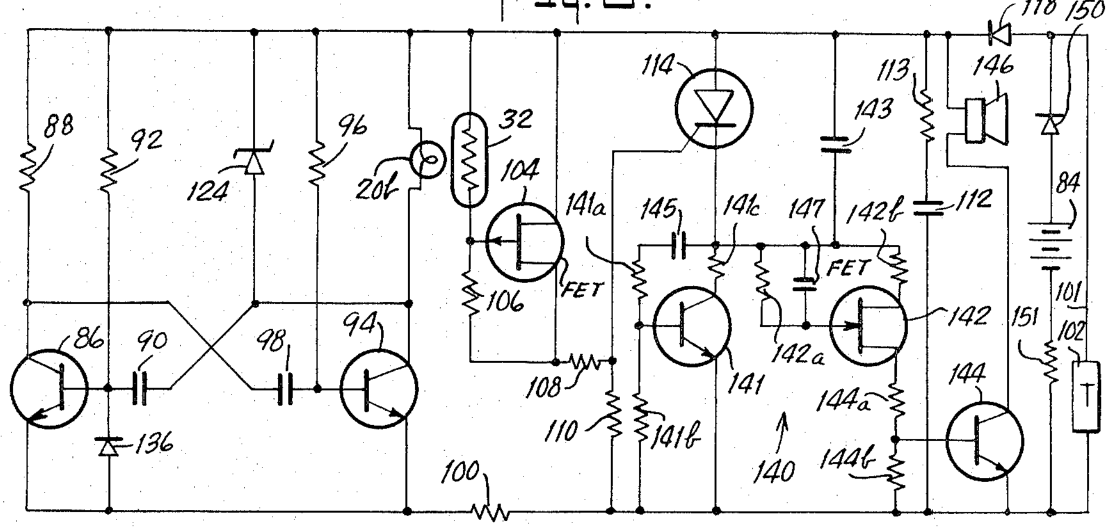


Fig. 8.



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VAPOR OR PARTICLE DETECTION DEVICE

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Continuation-in-part of application Ser. No. 585,782, Oct. 11, 1966. This application Oct. 29, 1968, Ser. No. 771,450

Int. Cl. G08b *17/10*

U.S. Cl. 340—237 3 Claims

ABSTRACT OF THE DISCLOSURE

A vapor, smoke or particle detection device of the type comprising a black-walled chamber containing a light source and a photoconductive cell, arranged to detect light from the source when reflected from particles present in the chamber, and including a self-balancing control circuit for actuating an alarm when the detection signal from the photoconductive cell exceeds a given level. The sensitivity or threshold level of the alarm control circuit is maintained constant despite wide variations in the applied operating voltage by means of a voltage dividing bridge arrangement using an insulated-gate field effect transistor for operating the gate of a controlled rectifier which controls current flow to the alarm device. Also provided in combination are means for intermittently operating the light source for longer battery life, a high temperature detection element and a fail-safe mechanism for signalling when the device is inoperative.

CROSS-REFERENCE

This application is a continuation-in-part of an application for patent filed by the present inventors on improvements in or relating to vapor or particles detection devices, Ser. No. 585,782, filed Oct. 11, 1966, now Pat. No. 3,474,435, issued Oct. 21, 1969.

BACKGROUND OF THE INVENTION

The present invention relates generally to fire and smoke detection and alarm systems and more particularly to a constant sensitivity alarm device for monitoring the presence of smoke, vapor or other particles in the ambient atmosphere.

A variety of electronic devices have been developed for monitoring the level of smoke, vapor or other particles present in a room or enclosure to detect and call attention to abnormal conditions which may result from fires, explosions or other dangerous occurrences. The circuitry associated with such devices has generally been complex and expensive as well as susceptible to failures which are not readily made known to those relying on the operativeness of the apparatus. The introduction of transistorized circuits has alleviated a number of the operating problems but many difficulties still remain such as regulating the sensitivity of the alarm circuit, increasing the life of the components, avoiding component failure at the critical moment and detecting fires which produce heat but a minimum of smoke.

