Oct. 21, 1969 G. S. WHITE ETAL 3,474,435

VAPOR OR PARTICLE DETECTION DEVICES

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FIG. 1.

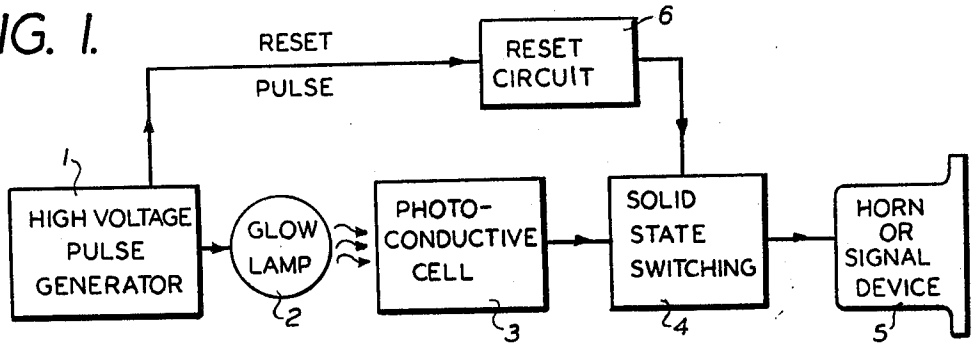


FIG. 2.

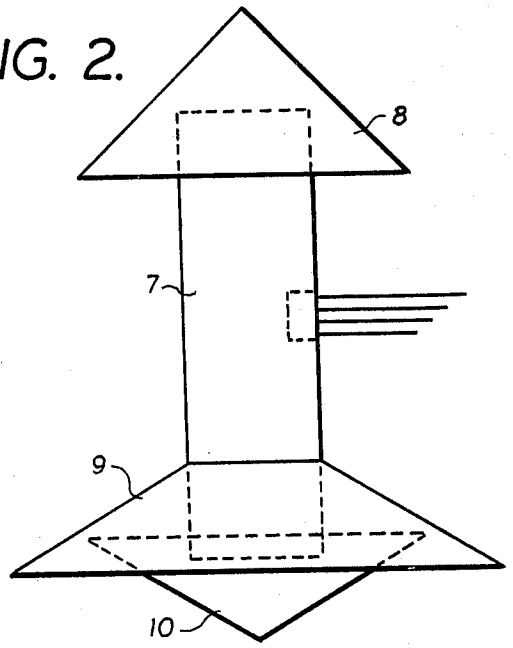


FIG. 3.

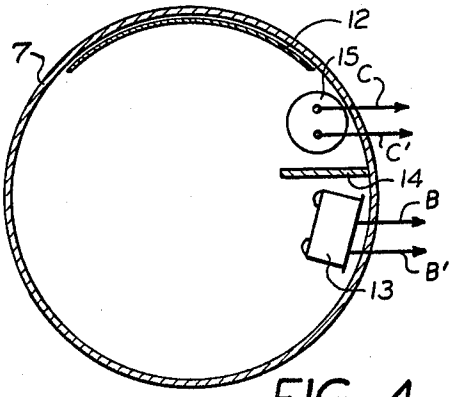


FIG. 4.

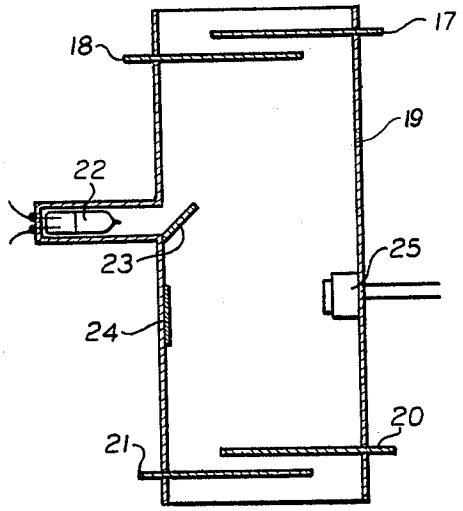
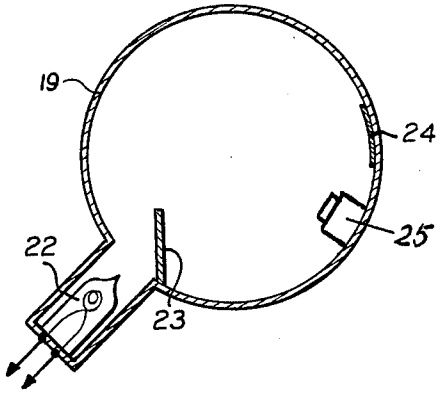


FIG. 5.



