

SELF-CALIBRATING RADIATION SENSORS AND CONTROL FOR
RADIATION SENSORS

The present invention relates to radiation sensors and to control circuitry for radiation sensors.

5 There is disclosed in Applicants' earlier filed Israel Patent Applications 54137, 54138 and 54139 fire and explosion suppression apparatus employing the combined outputs of UV and IR detectors. It is known that IR detectors are usually calibrated to a predeter-
10 mined and fixed threshold radiation level for response. This fixed calibration involves difficulties where the radiation background is changing, since the sensor response to a predetermined radiation signal changes as a function of background.

15 It is also appreciated by the Applicants that the presence of spurious background UV radiation can result in false alarms. It is therefore desirable to prevent such false alarms in the sensed continuous presence of UV radiation.

20 The present invention seeks to provide radiation sensing apparatus whose response to a given predetermined signal input is substantially constant in the presence of a changing background. The present invention also seeks to provide radiation sensing apparatus which does
25 not produce a detection output in the presence of a continuous UV radiation input.

In accordance with the present invention there is provided self-calibrating radiation detection apparatus comprising: an infra-red detector element; calibration
30 apparatus for maintaining a generally constant response of the infra-red detector element to a predetermined radiation input notwithstanding changes in the level of background radiation sensed by the detector element, said calibration apparatus having a calibrating filament
35 disposed in predetermined radiation communicating relationship with said detector element and representing,

when energised, a predetermined standard fire; threshold means receiving the output of the infra-red detector and having a variable threshold which is determined by the response of the infra-red detector element to energisation
5 of said calibrating filament; a UV detector element; and means for combining the outputs of said infra-red detector element and said UV detector element.

According to a preferred arrangement the apparatus is provided with means for disabling the
10 combined output of said infra-red detector element and said UV detector element in response to receipt of a continuing radiation input by said UV detector element for a predetermined duration.

Means may be provided for actually terminating
15 calibration of said infra-red detection element upon detection of UV radiation by said UV detector element.

In a preferred construction, the detector element and said calibration apparatus are disposed in a rigid medium which permits radiation communication
20 therebetween. Conveniently, the rigid medium is an epoxy resin.

The following description in which reference is made to the accompanying drawings is given by way of further explanation, and illustration, of the
25 invention.

In the drawings:

Fig. 1 is a schematic representation of an example of an apparatus according to the invention;

Fig. 2 is a detailed schematic illustration
30 of the circuitry of Fig. 1; and

Fig. 3 shows the operation of the circuitry of Figs. 1 and 2.

In the apparatus of Fig. 1, an input stage 10, typically a Lambda 1512 voltage regulator, receives a power input and provides a stabilized 12 Volt output to a step up unit 12, typically comprising a transformer and oscillator, and to an IR input stage 14.

A UV sensor 16, such as an Edison 630, receives a high voltage (500 VDC approx.) from the step up unit 12. Sensor 16 provides output pulses so long as UV radiation is present thereat. Counter 18, such as a 4017, receives the pulse output of sensor 16 and provides an output signal to first and second one-shot circuits 20 and 22 when it receives a predetermined number of output pulses from sensor 16 before counter reset by a timing circuit 38. This number corresponds to a predetermined threshold established for receipt of UV radiation.

One shot circuit 20 remains SET when the output of counter 18 is present thereat and for a time t_1 thereafter. Time t_1 may be, for example, 5 seconds. Thus if counter outputs appear with frequency of at least $\frac{1}{t_1}$, the one shot circuit 20 remains SET and indicates the continuous presence of UV radiation.

The output of one-shot circuitry 20 is supplied to reset to calibration stage circuitry 24, calibration stop circuitry 26 and to enable to AND gate circuitry 28. Circuitry 24 is operative in response to RESET of one shot circuitry 20 to provide an output signal to calibration control circuitry 30 for causing calibration of the IR sensor 32. This calibration thus occurs upon termination of receipt of UV radiation.

Circuitry 26 is operative to provide a signal to calibration control circuitry 30 for terminating calibration of the IR sensor immediately upon return of one shot circuitry 20 to a SET state. Circuitry 28 is operative to disable the output of an AND gate 34 beginning a predetermined time t_3 , typically 60 seconds, following SET of one shot circuitry 20.

The output of one shot circuit 22 is a pulse t_2 typically of duration 100 msec. which is supplied to AND gate 34.

IR sensor 32 is fixedly associated with a calibration element 36 such as a filament representing a standard flame and may be enclosed together therewith in an epoxy enclosure which permits radiation communication therebetween. This combination enables the IR sensor to be calibrated to the standard flame under every operating condition and background so as to provide uniformly accurate results. Operation of the calibration element is controlled by calibration control circuitry 30 which also provides an output to the IR input stage 14. The output of the IR sensor, which may be a P398 R of Hamamatsu, is supplied via the IR input stage 14 to AND gate 34. Calibration controller 30 prevents the output of the IR sensor 32 from reaching AND gate 34 during calibration.

AND gate 34 is operative for providing a detection output to utilization circuitry (not shown) during simultaneous appearance of outputs from input stage 14 and from one shot circuitry 22 indicating simultaneous detection of UV and IR radiation other than in the continuous presence of UV radiation and when not disabled by circuitry 28 which indicates continuous presence of UV from a spurious source.