The present invention is intended to provide a smoke detecting device of increased reliability which may also be made heat sensitive and whose sensitivity is maintained constant over long periods of use. In addition, attention-getting alarm signals and a fail-safe feature may be included.

SUMMARY OF THE INVENTION

The present invention embodies a smoke detection device comprising a chamber containing a light source and

a photoconductive cell, which is arranged to detect light from the source only when reflected from particles present in the chamber, and includes a self-balancing control circuit for actuating an alarm. The self-balancing control circuit, which is actuated when the light detection signal from the photoconductive cell exceeds a given level, comprises a voltage dividing bridge arrangement using an insulated-gate field effect transistor for operating the gate of a controlled rectifier which controls current flow to the alarm device. By virtue of this bridge arrangement the sensitivity or threshold level of the alarm control circuit is maintained constant despite wide variations in the applied operating voltage. Other features incorporated in the device are circuits for intermittently operating the light source and the alarm device, alternate power sources, and a fail-safe mechanism for actuating the alarm when the light source is burned out, along with sensitivity adjusting means, and means for detecting the presence of high temperatures in the absence of smoke.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in elevation of the vapor or particle detection chamber of the present invention;

FIG. 2 is a cross-sectional view of the chamber taken along the line 2—2 of FIG. 1;

FIG. 3 is a schematic diagram of the operating circuitry of one form of detection device disclosed in the parent application;

FIG. 4 is a schematic diagram of the operating circuitry of another form of detection device disclosed in the parent application;

FIG. 5 is a schematic diagram of the operating circuitry of the present invention using an amplification circuit containing a self-balancing alarm control circuit and including high temperature sensitive and fail-safe features;

FIG. 6 is a schematic diagram of the operating circuitry of a modified form of the present invention;

FIG. 7 is a schematic diagram of the operating circuitry of another modified form of the present invention; and

FIG. 8 is a schematic diagram of the operating circuitry of a form of the present invention including the use of a speaker in the alarm system.

DETAILED DESCRIPTION

The smoke detecting portion of the device, shown in FIGS. 1 and 2, comprises a vapor or particle detection chamber, indicated generally by the numeral **10**, consisting of an open-ended cylinder **12** and two end plates **14**, **16** which fit loosely over the ends of the cylinder **12** and have inturned peripheral flanges **15**, **17**. Spring tabs **18**, extending from the ends of the cylinder **12** hold the end plates **14** and **16** thereon and maintain the end plates flanges **15** and **17** outwardly spaced from the walls of the cylinder **12**. All the inner surfaces of the chamber **10** are painted dull black so as to be nonreflective.

As best seen in FIG. 2, a light source **20**, such as a bulb or glow lamp, is mounted in a tube **22** extending radially from the wall of the cylinder **12**. This tube **22** also contains a lens **24** which focuses the light **21** from the bulb **20** into a similar tube **26** located directly across the cylinder **12** on the opposite side, the light **21** being focused into a small area on an end cap **28** for the tube **26**. The two tubes **22** and **26** minimize the dispersion of light from the bulb **20** into the main portion of the cylinder **12** thus tending to prevent reflection of light from the cylinder walls.

Extending at right angles to the previously described tubes is a third tube **30**, which protrudes inwardly through the wall of the cylinder **12** while also projecting outwardly beyond the wall. In the outer portion of the third tube **30** there is located a photoconductive cell **32**, which may be a cadmium sulfide cell, and a lens **34** to focus light reflected from any vapor or particles present within the cylindrical chamber onto the cell **32**. The field of view of the lens **34** is greater at the portion of the cylinder wall diametrically opposite the third tube **30** than at the point where the light beam **21** emanating from the bulb **20** crosses the field of view of the lens **34**. The inner portion of the tube **30** is cut on a bias so that the open end is directed away from the light bulb **20**. Moreover, part of the open end of the tube **30** is blocked by a lip **35** so that indirect rays from the end cap **28** will not be reflected onto the photoconductive cell **32**.

