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Published:
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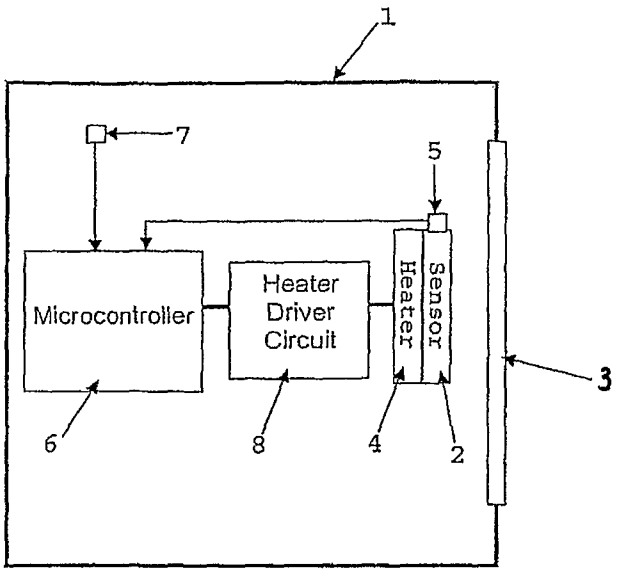
(54) **Title:** A DETECTOR



(57) **Abstract:** A detector comprises a housing (1), a pyroelectric array sensor (2) mounted within the housing, a heater (4) associated with the pyroelectric array sensor, and control means (6) for varying the power supplied to the heater to control the temperature of the pyroelectric array sensor relative to the ambient temperature in order to minimise the rate of change of temperature of the pyroelectric array sensor and to keep a predetermined difference between the temperature of the pyroelectric array sensor and the ambient temperature.

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A Detector

This invention relates to a detector, and in particular to a flame detector provided with a sensor, such as a pyroelectric sensor, for detecting the presence of a flame.

A known flame detector includes either a single pyroelectric sensor or multiple pyroelectric sensors, either of which is sensitive to infrared radiation emitted by a flame source. The signal sensed by such a detector is analysed to determine if a flame has been detected. The pyroelectric sensor within the flame detector is sensitive to ambient temperature changes. A flame detector is typically mounted outdoors, and will experience a wide range of ambient temperatures owing, for example, to changing weather conditions. Thus, as the ambient temperature changes, a pyroelectric sensor will produce an output signal which varies with the change in temperature. Certain changes in ambient temperature can produce such a large signal from a pyroelectric sensor that it is the maximum signal it can output. This is undesirable, as detection of a flame cannot then occur. The pyroelectric sensor is more sensitive to temperature changes at low ambient temperatures; whereas, at higher ambient temperatures, greater temperature changes can be tolerated.

An aim of the invention is to provide a flame detector having one or more pyroelectric sensor(s) not susceptible to changes in ambient temperature. In particular, the invention aims to provide a flame detector having a pyroelectric array sensor and a control system for maintaining the temperature variation of the pyroelectric array sensor within predetermined limits, thereby to minimise the level of unwanted signals which result from ambient temperature changes.

It is generally advantageous that, owing to power distribution requirements in installations, the power consumed by a flame detector is kept to a minimum. Consequently, a further aim of the invention is to provide means for controlling the temperature changes of the pyroelectric sensor, which control means uses minimum power.

The present invention provides a detector comprising a housing, a sensor mounted within the housing, a heater positioned adjacent to the sensor, and control means for

varying the power supplied to the heater to control the temperature of the sensor relative to the ambient temperature in order to minimise the rate of change of the temperature of the sensor.

Advantageously, the arrangement is such that the control means controls the power supplied to the heater in such a manner as to adjust the temperature of the sensor to establish a predetermined difference above ambient temperature at a controlled rate, whilst minimising the power consumption of the detector.

Preferably, the predetermined difference between the temperature of the sensor and the ambient temperature is dependent upon the largest temperature change that the detector has been designed to sustain in its intended operating environment.

In a preferred embodiment, the control means is such as to vary the predetermined temperature difference according to the ambient temperature. Preferably, the control means is such that the predetermined temperature difference reduces to zero when the ambient temperature is sufficiently high that the sensor is able to cope with expected variations in the ambient temperature without power being supplied to the heater. The ambient temperature at which the offset is reduced to zero is determined by the actual sensitivity of that sensor.

Conveniently, the heater is fixed to one surface of the sensor.

