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EXPLOSION DETECTION AND SUPPRESSION

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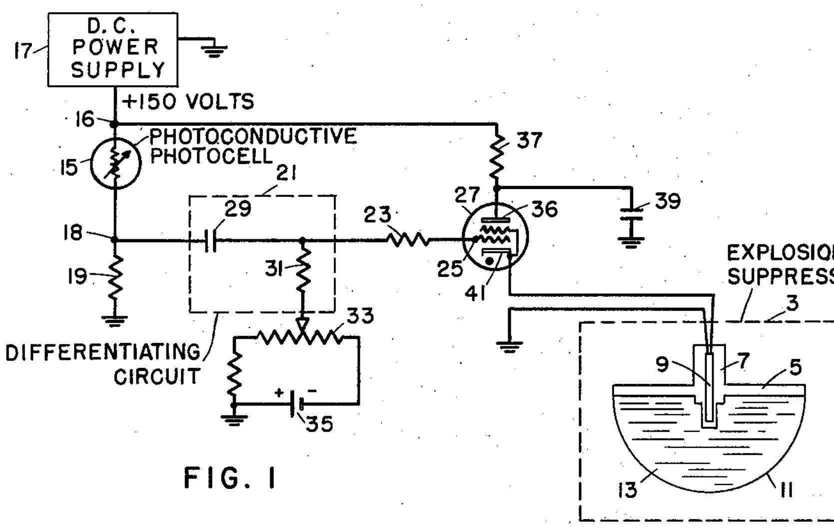

FIG. 1

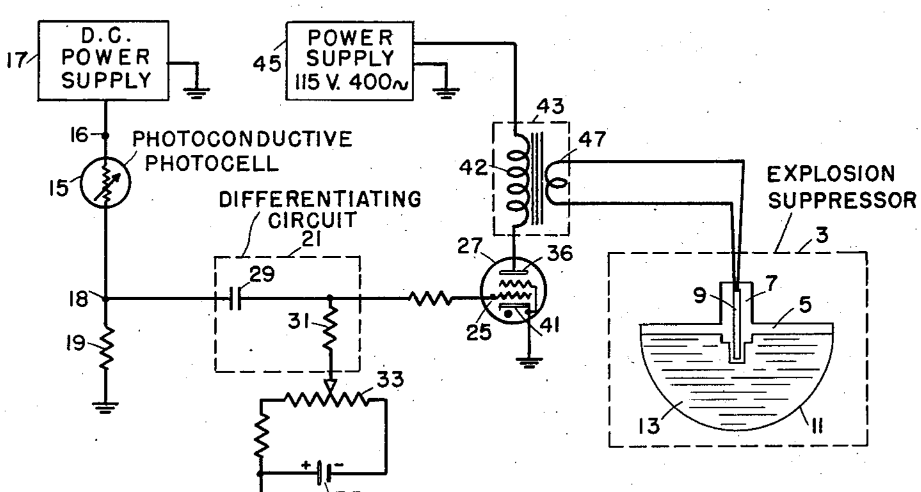

FIG. 2

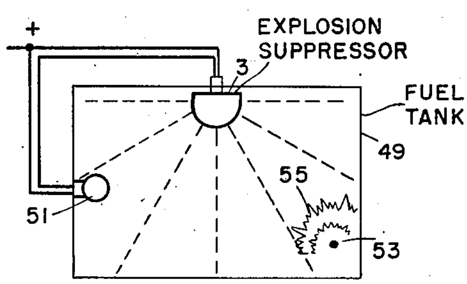

FIG. 3

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EXPLOSION DETECTION AND SUPPRESSION

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This invention relates to apparatus to detect an incipient explosion and to suppress it before it has reached a dangerous energy level. More particularly, it relates to the detection and suppression of explosions occuring in mixtures of air with combustible vapors or gases, sprays, mists, dusts or the like, and with the prevention or extinction of fires resulting from such explosions.

As compared with the explosion of a substance which carries its own oxygen, an explosion of a mixture such as that of air and gasoline has the characteristic that the rate of development of presure is relatively slow; thus, for example, an explosion of a mixture of air and paraffin spray may take 0.5 second to develop maximum pressure.