Smoke detection occurs generally as follows. Smoke or other particles in the room containing the device will enter the chamber **10** through apertures **18a** between the spring tabs **18** of the cylinder **12** and the end plates **14** and **16**. When the smoke or particles drift into the beam of light **21**, the light is reflected by them onto the photoconductive cell **32**, causing the cell **32** to produce a signal indicating the presence of the light reflecting particles. When the signal reaches a given threshold level, appropriate circuitry, connected to the cell **32** through leads **33**, is activated and accordingly operates an alarm device. The associated operating circuitry comprises the present invention.

Accordingly, improved electrical circuits are provided for operating the light bulb **20**, amplifying the signal from the photoconductive cell **32**, and actuating the alarm device. These circuits are shown in FIGS. 3 through 8 with the circuits of FIGS. 3 and 4 being substantially those shown in the previously cited copending application Ser. No. 585,782, of the present applicants, of which this application is a continuation-in-part.

The circuit disclosed in FIG. 3 shows the general arrangement of all the composite circuits and particularly consists of a relaxation oscillator circuit, at the left side of the figure, for controlling the light source, such as glow lamp **20a**; a gating and amplification circuit, at the right side, for increasing the strength of the signals sent by the photoconductive cell **32** to an alarm horn **36**; and a circuit, at the upper center, for resetting the gating circuit to its original standby condition.

In the oscillator portion of the circuit during normal operation, capacitor **42** is slowly charged by current from battery **84**, which current passes through resistor **40** until the firing voltage of unijunction transistor **38** is reached. At that point capacitor **42** is rapidly discharged through transistor **38** and resistor **44**, producing a current pulse through resistor **44** and a voltage pulse across resistor **40**. Resistor **43** serves to transmit bias current to the base of the transistor **38**. A portion of the current pulse passing through transistor **38** is divided off and passes through resistor **46** to the cathode gate of a controlled rectifier **48**. The rectifier **48** is triggered to operation by this pulse and acts as a switching element to supply the correct current and voltage to intermittently light the glow lamp **20a**. The pulse rate may be set at approximately one pulse per second by determining the appropriate circuit parameters.

The oscillator circuit in this embodiment is particularly intended for use with a long life glow lamp and the actual lighting of the glow lamp **20a** is accomplished as follows. While capacitor **42** is being charged, capacitor **50** is simultaneously being charged through resistor **52**. During the charging period of time, the controlled rectifier **48** is in the "off" state. When a current pulse arrives at the cathode gate, the rectifier **48** rapidly switches to the "on" state and discharges capacitor **50** through the transformer **54**, which, by mutual inductance, charges the glow lamp **20a** until its firing voltage is reached. When capacitor **50** is fully discharged, transformer **54** produces a small reverse charge on the capacitor **50**, which in turn results in a reverse voltage across the controlled rectifier **48**, switching the rectifier to its "off" state. The entire charging cycle is then resumed. The lamp **20a** is thus intermittently lit at a rate which may be set or adjusted by varying the circuit parameters of the oscillator.

When the pulses of light from the glow lamp **20a** are reflected by smoke or vapor, or the like, they fall on the photoconductive cell **32**. The photoconductive cell **32** is included in an amplifying and alarm operating circuit. The light falling on cell **32** reduces its resistance and an indicative current is thereby caused to flow to the base of a current-amplifying transistor **56**, which is biased by a current through resistors **58**, **60**, and **62**. The bias current determines the sensitivity of transistor **56** to the current from the photoconductive cell **32** and can be set at a level for maximum sensitivity by adjusting the variable resistor **58**. Also, it will be seen that the pulsed emitter current when transistor **56** is conducting flows through resistors **64** and **66** and sets up a pulsed potential at capacitor **68**, which results in a higher input impedance for current pulses passing through the input circuit to the base of transistor **56**. Resistor **70** limits the maximum current through transistor **56** while capacitor **72** allows for a higher peak current to be transferred at the moment the current pulse arrives at the base. Thus, when the signal fom photoconductive cell **32** reaches a given threshold value, transistor **56** is gated to conduction and provides an amplified current pulse which appears at the cathode gate of controlled rectifier **74**. The controlled rectifier **74** is switched rapidly to its "on" state when amplified current from transistor **56** arrives at its cathode gate. Conduction of controlled rectifier **74** then causes current to flow through the alarm device or horn **36** producing an appropriate alarm.