In a preferred embodiment, the heater is constituted by at least one thick film resistive element printed onto said surface of the sensor. Alternatively, the thick film resistor is printed on the opposite surface of the sensor.

The control means may be constituted by a microcontroller which controls the supply of power to the heater via a heater drive circuit.

Preferably, the detector further comprises a first temperature sensor for sensing the temperature of the sensor, and a second temperature sensor mounted in the housing remote from the heater for sensing the temperature elsewhere in the detector. The temperature sensed by the second temperature sensor is hereinafter referred to as the

ambient temperature. Importantly, the detector housing integrates external temperature fluctuations, thus reducing ambient temperature changes. The second (ambient) temperature sensor may be positioned so that it is effectively unaffected by the pyroelectric sensor heater. Both temperature sensors provide output signals to the microcontroller.

Advantageously, the microcontroller is programmed with software which permits the microcontroller to track the ambient temperature, to compare the ambient temperature with the temperature of the sensor, and to control the heater drive circuit to supply sufficient power to the heater to control the temperature of the sensor relative to the ambient temperature in order to minimise the rate of change of temperature of the sensor.

In order to accommodate changes in the ambient temperature, the microcontroller may be programmed so as to apply a nominal power level to the heater to maintain the temperature of the sensor at a predetermined offset above the ambient temperature. Under varying ambient temperatures, the microcontroller will then control the applied power to the heater to compensate for changes in the ambient temperature, in such a way as to keep the rate of change of temperature at the sensor within predetermined limits whilst aiming to maintain the temperature of the pyroelectric sensor at the predetermined temperature difference. The maximum rate of change allowed at the pyroelectric sensor is determined by the sensitivity of that sensor. In this connection, it will be appreciated that manufacturing tolerances will result in a given type of pyroelectric sensor having a sensitivity lying within a predetermined, small range. The maximum rate of change is, therefore, determined by the actual sensitivity of the sensor, rather than its rated sensitivity.

Preferably, the microcontroller is programmed so that the predetermined temperature difference is dependent on the largest temperature change that the detector has been designed to sustain in its intended operating environment. Conveniently, the microcontroller varies this temperature difference according to the ambient temperature. A typical range of temperature difference values would be from 20°C to 30°C.

Advantageously, programming the microcontroller in this way minimises the power required by the heater in comparison to the power that would be required to keep the sensor at a fixed temperature.

In a preferred embodiment, the sensor is a flame detector sensor which is positioned within the housing adjacent to a window through which it can detect an external flame. Preferably, said one surface of the sensor faces away from the window, the opposite surface of the sensor constituting means for sensing an external flame.

In a preferred embodiment, the sensor is a pyroelectric array sensor.

The invention will now be described in greater detail, by way of example, with reference to the drawing, the single figure of which is a schematic representation of a flame detector constructed in accordance with the invention.

Referring to the drawing, a flame detector has a housing 1 provided with a pyroelectric array sensor 2 for detecting the presence of a flame external to the detector through a window 3. A heater 4, constituted by thick film resistive elements, is printed on to one surface of the pyroelectric array sensor 2. A temperature sensor 5 is mounted on the pyroelectric array sensor 2, the temperature sensor 5 being linked to a microcontroller 6. A second temperature sensor 7 is also linked to the microcontroller 6. The microcontroller 6 controls the temperature of the heater 4 via a heater drive circuit 8. The temperature sensor 7 monitors the ambient temperature within the flame detector, whilst the temperature sensor 5 monitors the temperature of the pyroelectric array sensor 2.

The microcontroller 6 is programmed with software to implement a temperature control algorithm to maintain the pyroelectric array sensor 2 at a substantially stable temperature relative to ambient, thereby minimising temperature changes of the pyroelectric array sensor and hence minimising any output signal of the pyroelectric array sensor due to temperature changes of that sensor. This minimises the levels of unwanted signals that could be produced by the pyroelectric array sensor 2 due to changes of temperature within the detector housing 1.

The microcontroller 6 monitors the ambient temperature within the flame detector housing 1 using the second temperature sensor 7, the ambient temperature within the flame detector housing 1 changing when the outside temperature changes due, for example, to changing weather conditions. The algorithm provided by the software in the microcontroller 6 tracks the ambient temperature, and how it is changing, and compares this to the temperature of the pyroelectric array sensor 2. The algorithm then calculates how much power to apply to the heater 4 via the heater drive circuit 8 to control the rate of change of temperature applied to the pyroelectric array sensor 2 within a predetermined level and to keep a predetermined offset between the temperature of the pyroelectric array sensor and the ambient temperature. The software controlled microcontroller 6 is arranged to check the heater 4 regularly for correct operation, so that any heater failure that could affect the operation of the pyroelectric array sensor 2 can be reported to an external monitoring system (not shown). For the algorithm to work properly, the sensor 7 must be inside the housing 1, to provide the signal integration temperature which results from the thermal mass/insulation of the housing.