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FIG. 6.

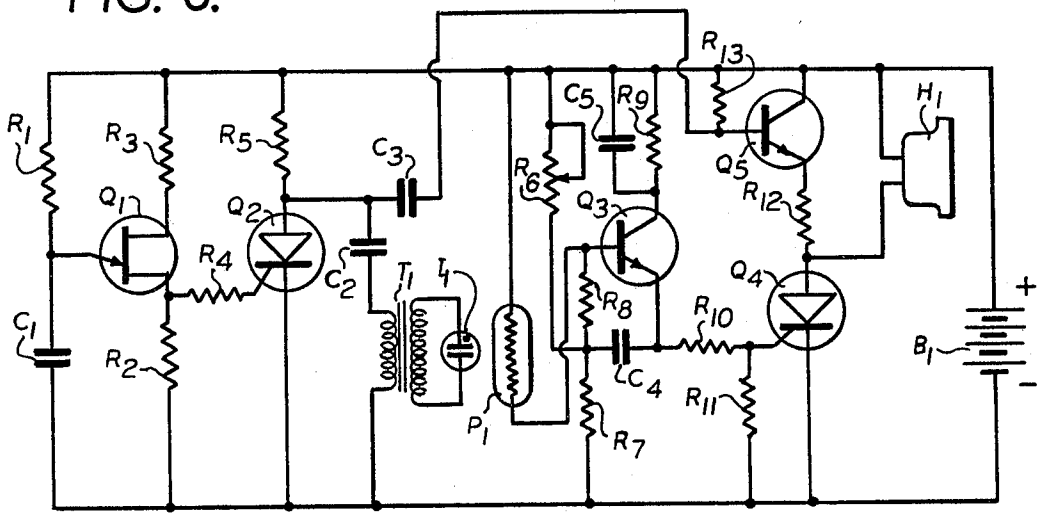
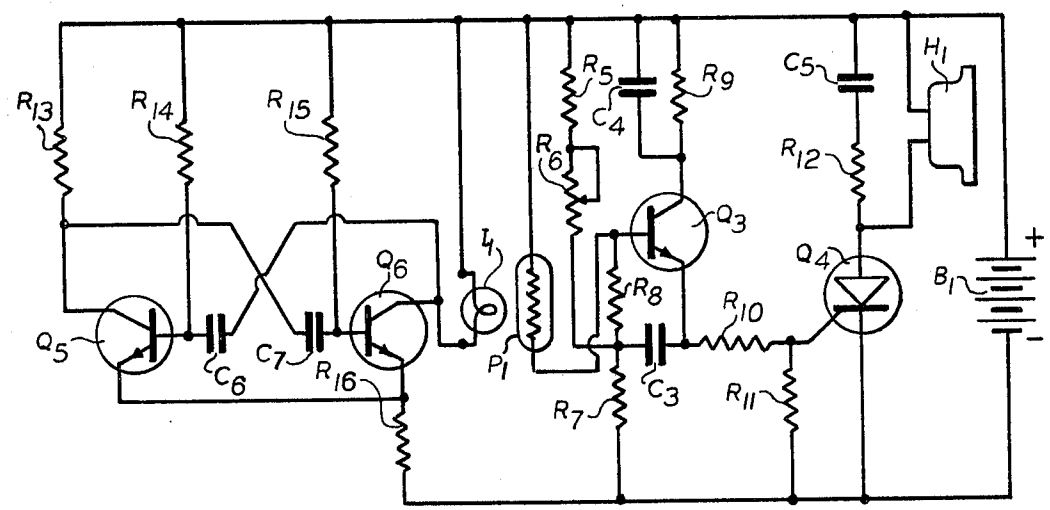


FIG. 7.