Since the horn **36** is operated by a rapid make and break device that causes an intermittent current flow through the horn **36**, the current to the anode of the controlled rectifier **74** is pulsed at a higher frequency than the gating current being transmitted from the photoconductive cell **32**. The controlled rectifier **74** would then ordinarily be shut off immediately after each gating. To prevent this a transistor **76** is provided to supply a holding current for the controlled rectifier **74** through resistor **78**, so that the rectifier **74** remains in its "on" state during the period when the current through the horn **36** diminishes to zero. Resistor **80** allows a bias current to pass to the base of transistor **76**, so that the latter remains in a saturated state and produces the required holding current. The horn **36** is thus caused to operate and produce an alarm when photocell **32** is sufficiently activated to gate amplifier transistor **56**. The alarm will ordinarily operate until controlled rectifier **74** shuts off.

The alarm may be made intermittent in its operation, however, by the provision of a reset circuit including capacitor **82**, which is connected between controlled rectifier **48** and transistor **76**. When rectifier **48** provides a pulse of current, its anode voltage changes rapidly to below ground potential, resulting in a very sharp negative current through capacitor **82** to the base of transistor **76**. This turns "off" the holding current supplied by transistor **76** to controlled rectifier **74**. If the horn **36** is drawing no current at this point, controlled rectifier **74** switches rapidly to its "off" state, where it remains until another current pulse is supplied to its cathode gate. If the horn **36** is conducting the alarm continues until the current shut off in both transistor **76** and horn **36** is coincident. As long as photocell **32** continues to supply a signal the alarm will be reactivated. Thus, horn **36** may be made to produce a pulsing alarm to better attract attention.

The battery **84**, which acts as the power supply for the circuit, need only be of moderate size to operate the device for many months, if the proper values are selected for the components of the circuit to minimize the current to lamp **20a**, as the lamp **20a** is only lit intermittently. Also, the use of a long life glow lamp will further increase the reliability of the detection device.

A more simplified modification of the above-described circuitry is shown in FIG. 4. Here a multivibrator or square-wave oscillator is used to provide intermittent operation of a conventional filament-type light bulb **20***b*. The oscillator circuit comprises two transistors **86** and **94** with base bias resistors **92** and **96** and coupling capacitors **90** and **98**. An output resistor **100** is connected to the emitters of both transistors. Transistor **86** in the left leg of the circuit has a resistance **88** connected to its collector and the bulb **20***b* is connected to the collector of transistor **94** in the right leg of the circuit. When the right leg is conducting the bulb **20***b* will light and when conduction switches to the left leg through transistor **86**, the bulb **20***b* will shut off. As before, the values of the circuit components can be adjusted to provide the desired flashing rate.

The amplification circuit of FIG. 4 is substantially the same as that described in FIG. 3 with the exception that the holding current producing transistor **76** with the resetting circuit are omitted. A shunting capacitor **79** for the horn **36** is substituted in their place.

While the two operating circuits shown in FIGS. 3 and 4 provide comparatively simple and inexpensive, but yet affective, alarm systems, upon consideration it will be seen that the sensitivity of these devices will be effected by variations in the supply voltage. This is a particularly important factor when the devices are operated by batteries over a long period of time since as the battery voltage diminishes, the biasing in the amplification circuit will change. The reliability of the apparatus thus decreases with time, which is, of course, undesirable.

A more simplified circuit for operating the detector device, which circuit is of improved reliability and maintains a constant sensitivity, despite wide variations in the supply voltage, is shown in FIG. 5. This circuit may be used with a battery or alternatively with a commercial 115-volt, 60-cycle power supply and has a heat sensitive feature, for responding to high temperatures unaccompanied by smoke, as well as a fail-safe mechanism for signalling when the light bulb **20***b* has broken down.