The microcontroller 6 is programmed with software which permits the microcontroller to track the ambient temperature, to compare the ambient temperature with the temperature of the pyroelectric array sensor 2, and to control the heater drive circuit 8 to supply sufficient power to the heater 4 to control the temperature of the pyroelectric array sensor relative to the ambient temperature in order to minimise the rate of change of temperature of that sensor.

In order to accommodate changes in the ambient temperature, the microcontroller 6 is programmed so as to apply a nominal power level to the heater 4 to maintain the temperature of the pyroelectric array sensor 2 at the predetermined offset above the ambient temperature. Under varying ambient temperatures, the microcontroller 6 will then control the applied power to the heater 4 to compensate for changes in the ambient temperature, in such a way as to keep the rate of change of temperature at the pyroelectric array sensor 2 within predetermined limits whilst aiming to maintain the temperature of that sensor at the predetermined offset above the ambient temperature.

The microcontroller 6 is further programmed so that the predetermined offset between the temperature of the pyroelectric array sensor 2 and the ambient temperature is dependent on the largest temperature change that the detector has been designed to sustain in its intended operating environment. A typical ranges of offset values is 20°C to 30°C. The microcontroller 6 varies this offset according to the ambient temperature. The offset will be reduced to zero when the ambient temperature is sufficiently high so that the sensor 2 is deemed able to cope with expected variations in the ambient temperature without power being supplied to the heater 4. The ambient temperature at which the offset is reduced to zero is determined by the actual sensitivity of the sensor 2.

It will be apparent that the detector described above is such that the pyroelectric array sensor 2 is maintained at a substantially stable temperature relative to ambient to enable the detector to operate with optimum performance. In this connection, the heater 4, which consists of thick film resistive elements printed on to the back of the pyroelectric array sensor 2, forms a low cost integrated heater/sensor arrangement. This results in the pyroelectric array sensor 2 being heated directly by the heater 4, and this is preferable to heating the whole enclosure, which would require considerably more power to control the temperature of the sensor. The integrated heater/sensor arrangement is also smaller and cheaper than a sensor and heater arrangement in which the heater has to heat the entire interior of the associated detector housing.

Although it is preferable to construct the heater in this manner, it will be appreciated that other forms of heater and heater control means could be used, though it would be preferable for any non-integral heater to be positioned adjacent to the pyroelectric array sensor 2.

Although the detector described above is designed specifically to detect a flame, it will be appreciated that the invention could be applied to infrared movement detectors or detectors which are used for counting and tracking objects or beings.

Claims:

1. A detector comprising housing, a sensor mounted within the housing, a heater positioned adjacent to the sensor, and control means for varying the power supplied to the heater to control the temperature of the sensor relative to the ambient temperature in order to minimise the rate of change of temperature of the sensor.

2. A detector as claimed in claim 1, wherein the arrangement is such that the control means controls the power supplied to the heater in such a manner as to adjust the temperature of the sensor to establish a predetermined difference above ambient temperature at a controlled rate, whilst minimising the power consumption of the detector.

3. A detector as claimed in claimed 2, wherein the predetermined temperature difference is dependent upon the largest temperature change that the detector has been designed to sustain in its intended operating environment.

4. A detector as claimed in claim 2 or claim 3, wherein the control means is such as to vary the predetermined temperature difference according to the ambient temperature.

5. A detector as claimed in claim 4, wherein the control means is such that the predetermined temperature difference reduces to zero when the ambient temperature is sufficiently high that the sensor is able to cope with expected variations in the ambient temperature without power being supplied to the heater.

6. A detector as claimed in any one of claims 1 to 5, wherein the heater is fixed to one surface of the sensor.

7. A detector as claimed in claim 6, wherein the heater is constituted by at least one thick film resistive element printed onto said surface of the sensor.

8. A controller as claimed in any one of claims 1 to 7, wherein the control means is constituted by a microcontroller which controls the supply of power to the heater via a heater drive circuit.