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VAPOR OR PARTICLE DETECTION DEVICES

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Int. Cl. G08b 21/00
U.S. Cl. 340—237 8 Claims

ABSTRACT OF THE DISCLOSURE

The invention consists in substance in a vapor detection device in which photoconductive means under control of light are caused to produce current pulses to control an alarm device; these current pulses are analyzed and, upon sensing, sufficient current will operate the alarm; the analyzer provides means to actuate the alarm for a certain period upon receiving a predetermined sequence of pulses, and the actuating means are automatically reset to its original standby condition upon receipt of a reset pulse derived from the actuating means.

This invention relates to vapor or particle detection devices and more specifically to means for detection of dense opaque vapor containing droplets or particles from which visible or invisible light or other radiation will reflect, depending on the reflectivity characteristics of the materal to be detected.

One of the objects of the invention is to detect the presence of a vapor or particle matter in the air in a specific area.

Another object of the invention is to operate the detection device from a small self-contained battery for many months.

Still another object of the invention is to detect a pulse or flash of light or other radiation which has been reflected from vapor or other particle matter prevailing in a specific area.

A further object of the invention is, under control of a vapor or particle detection pulse or pulses to actuate an audible or visual signalling device such as a horn, buzzer, or light for a period of time upon receipt of a pulse, and then automatically reset such actuation to the original standby condition upon receipt of a pulse and then automatically reset such actuation in the original standby condition upon receipt of a reset pulse.

Still further an object of the invention is to provide an adjustable vapor or particle sensor and so bias the conditions of the sensor and associated circuits so as to maintain a predetermined degree of sensitivity.

These and other objects of the invention will be more fully apparent from the drawings annexed herewith, in which:

FIG. 1 shows in a simplified block diagram the basic layout of a system embodying certain objects of the invention.

FIG. 2 shows an electro-mechanical arrangement which may be used for the area of vapor accumulation in which the detection is to be accomplished.

FIG. 3 represents a cross-section view of FIG. 2.

FIGS. 4 and 5 show a modification of FIGS. 2 and 3, respectively.

FIG. 6 shows a diagram of electronic circuitry used to accomplish some of the objects of this invention.

FIG. 7 illustrates a modification of FIG. 6.

According to FIG. 1, pulse generator 1 produces a pulse at a low repetition rate, preferably above visibility range or below 60 c.p.s., for example one pulse per second, of sufficient voltage and current intensity to

cause glow lamp 2 to fire and to properly light for a predetermined period of time dependent on the time constant of the electrical components producing the pulse. When a portion of the light pulse emitted by lamp 2 reaches photoconductive cell 3, it causes a change in the conductivity of 3, thus allowing a current pulse to flow in lamp 3 which is simplified and analyzed by a portion of solid state switching device 4. If device 4 senses sufficient current in the current pulse, device 4 will switch on and supply the proper current to a horn or signalling device 5.

The arrangement depicted in FIG. 2 serves to exclude as much ambient light as practical while maintaining free passage for air, gases or particle matter. Tube 7 and cones 8, 9 and 10 represent an assembly of elements consisting of black paper or of metal painted a dull black so as to minimize the reflection of light. This assembly operates so as to permit air, gas or particle matter to pass between the edge of cone 10 and the inner surface of cone 9, thence around and into the lower end of tube 7, through tube 7 and out past the inside of cone 8.

In FIG. 3 tube 7 represents an enlarged sectional view of tube 7 of FIG. 2 at approximately the center of the length of tube 7. Phosphorescent or luminescent coated paper 12 is located so that the proper amount of light will reach photoconductive cell 13, thereby providing a bias level and preventing cell 13 from going to its minimum conductivity value. Shield 14 prevents the light pulse from passing directly from glow lamp 15 to photoconductive cell 13.

In the modification of FIGS. 4 and 5, the assembly is shown to consist of screens 17 to 21. The glowlamp is arranged in area 22, the screen in area 23, the fluorescent coating in area 24 and the photocell in area 25.

In FIG. 5, part Q1 represents a unijunction transistor as the active element in a unijunction relaxation oscillator circuit. Current pulses are produced in resistor R2 through the action of the following:

Capacitor C1 is slowly charged by current through resistor R1 until the firing voltage of transistor Q1 is reached, at which time capacitor C1 is rapidly discharged through Q1 and R2 producing the current pulse across R2 and a voltage pulse across R1. A portion of this repetitive current pulse, approximately one pulse per second passes through resistor R4 to the cathode gate of silicon controlled rectifier Q2. Transistor Q2 is the switching element in a capacitance discharge circuit which serves to supply the required voltage and current to briefly light the glow lamp L1. During the time capacitor C1 is in the charging cycle, capacitor C2 is receiving a charge by means of current flowing through current limiting resistor R5. Capacitor C2 is charged nearly to the full supply voltage.