As seen in FIG. 5, no oscillator or multivibrator is used to pulse the light source **20***b*, but rather the source **20***b* is constantly lit, being operated directly by the battery **84** or the alternate 115-volt power supply **101** through a transformer **102**. Diode **150** and resistor **151** protect the battery **84** from the alternating current from transformer **102**. The current to the photoconductive cell **32** is half-wave rectified by a diode **118**, with a protective filter including capacitor **112** and resistor **113**. The light sensitive cell **32** itself is connected in a voltage dividing bridge arrangement along with an insulated-gate field effect transistor **104**. The bridge arrangement includes photoconductive cell **32**, which is connected to the base of the field effect transistor **104** along with bias resistor **106**, and resistors **108** and **110** also connected to field effect transistor **104**. The output terminal or drain of the field effect transistor **104** is connected through resistor **108** to the gate of a controlled rectifier **114** which controls the flow of current through the alarm horn **36**.

The D.C. power, as receiver from the half-wave rectifier circuit, contains an A.C. pulse of a predetermined wave form and voltage which is superimposed on the D.C. supply voltage. By selecting the appropriate resistance-capacity parameters for the rectifier **118**, capacitor **112** and the low resistance load across the bridge, the leading edge in rise and fall time in combination with the wave shape pulse height will produce a pulse height which can be controlled by the resistance of the photoconductive cell **32**. So, when the photoconductive cell **32** receives light, being biased part way up from the dark, high resistance region, it will respond much more quickly to a given change in light versus resistance. This response will add to the superimposed A.C. wave component permitting it to reach a threshold value with respect to the field effect transistor **104**. Thus, both D.C. and A.C. biasing are used on the photoconductive cell **32** to produce

a controlled pulse of sufficient height to trigger the controlled rectifier **114** as follows.

When light falls on the photoconductive cell **32** the increased conduction will reach a threshold value gating on the "normally off" field effect transistor **104**. Conduction of the transistor **104**, in turn, triggers the controlled rectifier **114**. Current is thus caused to flow through the horn **36** resulting in an alarm signal. The current through the horn **36** is half-wave rectified by the controlled rectifier **114**, which is continuously reset by the alternating voltage from the transformer **102**.

It will be seen that, in addition to the improved biasing, by virtue of the inherent automatic gain control properties of the field effect transistor **104** this control circuit is self-balancing for a wide variation of changes in applied voltage, as sometimes occurs with a commercial power supply or battery source, without disturbing its sensitivity. This constant sensitivity improvement is accomplished while reducing the number of circuit components required.

The circuit may also be made sensitive to high temperatures unaccompanied by smoke by the insertion of a heat sensitive switch **116** connected in parallel with the controlled rectifier **114**. The switch **116** may be of the bimetal type and when actuated permits a steady current to flow through the horn **36** providing a signal in contrast with that produced by the rectified current through the controlled rectifier **114**.

The light source **20***b* in this arrangement is steadily lit and may be utilized as an indicator to show that the unit is operating. In the event that the light bulb **20***b* fails, a relay **119** is provided which is thereby energized and closes the switch **120** placing a battery **122** in circuit with the horn **36**. Thus, a steady signal will result until the battery **122** is disconnected or the defective bulb is replaced.

A modified circuit substantially combining the circuits of FIGS. 4 and 5 is shown in FIG. 6 and provides the features and advantages of both. Alternate power sources may again be used comprising: a commercial supply **101** and transformer **102**, and (2) a battery **84**. These alternate power sources are connected in parallel with the diode **150** and resistor **151** in the battery leg which causes the stand-by battery **84** to be charged when the commercial power source **101** is in use.

The multivibrator or square wave oscillator shown in FIG. 4 is used to intermittently operate the light source **20***b*. An additional improvement in this ocillator circuit is the inclusion of a Zener diode **124** connected across the lamp **20***b*. The Zener diode **124** closely regulates the voltage across the lamp **20***b* so that the intensity of illumination will not vary with the supply voltage. Thus, both the lamp operating and the amplification circuits are voltage balanced.

The field effect transistor **104**, controlled rectifier **114**, heat sensitive switch **116** and the bridge resistors **106**, **108**, and **110** are connected in the same manner as shown in FIG. 5 to operate the alarm horn **36**. An additional transistor **126** with a base bias resistor **127** is connected across the horn **36** through a resistor **128**. This transistor **126** is effective to intermittently shunt the horn **36** to cut off the alarm so that in the presence of smoke, the horn **36** operates intermittently at the frequency of the flashing light source **20***b*. An additional shunting leg including the capacitor **130** and resistor **132** is provided as a bypass filter for occasional voltage peaks which may appear on the commercial supply or the stand-by battery **84**.

