United States Patent [19]

Trimpi et al.

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[54] COMBUSTION DETECTOR

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[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**

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[52] **U.S. Cl.** .....**250/217 F,** 340/228 S, 340/418

[51] **Int. Cl.** **G08b 17/00**

[58] **Field of Search** .....340/418, 228 S; 250/217 F, 250/83.3 UV; 356/45, 74

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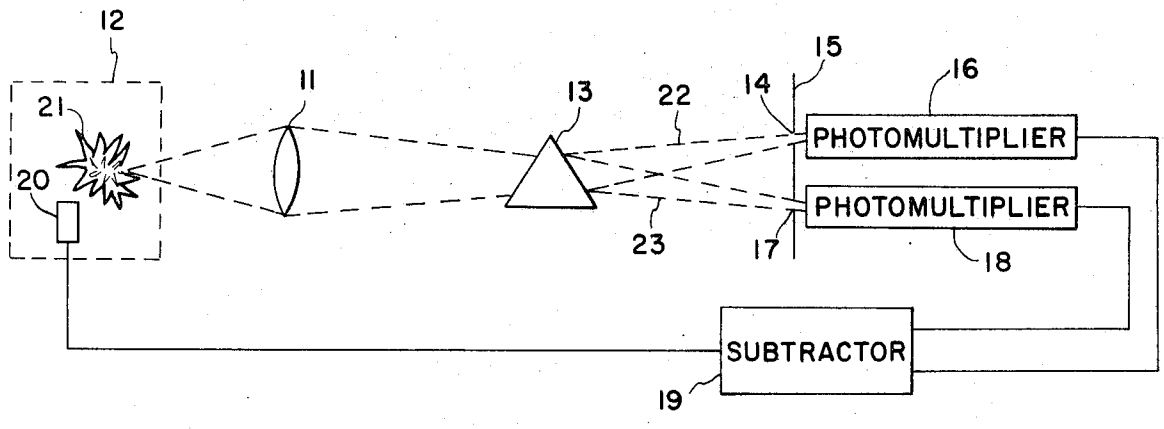
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[57] **ABSTRACT**

A device for generating a rapid response signal upon the radiation-emitting combustion reaction of certain gases (or other materials) in order to provide a means for the detection and identification of such reaction and concurrently discriminate against spurious signals. This combustion might be the first stage of a coal mine explosion process, and thereby this device could provide a warning of the impending explosion in time to initiate quenching action. This device has the capability of distinguishing between the light emitted from a combustion reaction and the light emitted by miners' lamps, electric lamps, welding sparks or other spurious events so that the quenching mechanism is triggered only when an explosion-initiating combustion occurs.