During the charging time, silicon controlled rectifier Q2 is in the "off" state. When a pulse appears at the cathode gate of rectifier Q2, Q2 rapidly switches to the "on" state and discharges capacitor C2 through transformer T1. The rapidly changing current which then flows through the low resistance primary winding of transformer T1, induces a magnetic field in the core material of T1 and thus, through mutual induction, a current flows in the secondary coil of transformer T1, rapidly charging the capacitance of glow lamp L1 until the firing voltage of L1 is reached and current passes through L1 exciting lamp L1. The turns ratio of transformer T1 and the inductance of T1 in combination with the value of the capacitance C2 determine the current which flows in lamp L1. When capacitance C2 is fully discharged the inductance of transformer T1 causes a small reverse charge to be built on capacitance C2. This places a reverse voltage on silicon controlled rectifier Q2, rapidly

switching Q2 to the "off" state, and the charge cycle of C2 through R5 is resumed. Resistor R3 supplies bias current to base 2 of transistor Q1.

The device operates as follows:

When a pulse of reflected light shines on photoconductive cell P1, the conductivity of P1 changes in a similarly pulsed manner so that a pulse of current flows to the base of transistor Q3. The bias current of Q3 is supplied through the resistors R6, R7 and R8 at a level which will provide maximum sensitivity for the current pulse arriving from cell P1. Q3 is used as a current amplifier and the emitter current flowing through resistors R10 and R11 to ground develops a voltage pulse at the plate of capacitor C4 which pulses the bias network in such a way as to present a much higher input impedance to pulse currents arriving at the input circuit, than would otherwise be present.

Resistor R9 limits the maximum current through transistor Q3, and capacitor C5 provides for a higher peak pulse current to be transferred at the moment a pulse arrives at the input. When a pulse which has been amplified by transistor Q3 arrives at the cathode gate of silicon controlled rectifier Q4, Q4 switches rapidly to the "on" state, carrying current from the lead of horn H1 which is attached to the anode of Q4, carrying that current to ground. Horn H1 draws current intermittently with approximately 50% duty cycle. A holding current is supplied to transistor Q4 so that Q4 remains in the "on" state during the time when the current drawn by horn H1 drops to zero value. This holding current is supplied by transistor Q5 through current limiting resistor R12 to the anode of transistor Q4. Transistor Q5 is operated in the saturated state with resistor R13 supplying the bias current to the base of Q5 so that it remain saturated and passes the required holding current.

A reset pulse is coupled to the base of transistor Q5 by capacitor C3 from the anode of silicon controlled rectifier Q2. When the capacitance discharge system Q2, C2, T1 pulses, the anode voltage of Q2 changes rapidly to ground potential, and even below, such as minus one volt with respect to ground. Thus, a very sharp negative pulse will arrive at capacitor C3, and similarly a very sharp negative pulse will arrive at the base of transistor Q5, turning off the holding current supplied to silicon controlled rectifier Q4. When the holding current is shut off and at the same time horn H1 is drawing zero current, Q4 switches rapidly to the off state and remains so until another on pulse is supplied to its cathode gate.

The same pulse generating system may be used for lighting lamp L1 and for reset purposes because of a delay which is naturally inherent in response to the conductivity of photoconductive cell P1, thus delaying the occurrence of the on pulse with respect to the reset pulse. With proper values for the components in this circuit, great economy of current consumption is effected so that battery B1 may be of a modest size, yet have the capability of operating the unit for many months.

In an alternative circuitry, the modification in FIG. 7 shows as a pulse generator, a known multivibrator, or a barrier flashing circuit, a directly coupled logic type flip flop circuit which is used to produce an on/off condition for lamp L1 at a pulse rate of about one pulse per second.

Here, too, in a manner similar to that illustrated in the block diagram of FIG. 1, a portion of the light pulse emitted by pulse generator 2 and reaching photoconductive cell 3, causes a pulsation in the conductivity of cell 3, thus producing a current pulse which is amplified and analyzed by a portion of the solid state switching device.