Referring now to Fig. 2, voltage input stage 10 comprises a pair of diodes D1 and D2 and capacitors C1, C³₂ and C4

interconnected with a Lambda 1512 chip as shown. Step up unit 12 comprises a pair of transistors Q 1 and Q 2 whose bases are interconnected by diodes D3 and D4; capacitors C 5 and C 6 and resistors R 1 and R 2 connected as shown at the input of a transformer 13, across whose output is coupled a capacitor C 7 and a rectifier comprising diodes D 5 and D6 and capacitors C8 and C9 connected as shown via a resistor R 4 and a grounded capacitor C 10 to the UV sensor 16.

The output of the UV sensor is supplied to counter 18 and associated circuitry comprising diodes D7, D8 and D9, resistors R5, R6 and R7, capacitor C11 and a pair of inverters 15 and 17.

The output of counter 18 is supplied to one shot circuit 20 comprising a diode D16, a capacitor C15, a resistor R15 and an inverter 19 whose output is supplied to circuits 24, 26 and 28. Circuit 24 comprises a capacitor C 18, a resistor R 20 a pair of inverters 21 and 41, a resistor R 29, a resistor R 30 and a transistor Q 4 connected as shown. Circuit 26 comprises a resistor R 22 and a transistor Q 5 and circuit 28 comprises a diode D18, a capacitor C19, a resistor R21, an inverter 23 and a diode D20.

A one shot circuit 22 also receives the output of counter 18 and comprises a diode D17, a capacitor C16, a diode D19 and a resistor R16 and provides an output to AND gate circuitry 34. AND gate circuitry 34 comprises a diode D21, a Zener D22 and an LED D23 as well as resistor pairs R 23-R 24 and R 25 - R 26, each defining a voltage divider for respective positive and negative inputs of an operational amplifier 27 at whose output the aforesaid diodes D21 - D 23 are connected.

Calibration control circuitry 30 comprises a timer 29 which receives inputs from circuits 24 and 26 and which provides

an output via a diode D 11 and a variable resistor R 12 to an IR emitter element 36 serving as an IR calibration element which, as mentioned above, is disposed in fixed propinquity and predetermined radiation communication relationship with the IR sensor 32.

Resistors R 9 and R 10 and capacitors C12 and C13 are associated with timer 29 as shown in Fig.2. IR emitter 36 is connected via a grounded resistor R 13 and diode D13 to the junction of resistor R 14 and diode D 14. This junction is also connected via a diode D 12 and a resistor R 11 to the base of transistor Q3.

The output of IR sensor 32 is supplied to IR input stage 14 including a diode D 10 a resistor R 8 and a capacitor C 20 coupled between ground and the positive input of an operational amplifier 33. The output of the operational amplifier 33 is supplied via a resistor R 14 and a diode D 14 to the IR input of AND gate circuitry 34 at the positive input of operational amplifier 27.

The negative input to operational amplifier 33 is connected to a capacitor C 14 which is charged by the follower 35 and Q3 to a reference voltage. The control of transistor Q3 is provided by calibration control circuitry 30. An operational amplifier 37 also charges capacitor C 14 but only when the detector is energized, providing a high reference voltage, in order to prevent a false indication of detection of IR radiation until the voltage is stabilized. Resistors R 17, R18 and R19 and capacitor C17 are associated with amplifier 37 as illustrated.

Reference is now made to Fig. 3 which shows the operation of the circuitry of Fig. 1 and 2. Upon energization of the circuitry, the RI sensor is automatically and immediately calibrated. The calibration is repeated each t_4 (typically 30 seconds). If there is detection by the UV detector, calibration of the IR sensor is terminated. If the IR sensor then detects the presence of IR radiation, a UV and IR detection signal is provided to the AND gate, providing an operating signal.

Whether or not the IR sensor detects, the circuitry inquires whether the UV detection has been continuous over at least 5 seconds. If not, the IR sensor is calibrated once the UV detection terminates. If the UV signal has been continuous over at least five seconds (t_5), the circuitry inquires whether t_3 (60 seconds) have passed since the appearance of the UV detection output. If so, the operation of the detector combination through the AND gate is disabled and remains so until the UV detection signal terminates, whereupon IR calibration takes place once again. If the UV detection signal has not been present for 60 seconds, the detector is not disabled and the detection signal indicating combined UV and IR detection can pass through the AND gate to the utilization circuitry.

It will be appreciated by persons skilled in the art that the invention is not limited to what has been particularly shown and described herein. Rather the scope of the invention is defined only by the claims which follow:

CLAIMS

1. Self-calibrating radiation detection apparatus comprising:

an infra-red detector element;

- 5 calibration apparatus for maintaining a generally constant response of the infra-red detector element to a predetermined radiation input notwithstanding changes in the level of background radiation sensed by the detector element, said calibration
- 10 apparatus having a calibrating filament disposed in predetermined radiation communicating relationship with said detector element and representing, when energised, a predetermined standard fire;

threshold means receiving the output of the

15 infra-red detector and having a variable threshold which is determined by the response of the infra-red detector element to energisation of said calibrating filament;

a UV detector element; and

- means for combining the outputs of said
- 20 infra-red detector element and said UV detector element.

2. Apparatus according to Claim 1 having means for disabling the combined output of said infra-red detector element and said UV detector element in response to receipt of a continuing radiation input

25 by said UV detector element for a predetermined duration.

3. Apparatus according to either of Claims 1 or 2 and having means for terminating calibration of said infra-red detection element upon detection of UV radiation by said UV detector element.

- 30 4. Apparatus according to any one of the preceding claims in which said detector element and said calibration apparatus are disposed in a rigid medium which permits radiation communication therebetween.

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5. Apparatus according to Claim 4 in which said medium is an epoxy resin.
6. Self-calibrating radiation detection apparatus according to Claim 1, substantially as hereinbefore
- 5 described and illustrated by reference to the accompanying drawings.

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