6 Claims, 2 Drawing Figures



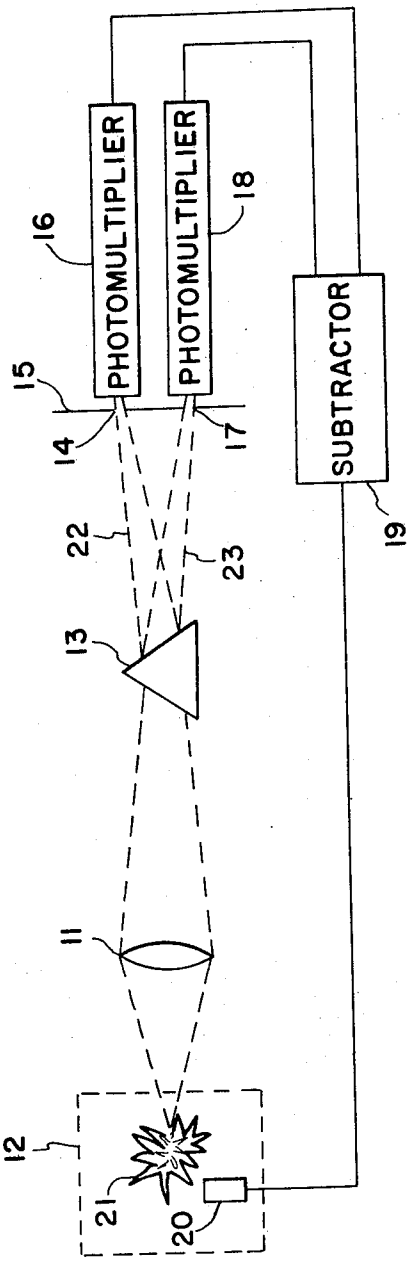


FIG. 1

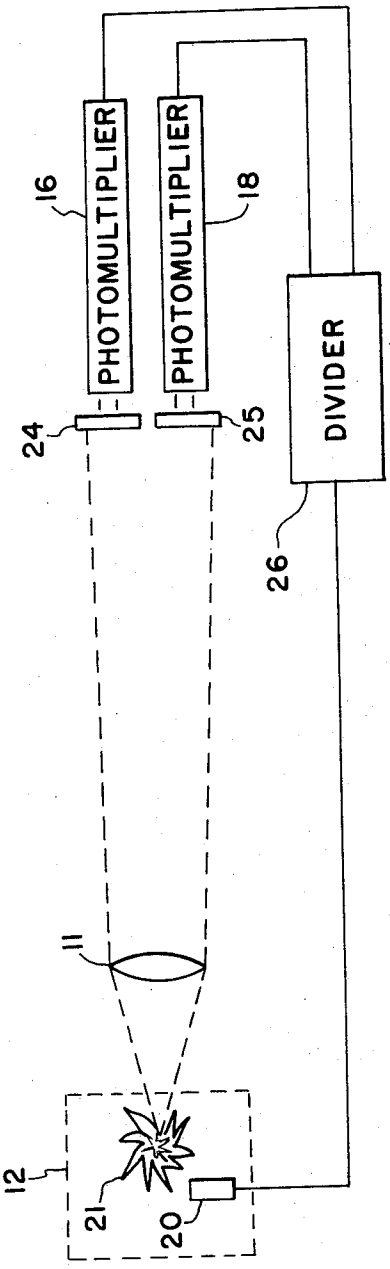


FIG. 2

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COMBUSTION DETECTOR

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the National Aeronautics and Space Administration and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The invention relates generally to a device for generating an electrical signal in response to a flash of light attributable to a combustion process and more specifically concerns a device for generating an electrical signal in response to the light of the combustion preceding an explosion in a coal mine.

One of the safety devices used in coal mines is a device for generating an electrical signal in response to the combustion which precedes an explosion. This signal is used to trigger a quenching mechanism which discharges quenching agents to arrest the combustion and contain the explosion.

In the past, devices for the detection and quenching of coal mine explosions suffered from their inability to discriminate between the light emitted from hydrocarbon combustion and that emitted by electric lights, electrical sparks, miners' cap lamps, etc. Since the quenchant mechanism is activated by an internal explosive charge, the possibility of serious injury to nearby personnel demands a detector which can reject false signals. It is therefore the primary purpose of this invention to provide a device for the detection of the initiating combustion and for the subsequent quenching of coal mine explosions, said device also having the ability to reject false signals. This device could also be applicable to the detection and rejection of, as well as discrimination between, other pairs of light emitting processes upon suitable wave length selection.

SUMMARY OF THE INVENTION

Coal mine explosions are usually the result of combustion of methane-air mixtures which are the first step of the process which terminates in the explosion. Through experimentation it has been proven that during the transient stages of the combustion initiation of methane, a strong emission from a methane flame occurs at 3,064 A, and it was also discovered that a region of relatively low emission simultaneously exists nearby at 3,000A. This same differential in emission does not exist for other sources such as an electric light, an electrical spark and miners' cap lamps. This discovery of the relative emission levels was used to design the device that constitutes this invention.

The component parts of this invention are: an optical system to collect the emitted light from the combustion process; means to spectrally separate this light into two separate wave length regions; detectors to measure the intensity in these two regions; and associated electronic equipment to functionally operate upon the output signals of the detectors to produce a quotient or difference of said signals. The output from the electric equipment is employed to activate a quenchant mechanism.

BRIEF DESCRIPTION THE DRAWINGS

FIG. 1 is a block diagram of one embodiment of the invention; and

FIG. 2 is a block diagram of another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The embodiments of the invention, as it might be applied in a coal mine, are selected for illustration in the drawings. The number 11 in FIG. 1 designates a lens which collects light from a selected area 12 in a coal mine. This collected light is separated by a prism 13 into a first wavelength region around 3,064A and a second wavelength region around 3,000A. Light in the first wave length region passes through an opening 14 of a mask 15 to a photomultiplier 16 which produces a first signal proportional to the amplitude of the intensity of the emitted light in the first wavelength region. Light in the second wave length region passes through an opening 17 in mask 15 to a photomultiplier 18 which produces a second signal proportional to the amplitude of the intensity of the emitted light in the second wavelength region. The second signal is subtracted from the first signal by a subtractor 19. The resulting difference signal is applied to a quenchant mechanism 20 which discharges a quenchant material over area 12 when the amplitude of the difference signal exceeds a predetermined value.

In describing the operation of the embodiment of the invention disclosed in FIG. 1, it will be assumed that there is a source of light emission in region 21 in the selected area 12. It will further be assumed that light emitted in region 21 is not due to a hydrocarbon-air mixture reaction. Then the light from region 21 is collected by lens 11 and applied to prism 13. The resulting light beams 22 and 23 in wavelength regions around 3,064A and 3,000A, respectively, are applied to photomultipliers 16 and 18. Inasmuch as the light emitted in region 21 is not due to a hydrocarbon-air mixture reaction the signal produced at the output of photomultiplier 16 is not significantly greater than that from photomultiplier 18, hence a very small, if any, signal is applied to quenchant mechanism 20. Consequently, quenchant mechanism 20 is not activated.