Thus an explosion of a mixture of a combustible vapor with air begins with a relatively slow build-up of energy, with correspondingly slow rises of pressure, heat and radiation. This rise may be spread over several hundredths of a second before a critical energy level is reached and a dangerous explosive pressure is developed.

An explosion detector and suppressor system has been proposed in which the detector comprises a pressure-responsive diaphragm which detects the rise in pressure occuring in an incipient explosion. This detector is connected in an electric circuit including a contact adapted to be closed by the detector to release an explosion or fire suppressing substance. The detector is made to respond to a small pressure rise when the rate of pressure rise is in excess of 50 lbs. per sq. in. per second, and is capable of closing the contact within .02 second of the initiation of the pressure rise. The suppressor is capable of distributing the explosion or fire suppressing substance within .05 second of the initiation of the pressure rise. The suppressor comprises a frangible container for the explosion or fire suppressing substance. A rapidly-acting detonator, which acts in response to the closing of the detector contact, is arranged to burst the container and thus scatter the explosion or fire suppressing substance which it contains. This system is described in detail in British Patent No. 643,188, published September 15, 1950.

The principal object of this invention is to provide an explosion detector which, together with a suppressor of the kind described above, combines to make an improved explosion detector and suppressor system which is faster acting and more sensitive than prior-art devices.

The explosion detector of this invention is essentially a device which is sensitive to the rise of electromagnetic radiation which occurs in an incipient explosion. This electromagnetic radiation is a flash of light detectable by a photocell, the world light being used here in its wider sense which includes light visible and invisible to the human eye. The most suitable type of photocell for this application is a lead sulfide photoconductive cell such as those shown in U. S. Patents 2,448,516 and 2,636,100. It comprises a photocell, the output of which is connected to an electronic valve through a differentiat-

ing network. This valve is normally nonconductive, and conducts when the photocell detects a rise of radiation of the type found in incipient explosions. Conduction of the valve actuates the explosion suppressor.

Other and incidental objects of the present invention will be apparent to those skilled in the art from a reading of this specification and an inspection of the accompanying drawing, in which: Figure 1 shows an embodiment of the present invention; Figure 2 shows another embodiment of the present invention; and Figure 3 shows schematically a fuel tank equipped with the explosion detector and suppressor of the present invention.

Referring to Figure 1, there is shown an explosion suppressor **3** comprising a relatively stiff backing plate **5** which includes a housing **7** for a detonator **9**. The wall of the housing **7** is reduced in thickness at the working end of the detonator **9**. A frangible cup **11**, made of phenolic-impregnated fabric, is securely attached to the backing plate **5** and forms a sealed cavity **13** in which explosion or fire suppressing fluid is placed. Provisions are made for filling and mounting the suppressor. These construction details, which are not shown in the drawing, are illustrated in British Patent No. 643,188, supra.

The explosion detector comprises a photocell **15** which is shown as being of the photoconductive type. One terminal **16** of the photocell **15** is connected to a D. C. power supply **17**, and the other terminal **18** of photocell **15** is connected to ground through a resistor **19**. The potential at terminal **16** is positive, and its magnitude may be of the order of 150 volts. Terminal **18** is connected through a differentiating circuit **21** and resistor **23** to the control grid **25** of an electronic valve **27** which is shown as an electron tube of the thyratron type. Differentiating circuit **21** comprises a capacitor **29** and a resistor **31**, one terminal of which is connected to the junction of capacitor **29** and resistor **23**, and the other terminal of which is connected to a source of biasing potential. This source of biasing potential is shown as a potentiometer **33** connected between a source of biasing potential **35** and ground. The anode **36** of valve **27** is connected to power supply **17** through resistor **37**, and to ground through capacitor **39**. The cathode **41** of valve **27** is connected to ground through the detonator **9** which includes a low electrical resistance.