More specifically, according to FIG. 7, the multivibrator includes transistors Q5, Q6, resistors R13 through R16 and condensers C6, C7 to excite lamp L1.

As before, photoconductive cell P1 is used in combination wtih a luminescent coated paper which is so located as to receive the flash of light which will be retained in a given amount by the luminescent paper and will in turn provide a bias means to prevent the photoconductive cell P1 from returning to its minimum resistance value. This biasing system has been found extremely effective, especially in comparison tests made in rooms at day light and total darkness, respectively. When cell P1 is subjected to total darkness, the biasing point changes, and the unit will no longer have the same sensitivity as in day light. The paper, when coated with the proper light absorbing luminescent coating, will prevent the cell from returning to maximum resistance when in total darkness.

We claim:

1. In a vapor detection device, pulse controlled lighting means, electrical pulse generating means for producing pulses of visible pulse repetition rate, of sufficient voltage and current intensity to cause said lighting means to light for a predetermined period of time depending upon the time constant of said pulse generating means, photoconductive means under control of light from said lighting means for producing at least one current pulse, a current controlled alarm device, and means for analyzing said current pulse, upon sensing sufficient current to produce current to operate said alarm device, said analyzing means including means for actuating said alarm device for a predetermined period of time upon receiving a predetermined sequence of pulses from said photoconductive means, and means for automatically resetting said actuating means to its original standby condition upon receipt of a reset pulse derived from said actuating means.

2. Device according to claim 1, wherein said pulse generating means include a multivibrator have a pulse repetition rate of the order of one pulse per second.

3. Device according to claim 1, wherein said pulse generating means include a barrier flashing circuit having a pulse repetition rate of the order of one pulse per second, and wherein said photoconductive means include biasing means so as to maintain a predetermined degree of sensitivity in the form of the arrangement of said lighting means and said photoconductive means in a walled space separated from each other to prevent direct illumination of said photoconductive means by said lighting means and providing free passage for the vapor but excluding ambient light by walls minimizing light reflection.

4. Device according to claim 3, wherein said walls are covered with diffuse reflecting material so located that only a predetermined amount of indirect light from said lighting means reaches said photoconductive means, thereby providing a predetermined bias level for said photoconductive means and preventing said photoconductive means from reaching a minimum conductivity condition.

5. In combination, at least one transistor, capacitive means for applying voltage to said transistor until its firing voltage is reached, means under control of said firing voltage for discharging said capacitive means, thereby producing a predetermined sequence of pulses, a controlled rectifier switchable to two positions, an off-position and an on-position, the latter position being operative under control of said pulse sequence, a glow discharge lamp and means under control of said rectifier when in on-position for controlling said glow discharge lamp to produce light pulses corresponding to said pulse sequence, said control means including an inductance capacitance coupling determining the current through said lamp and causing a reverse voltage to be applied to said rectifier, switching said rectifier to its off-position; a photoconductive cell under control of said light pulses to change its conductivity in a similarly pulsed manner; and an alarm device under control of said cell, and resetting means under con-

trol of said pulse generating means, said resetting means having a delay inherent response to the conductivity of said photoconductive means, thereby delaying the occurrence of the on-pulse on said glow discharge lamp, with respect to the reset pulse derived from said resetting means.

6. Device according to claim 5, comprising a transistor amplifier controlling said cell and having biasing means applied at a level to provide maximum sensitivity for the current pulses derived from said cell; said biasing means being additionally pulsed in such a way as to prevent a substantially higher input impedance to the pulse current from arriving at said transistor amplifier than would otherwise be present, and a second controlled rectifier coupled to the output of said transistor amplifier and switchable to two positions, an off-position and an on-position, and means for applying a holding current to said second rectifier so that it remains in on-position while its output current drops to zero-value.

7. Device according to claim 6, wherein said holding current means includes a further transistor operative in its saturated condition, and means for biasing said further transistor so that it remains saturated when passing said holding current.

8. Device according to claim 6, comprising resetting means including a further transistor under control of a reset pulse derived from said transistor amplifier, the capacitance of said inductance capacitance coupling causing the output of said first controlled rectifier to change rapidly to not more than ground potential, thereby causing a sharp negative pulse to arrive at said further transistor, turning off the holding current supplied to said second rectifier and switching said second rectifier to its off-position.

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