Now assume a methane-air mixture combustion reaction occurs in region 21. The signal produced at the output of the photomultiplier 16 is appreciably greater than the signal produced at the output of photomultiplier 18. Hence a relatively large signal is applied to quenchant mechanism 20 causing it to discharge quenchant material over area 12.

The embodiment of the invention shown in FIG. 2 is the same as that shown in FIG. 1, except that filters 24 and 25 are used in place or prism 13 and mask 15; and divider 26 is used in place of subtractor 19. Filter 24 passes light in the wave length region around 3,064A and filter 25 passes light in the wave length region around 3,000A.

The advantage of this invention over the prior art is its ability to differentiate between combustion light emission and that emitted by miners' lamps, welding sparks, electric lights, etc. Since the quenchant mechanisms for mines must respond very rapidly and are often a cylinder of quenchant which is explosively

discharged by an internal charge, the activation of these quenchant mechanisms is very violent and can result in injury to nearby personnel. Consequently, the avoidance of "false alarms" is vital, and prior devices have not had this avoidance capability.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred embodiments. Various changes may be made in the shape, size and arrangement of parts. For example, equivalent elements may be substituted for those illustrated and described herein; parts may be reversed and certain features of the invention may be utilized independently of the use of other features, all without departing from the spirit or scope of the invention as defined in the subjoined claims. A mirror could be used instead of the lens **11**. A diffraction grating could be used in place of prism **13**. Subtractor **19** could be replaced with a divider and divider **26** could be replaced with a subtractor. "Light pipes" could be used to transmit the emitted light in both the external regions from the combustion to the detector and also in the internal detector system itself. Solid state photodetectors could be used in place of photomultipliers **16** and **18**. The invention could be used distinguishing any one light source from all other light sources if the one light source has sufficiently different spectral characteristics.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for indicating that a radiation emitting combustion reaction of a predetermined type has occurred in a selected area comprising: optical means for collecting light for all combustions that occur in said selected area; means for spectrally separating said collected light into first and second separate narrow wave length regions with the center of said first wavelength region being at λ and with the center of said second wavelength region being in the range of 0.9 λ to 1.1 λ, said first wavelength region being one of relatively high emission for said predetermined type of combustion reaction and concurrently for all spurious light sources the emission from the first wave length region being approximately equal to or less than the emission in the second wavelength region; means for producing a first signal whose amplitude is proportional to the emission in said first wavelength region and a second signal whose amplitude is proportional to the emission in said second wavelength region; and a subtractor receiving said first and second signals for producing an electrical signal whose amplitude is proportional to the difference in amplitudes of said first and second signals whereby whenever the amplitude of said electrical signal exceeds a predetermined value there is an indication that a combustion reaction of said predetermined type has occurred in said selected area.

2. Apparatus according to claim **1** wherein said predetermined type of combustion reaction is a methane-air mixture type; said selected area is an area in a coal mine; said first wavelength region is a narrow region around 3,064A; and said second wavelength region is a narrow region around 3,000A.

3. Apparatus according to claim **1** wherein a divider is substituted for said subtractor.

4. A method for indicating that a radiation emitting combustion reaction of a predetermined type has occurred in a selected area comprising the steps of: collecting light from all combustions that occur in said selected area; spectrally separating said collected light into first and second separate narrow wavelength regions with the center of said first wavelength region being at λ and with the center of said second wavelength region being in the range of 0.9 λ to 1.1 λ, said first wavelength region being one of relatively high emission for said predetermined type of combustion reaction and said second wavelength region being one of relatively low emission for said predetermined type of combustion reaction and concurrently for all spurious light sources the emission from the first wavelength region being approximately equal to or less than the emission in the second wavelength region; producing a first signal whose amplitude is proportional to the emission in said first wavelength region; producing a second signal whose amplitude is proportional to the emission in said second wavelength region; and producing an electrical signal whose amplitude is proportional to the difference in the amplitudes of said first and second signals whereby whenever the amplitude of said electrical signal exceeds a predetermined value there is an indication that a combustion reaction of said predetermined type has occurred in said selected area.

5. A method according to claim **4** wherein the step of producing an electrical signal whose amplitude is proportional to the ratio of the amplitudes of said first and second signals is substituted for the step of producing an electrical signal whose amplitude is proportional to the difference in the amplitudes of said first and second signals.

6. A method according to claim **4** wherein said predetermined type of combustion reaction is a methane-air mixture type; said selected area is an area in a coal mine; said first wavelength region is a narrow region around 3,064A; and said second wavelength region is a narrow region around 3,000A.

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