The operation of the explosion detector of Figure 1 is as follows: the photocell **15** and resistor **19** form a potential divider connected between terminal **16** and ground. The potential at terminal **18** thus varies with the resistance of photocell **15** and, consequently, with the amount of radiant energy impinging upon photocell **15**. A negative biasing voltage from potential source **35** is applied through resistors **31** and **23** to the control grid **25** of thyratron **27** which is thus normally held in a nonconductive state. Terminal **18** is coupled to the control grid **25** of thyratron **27** through differentiating circuit **21**. The time constant of differentiating circuit **21** should be chosen so that it will pass a positive pulse of sufficient magnitude to overcome the bias on thyratron **27** and fire it only when the rate of change of potential at terminal **18** corresponds to that which would be caused by an incipient explosion. A time constant of 10 milliseconds has been found satisfactory for the detection and suppression of explosions in a mixture of fuel with air. When the bias on thyratron **27** is overcome and it fires, capacitor **39**, which was previously charged through resistor **37**, discharges through thyratron **27** to ground, and this discharge fires detonator **9**. The firing of detonator **9** bursts the cup **11**, and the explosion or fire suppressing fluid which it contains is scattered, thus suppressing the explosion.

The explosion detector of Figure 2 differs from that of Figure 1 in that the anode of thyratron **27** is connected, through the high-voltage winding **42** of a transformer **43**, to an alternating current power supply of the type customarily found in aircraft. The low-voltage winding **47** of transformer **43** is connected to the detonator **9**. The advantage of this embodiment is that it avoids the use of the large electrolytic capacitor **39** of Figure 1. As in Figure 1, thyratron **27** is kept in a nonconductive state until the radiant energy from an incipient explosion impinges upon photocell **15**. Thyratron **27** then conducts, and the current through winding **47** of transformer **43** fires the detonator **9**, thus operating the suppressor **3**.

The photoconductive cell **15** is preferably of the activated lead sulfide type, which has good sensitivity in the infrared portion of the frequency spectrum. The explosion or fire suppressing fluid may be methyl bromide, carbon tetrachloride or any other extinguishant. Water has been used successfully in some tests; it acts mainly by cooling. Gasoline has also been used successfully; it can suppress an explosion by creating too rich a mixture of fuel with air.

Figure 3 illustrates an aircraft fuel tank **49** equipped with an explosion detector shown schematically at **51** and with an explosion suppressor **3**. The source of ignition of an explosion is shown at **53**, and the flame front of the explosion is shown at **55**. The radiant energy from the incipient explosion travels with the speed of light and impinges upon the detector **51**. Detector **51** actuates the suppressor **3** which scatters the explosion or fire suppressing fluid as shown schematically by the broken lines of Figure 3.

We claim:

1. An explosion detector comprising: a radiation-sensitive circuit including a photoelectric cell, an electron tube having an anode, a cathode and a control electrode, biasing means to maintain said electron tube normally nonconductive, a capacitor connected between the anode of said electron tube and a point of reference potential, means adapted to charge said capacitor, means to connect to the cathode of said electron tube explosion suppressor means responsive to the discharge of said capacitor through said electron tube, and means including a differentiating circuit connected between said radiation-sensitive circuit and the control electrode of said electron tube.

2. An explosion detector comprising: a radiation-sensitive circuit including a photoelectric cell, an electron tube having an anode, a cathode and a control electrode, biasing means to maintain said electron tube normally nonconductive, a source of alternating current, a transformer having two windings, means to connect a first winding of said transformer between the anode of said electron tube and said source, means to connect the cathode of said electron tube to a point of reference potential, means to connect to a second winding of said transformer explosion suppressor means responsive to the passage of current through said transformer and through said electron tube, and means including a differentiating circuit connected between said radiation-sensitive circuit and the control electrode of said electron tube.

3. An explosion detector and suppressor system comprising: a radiation-sensitive circuit including a photoconductive cell, an electronic valve having an input and an output, biasing means to maintain said electronic valve normally nonconductive, detonator-actuated explosion suppressor means responsive to conduction through said valve, means to connect said explosion suppressor means to the output of said valve, and means including a differentiating circuit connected between said radiation-sensitive circuit and the input of said valve.

References Cited in the file of this patent

UNITED STATES PATENTS

1,453,091	Delbare	Apr. 24, 1923
1,708,869	Buddecke	Apr. 9, 1929
2,355,664	McMann	Aug. 15, 1944
2,492,148	Herbold	Dec. 27, 1949
2,570,280	Roffman	Oct. 9, 1951
2,668,289	Conrad et al.	Feb. 9, 1954