Another modification of the smoke detector is shown in FIG. 7. In this modification the glow lamp **20***a* and incandescent bulb **20***b* are replaced by a light source **20***c* of the radioactive type, such as a commercially available self-luminous tritium activated light source or the like. Lights of this type are sold under the registered trademark Betalight by Canrad Precision Industries of New York.

The self-luminous light source **20***c* requires no external power supply and may be used, for example, with the circuit shown in FIG. 6 by adding an additional field effect transistor stage of amplication in the gate circuit to the controlled rectifier **114**. The two stages then comprise field effect transistors **104***a* and **104***b* with their associated bias resistors **108***a*, **110***a* and **108***b*, **110***b*. The power requirements of the device are thus reduced by the use of the self-contained light source **20***c* while the reliability is increased.

If it is desired to operate the device solely by battery, the improved photocell biasing may be achieved by including a unijunction oscillator **170** along with filtering capacitor **171** in the circuit in lieu of the commercial power supply **101**. The unijunction oscillator **170** introduces an additional biasing pulse on the supply voltage from battery **84** rendering the photocell **32** and amplifier arrangement more sensitive to impinging light.

The alarm control section of the circuit also includes a variable resistor **138** which may be used to vary the bias on the gate of the field effect transistor **104***a* to adjust the sensitivity of the device. By varying the resistance **138** the user can thus reduce the sensitivity of the device during those occasions when the normal concentration of smoke will increase such as from cigarette cigarette smoking during a meeting or party being held in the room containing the detector.

The modification of the invention shown in FIG. 8 is intended for use with a speaker **146** instead of a horn.

Here, the multivibrator used for controlling the lamp **20***b* is the same as that used in FIG. 6 with the addition of a diode **136** connected between the base and emitter of transistor **86** to act as a voltage limiting device preventing the transistor **86** from receiving a large negative pulse.

The amplification portion of the circuit is modified so that the controlled rectifier **114** operates an oscillator **140** which drives the speaker **146** providing the alarm signal. The oscillator circuit **140** comprises amplifying transistors **141** and **144** in combination with unijunction transistor **142** which determines the timing of the oscillator output. Resistors **141***a*, **141***b*, **141***c*, **142***a*, **142***b*, **144***a* and **144***b*, along with capacitors **143**, **145** and **147** provide the proper biasing for the oscillator **140**. It will be seen that either the speaker **146** or the horn **36** may be replaced by a suitable electronic means which is capable of emitting a high intensity audio signal.

An improved smoke and heat detection device is thus provided which requires a minimum of operating power, which may be made self-balancing for a wide variation of change in applied voltage, and which may be simply modified to provide various types of alarm signals. The unit may be operated from a commercial power source or a battery and is provided with a fail-safe feature and heat sensing means. All of the improved features are accomplished with comparatively simplified and inexpensive circuitry using a minimum of components.

What is claimed is:

1. A device for detecting the presence of suspended light reflective particles in a light transmitting fluid medium comprising:

(a) means defining a chamber having nonreflecting internal surfaces and a passage through said chamber open to the flow of said medium;

(b) means including a light source for directing a beam of light across said chamber;

(c) photosensitive means exposed to the interior of the chamber and out of alignment with said beam so that it is subject to illumination only by light reflected from particles suspended in said beam, said photosensitive means having an electrical characteristic varying as a function of the intensity of the light impinging thereon;

(d) power supply means including a pair of power supply lines;

(e) a first electrical connection between said power supply lines including the photosensitive means and a resistor connected in series; and

(f) an alarm to be actuated when the density of particles in said medium exceeds a predetermined value;

wherein the improvement comprises:

(g) said power supply means, including a direct current power supply and an alternating current supply connected in parallel across said power lines;

(h) a half-wave rectifier connected in series with one of said power lines; and

(i) a filter connected across said power lines on the opposite side of said rectifier from the power supply means, said filter being effective to bypass high frequency currents;