9. A detector as claimed in claim 8, further comprising a first temperature sensing element for sensing the temperature of the sensor, and a second temperature sensing element mounted in the housing remote from the heater for sensing the ambient temperature, both temperature sensing elements providing output signals to the microcontroller.

10. A detector as claimed in claim 9, wherein the first temperature sensing element is integrated within the sensor.

11. A detector as claimed in claim 8 or claim 9, wherein the microcontroller is programmed with software which permits the microcontroller to track the ambient temperature, to compare the ambient temperature with the temperature of the sensor, and to control the heater drive circuit to supply sufficient power to the heater to control the temperature of the sensor relative to the ambient temperature in order to minimise the rate of change of temperature of the sensor.

12. A detector as claimed in any one of claims 8 to 10, wherein the microcontroller is programmed so as to apply a nominal power level to the heater to maintain the temperature of the sensor at the predetermined temperature difference.

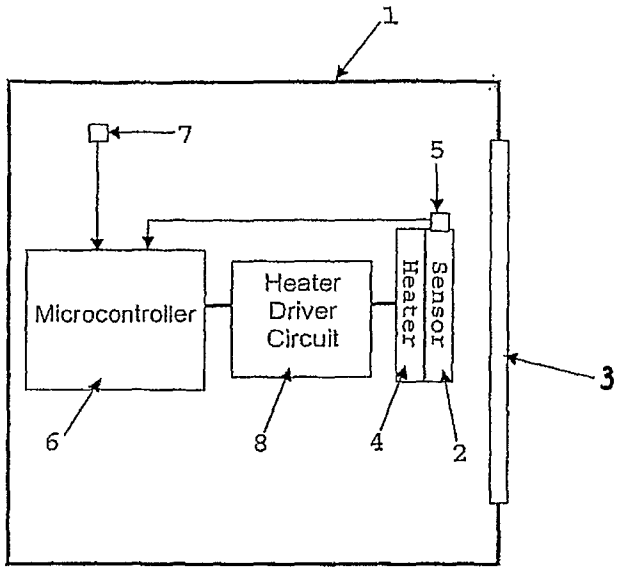
13. A detector as claimed in any one of claims 8 to 12, wherein the microcontroller is programmed so as to minimise the power required by the heater in comparison to the power that would be required to keep the sensor at a fixed temperature.

14. A detector as claimed in any one of claims 1 to 13, wherein the sensor is a flame detector sensor which is positioned within the housing adjacent to a window through which the sensor can detect an external flame.

15. A detector as claimed in claim 14 when appendant to claim 6, wherein said one surface of the sensor faces away from the window, the opposite surface of the sensor constituting means for sensing an external flame.

16. A detector as claimed in any one of claims 1 to 15, wherein the sensor is a pyroelectric array sensor.

17. A flame detector substantially as hereinbefore described with reference to, and as illustrated by, the drawing.


1
7
5
Microcontroller
Heater Driver Circuit
Heater
Sensor
3
6
8
4
2

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004444

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01J5/00 G01J5/34 G01J5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/266943 A1 (PHELAN ROBERT J JR [US] PHELAN JR ROBERT JOSEPH [US]) 30 November 2006 (2006-11-30) abstract; figure 8 paragraphs [0021], [0034], [0035], [0038], [0051]	1-16
X	US 5 860 741 A (TSAO SIMON [TW] ET AL) 19 January 1999 (1999-01-19) abstract; figures 2A,5A,5B,6A column 2, lines 4-15 column 6, line 61 - column 7, line 16 column 8, lines 24-29 column 8, line 45 - column 9, line 1 column 9, lines 16-36	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2008	20/02/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Varelas, Dimitrios

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2007/004444

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 17
because they relate to subject matter not required to be searched by this Authority, namely:

see FURTHER INFORMATION sheet PCT/ISA/210

2. [X] Claims Nos.: 17
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.1

Claims Nos.: 17

Claim 17 contains references to the description and the drawings. According to Rule 6.2(a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here. The search has been carried out for those parts of the application which appear to be clear within the meaning of Article 6 PCT, namely claims 1-16.

Continuation of Box II.2

Claims Nos.: 17

Claim 17 contains references to the description and the drawings. According to Rule 6.2(a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here. The search has been carried out for those parts of the application which appear to be clear within the meaning of Article 6 PCT, namely claims 1-16.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2)PCT declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2007/004444

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006266943 A1	30-11-2006	NONE	
US 5860741 A	19-01-1999	EP 0798546 A1	01-10-1997