(j) said power supply means being effective to bias said photocell with a unidirectional potential on which an alternating component is superimposed to increase periodically the sensitivity of the device;

(k) a normally off field effect transistor having a gate connected to the common junction of said photosensitive means and said resistor;

(l) second and third electrical connections between the source and drain electrodes of the field effect transistor and the respective power supply lines;

(m) a voltage divider including two resistors connected in series in one of said second and third connections, said photosensitive means being effective when the intensity of the light impinging thereon exceeds a predetermined level to switch said transistor on and thereby to produce a substantial current in said voltage divider;

(n) a normally off controlled rectifier having a gate, an anode and a cathode;

(o) a connection between said gate and a junction in said voltage divider, said connection cooperating with said gate to switch said controlled rectifier on in response to said current flow in the voltage divider; and

(p) an energizing circuit for said alarm responsive to current flow through the anode and cathode of said controlled rectifier.

2. A device for detecting the presence of suspended light reflective particles in a light transmitting fluid medium comprising:

(a) means defining a chamber having nonreflecting internal surfaces and a passage through said chamber open to the flow of said medium;

(b) means including a light source for directing a beam of light across said chamber;

(c) photosensitive means exposed to the interior of the chamber and out of alignment with said beam so that it is subject to illumination only by light reflected from particles suspended in said beam, said photosensitive means having an electrical characteristic varying as a function of the intensity of the light impinging thereon;

(d) power supply means including a pair of power supply lines;

(e) a first electrical connection between said power supply lines including the photosensitive means and a resistor connected in series; and

(f) an alarm to be actuated when the density of particles in said medium exceeds a predetermined value;

wherein the improvement comprises:

(g) a normally off field effect transistor having a gate connected to the common junction of said photosensitive means and said resistor;

(h) second and third electrical connections between the source and drain electrodes of the field effect transistor and the respective power supply lines;

(i) a voltage divider including two resistors connected in series in one of said second and third connections, said photosensitive means being effective when the intensity of the light impinging thereon exceeds a predetermined level to switch said transistor on and thereby to produce a substantial current in said voltage divider;

(j) a normally off controlled rectifier having a gate, an anode and a cathode;

(k) a connection between said gate and a junction in said voltage divider, said connection cooperating with said gate to switch said controlling rectifier on in response to said current flow in the voltage divider;

(l) said light source being a self-luminous radioactive source; and

(m) said connection between the gate of the controlled rectifier and the junction in the voltage divider includes:

(1) a second normally off field effect transistor having a gate connected to the junction in the voltage divider;

(2) a second voltage divider including two resistors connected in series between one of the source and drain electrodes of the second field effect transistor and one of the power supply lines; and

(3) a connection between the gate of the controlled rectifier and the junction between the two resistors in the second voltage divider; and

(n) an energizing circuit for said alarm responsive to current flow through the anode and cathode of the controlled rectifier.

3. A device for detecting the presence of suspended light reflective particles in a light transmitting fluid medium comprising:

(a) means defining a chamber having nonreflecting internal surfaces and a passage through said chamber open to the flow of said medium;

(b) means including a light source for directing a beam of light across said chamber;

(c) photosensitive means exposed to the interior of the chamber and out of alignment with said beam so that it is subject to illumination only by light reflected from particles suspended in said beam, said photosensitive means having an electrical characteristic varying as a function of the intensity of the light impinging thereon;

(d) power supply means including a pair of power supply lines;

(e) a first electrical connection between said power supply lines including the photosensitive means and a resistor connected in series; and

(f) an alarm to be actuated when the density of particles in said medium exceeds a predetermined value;

(g) amplifying means responsive to the output of the photosensitive means and controlling said alarm;

wherein the improvement comprises:

(h) said power supply means, including a direct current power supply and an alternating current supply connected in parallel across said power lines;

(i) a half-wave rectifier connected in series with one of said power lines; and

(j) a filter connected across said power lines on the opposite side of said rectifier from the power supply means, said filter being effective to bypass high frequency currents;

(k) said power supply means being effective to bias said photocell with a unidirectional potential on which an alternating component is superimposed to increase periodically the sensitivity of the device.

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